Faculty of Disability Management and Special Education (FDMSE)

Ramakrishna Mission Vivekananda Educational and Research Institute (RKMVERI) Coimbatore Campus

Programme Outcomes
B.Ed Special Education

Programme: B.Ed. Special Education

PO1.Teaching knowledge: Apply the knowledge of teaching skills such as explanation and illustratory skills, demonstration, stimulus variation, use of various teaching aids and devices, and classroom management in special, integrated and inclusive educational settings.

PO2. Problem Solving: Identify and assess the students with special needs and provide appropriate and timely intervention for them using the principles of Universal Design for Learning.

PO3. Design/development of solutions: Design solutions to address the unique individual challenges of diverse learners by preparing adapted and modified teaching learning materials and equipments which in turn will them to increase their functional capabilities.

PO4. Conduct projects on emerging issues: Carry out investigations to solve emerging issues prevail among the stake holders such as children with special needs, their parents, teachers and professionals working in the field of special education and disability management.

PO5. Assistive technology usage: Select, assess and apply appropriate assistive technological devices and services considering the individual limitations.

PO6. The teacher and society: Apply reasoning informed by the contextual knowledge to assess personal, social, emotional, academic, functional, health and hygiene, safety and security, ethical, and cultural issues and shoulder the responsibilities relevant to teaching profession.

PO7. Environment and sustainability: Understand the impact of the solution evolved from teaching profession in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the teaching profession.

PO9. Individual and collaborative work: Work effectively as an individual, and as a member or leader in diverse teams including para-professional, and other service providers in interdisciplinary, trans-disciplinary and multidisciplinary settings.

PO10. Communication: Communicate effectively to comprehend and prepare effective administrative and academic reports and documentation, make effective presentations and appropriate interaction for further reference.

PO11. Life-long learning: Recognise the need for, and have the preparation and ability to engage in life-long learning for self and children with special needs through online and National Institute of Open School (NIOS).

Programme Specific Outcomes
B.Ed – Special Education
(Visual Impairment)

Programme Specific Outcome

Programme: B.Ed. Special Education (Visual Impairment)

B.Ed. Special Education (Visual Impairment) is a two year programme in the area of visual impairment. The course work prepares the student trainees to understand the nature and basic concepts of core subjects like human growth and development, educational psychology, educational planning and management and educational evaluation. It develops skills to identify and assess the needs of individuals with visual impairment. It helps them to plan and adapt curriculum, teaching strategies and materials for individuals with visual impairment. They will be able to learn and apply the expanded core curricular skills such as compensatory academic skills (Braille, use of mathematical devices such as Abacus, Taylor frame etc…), Orientation and Mobility, Sensory Training and Daily Living Skills in training individuals with visual impairment. The programme offers hands on experience to understand and learn about applications of assistive technological devices and softwares pertaining to individuals with visual impairment.

Course Outcomes
B.Ed – Special Education
(Visual Impairment)

Course Outcomes

Programme: B.Ed. Special Education (Visual Impairment)

Title of the Course	No.	Course Outcomes
Human Growth and Development 1BA1	CO1	Explain the process of development during infancy
	CO2	Explain the process of development during childhood
	CO3	Explain the process of development during adolescence
	CO4	Analyze the developmental variations among children.
	CO5	Describe adolescence as a period of transition and threshold of adulthood
	CO6	Enumerate different factors affecting child development.
Contemporary India and Education 1BA2	CO1	Explain the history, nature and process of education
	CO2	Explain the philosophies and their contributions to education
	CO3	Describe the role of education in the modern context
	CO4	Explain the concept of diversity
	CO5	Enumerate the trends seen in contemporary Indian Education
	CO6	Enumerate the issues and challenges faced by contemporary Indian Education in global context
Learning, Teaching and Assessment 2BA3	CO1	Explain theories of learning and intelligence
	CO2	Enumerate the applications of theories of learning and intelligence for teaching children
	CO3	Describe the learning process
	CO4	Describe the nature and theory of motivation
	CO5	Explain stages of teaching and learning
	CO6	Describe the role of the teacher
	CO7	Narrate experiences of the teaching learning process
	CO8	Explain the scope and role of assessment in teaching learning process to introduce dynamic assessment scheme for educational set up towards enhanced learning
Pedagogy of School Subjects – Paper I 2BA4 Methodology of Teaching Tamil A4 (A)	CO1	Realize the rationale of learning Tamil language
	CO2	Explain the various methods of learning Tamil
	CO3	Illustrate the techniques in teaching prose, poem, grammar and essay
	CO4	Exemplify the fundamental skills of language
	CO5	Comprehend the principles of curriculum development
Methodology of Teaching English A4 (B)	CO1	Explain the role of English language and mother tongue
	CO2	Acquire skills and methods of teaching prose and poetry
	CO3	Demonstrate the skills and methods of teaching vocabulary and composition
	CO4	Comprehend the method of teaching the four-fold language skills
	CO5	Distinguish various approaches and techniques of teaching English

Methodology of Teaching Mathematics A4 (C)	CO1	Describe the history of mathematics and its value in day to day applications
	CO2	Apply different methods and techniques in teaching mathematics effectively
	CO3	Understand and identify influence of various psychological factors in learning
	CO4	Make out the individual differences in learning mathematics and to plan activities according to the needs of the students
	CO5	Organize learning resources and apply them appropriately in everyday teaching
Methodology of Teaching Physical Science A4 (D)	CO1	Understand the need and importance of teaching physical science in higher secondary level
	CO2	Able to prepare a lesson plan and presenting them effectively in the classroom
	CO3	Identify and apply various teaching methods for teaching of physical science
	CO4	Develop theoretical and practical understanding of the hardware and software relating to the technology of teaching.
	CO5	Apply the evaluation techniques in the classroom
Methodology of Teaching Biological Science A4 (E)	CO1	Understand the aims, objectives and challenges in teaching biology
	CO2	Obtain various skills needed for class room instruction
	CO3	Identify and prepare various aids for teaching biology
	CO4	Explain the techniques in preparing special aids for teaching biology
	CO5	Acquire the knowledge on the content of biology syllabus for IX standard
Methodology of Teaching Social Science A4 (F)	CO1	Identify the need of teaching social science in school curriculum
	CO2	Apply various instructional strategies in teaching social science
	CO3	Express the need and types of teaching aids in social science
	CO4	Develop skills in writing objectives, preparing lesson plan, unit plan and the need for developing micro teaching skills.
	CO5	Comprehend the essential qualities and functions of a teacher
Methodology of Teaching Computer Science A4 (G)	CO1	Understand the Bloom's taxonomy of educational objectives
	CO2	List out the objectives of teaching of computer science in schools
	CO3	Apply the micro teaching skills during classroom instruction & Point out the qualities of good computer science text book
	CO4	Comprehend the principles of curriculum development
	CO5	Develop skills in constructing test and evaluation

Methodology of Teaching Commerce A4 (H)	CO1	Obtain awareness on nature and scope of commerce and accountancy
	CO2	Understand the aims, objectives and values of teaching commerce and accountancy
	CO3	Plan and prepare lessons and teaching aids for teaching commerce
	CO4	Understand various methods and techniques of teaching commerce and its application to children with learning difficulties
	CO5	Develop skills in preparation and use of appropriate instructional aids
Methodology of Hindi A4 (I)	CO1	Explain Role of Hindi language and mother tongue
	CO2	Acquire skills and methods of teaching prose and poetry
	CO3	Acquire skills and methods of teaching vocabulary and composition
	CO4	Understand method of teaching the four-fold language skills
	CO5	Understand about various approaches and techniques of teaching Hindi
PedagogyofSchoolSubjects – Paper II 3BA5 Methodology of Teaching Tamil A5 (A)	CO1	Understand the origin and development of Tamil Language
	CO2	Identify the importance of language in curriculum and principles of poem
	CO3	Comprehend the structure of sound in Tamil language
	CO4	Explain the literary appreciation
	CO5	Distinguish the importance and special features of Tamil Language
Methodology of Teaching English A5 (B)	CO1	Employ various methods for teaching English language
	CO2	Clarify the nature of classroom climate and teachers' behaviour
	CO3	Identify the principles of selecting teaching aids and uses of audio visual aids
	CO4	Apply various technologies for teaching English language
	CO5	Explain various strategies, techniques of testing and evaluation in English language
Methodology of Teaching Mathematics A5(C)	CO1	Elaborate the concept, need, principles and types of curriculum construction
	CO2	Describe the stages of developingmathematics curriculum
	CO3	Construct Mathematics curriculum and make out the suggestions for its improvement
	CO4	Use various models of teaching in mathematics
	CO5	Apply and evaluate different techniques including IT in mathematics.

Methodology of Teaching Physical Science A5 (D)	CO1	Know the principles of curriculum construction and science curricular projects.
	CO2	Chalk out the problems of organising and maintaining physics and chemistry laboratories.
	CO3	Classify the individual differences and provide remedial teaching.
	CO4	Develop skills in planning for science clubs and exhibition.
	CO5	Approach the problems with scientific perspective
Methodology of Teaching Biological Science A5 (E)	CO1	Construct curriculum for various levels in school
	CO2	Obtain various skills needed for class room instruction
	CO3	Identify and prepare various aids for teaching biology
	CO4	Explain the techniques in preparing special aids for teaching biology
	CO5	Acquire the knowledge on the content of biology syllabus for IX standard
Methodology of Teaching Social Science A5 (F)	CO1	Understand the need of teaching social science in school curriculum
	CO2	Describe the structure of organizing the Social science content
	CO3	Express the need of resources and equipments in Social science subject
	CO4	Identify the issues in teaching and learning process
	CO5	Comprehend the evaluation procedure in Social science
Methodology of Teaching Computer Science A5(G)	CO1	Understand the software techniques involved in teaching learning process
	CO2	Acquire the knowledge on latest trends in information technology
	CO3	Explain the need and importance of computer laboratory in school
	CO4	Point out the qualities need for computer science teacher
	CO5	Use computer assisted instruction for teaching exceptional children

Methodology of Teaching Commerce A5 (H)	CO1	Obtain awareness on nature and scope of commerce and accountancy
	CO2	Understand the aims, objectives and values of teaching commerce and accountancy
	CO3	Plan and prepare lessons and teaching aids for teaching commerce
	CO4	Understand various methods and techniques of teaching commerce and its application to children with learning difficulties
	CO5	Develop skills in preparation and use of appropriate instructional aids in teaching commerce
Methodology of Teaching Hindi A5 (I)	CO1	Acquire knowledge about the role, status, objectives and problems of teaching Hindi as a second language in India
	CO2	Understand the nature and resources of language and issues related to language acquisition, variation and change
	CO3	Enrich the knowledge of Hindi vocabulary, structures, grammar and usage and to develop the ability to teach them
	CO4	Know, compare and analyse various methods and approaches of teaching Hindi as a second language
	CO5	Improvise and use appropriate aids for teaching Hindi
	CO6	Use various techniques for the evaluation of learner's achievement in Hindi
	CO7	Identify and analyze errors and plan and execute remedial instruction
	CO8	Use various techniques for the evaluation of learner's achievement in Hindi
Introduction to Sensory Disabilities 1BB1	CO1	Name the different types of sensory impairments and its prevalence and describe the process of hearing & implications of various types of hearing loss.
	CO2	Explain the issues & ways to address challenges in educating students with hearing loss.
	CO3	Describe nature, characteristics & assessment of students with low vision & visual impairment.
	CO4	Suggest educational placement and curricular strategies for students with low vision& visual impairment.
	CO5	Explicate the impact of deaf-blindness & practices for functional development
Introduction to Neuro Developmental Disabilities 1BB2	CO1	Discuss the characteristics and types of learning disability.
	CO2	Describe the tools, areas of assessment and apply intervention strategies to enhance learning.
	CO3	Explain the characteristics and types of Intellectual disability.
	CO4	Describe the tools, areas of assessment and prepare and apply intervention strategies for independent living.
	CO5	Explain the characteristics and types of Autism

	CO6	Describe the tools, areas of assessment and apply intervention strategies.
Introduction to Locomotor and Multiple Disabilities 1BB3	CO1	Identify the persons with Locomotor disabilities such as Cerebral Palsy, Amputees, Polio, Leprosy cured, Muscular dystrophies, Neural and spinal defects and Multiple disabilities.
	CO2	Plan an effective programme for creating awareness about the persons with
	CO3	Locomotor disabilities and Multiple disabilities.
	CO4	Plan an effective therapeutic and programme for the persons with Locomotor disabilities and Multiple disabilities and to refer for medical intervention if necessary.
	CO5	Plan an effective educational programme and functional activities for the persons with Locomotor disabilities and Multiple disabilities.
Early Childhood Care And Education 3BB4(A)	CO1	Explain the biological & sociological foundations of early childhood education.
	CO2	Describe the developmental systems approach and role responsibilities of interdisciplinary teams for early education of children with disabilities.
	CO3	Enumerate the inclusive early education pedagogical practices.
Application of ICT in Classroom 3BB4(B)	CO1	Gauge the varying dimensions in respect of ICT and Applications in Special Education.
	CO2	Delineate the special roles of ICT Applications.
	CO3	Acquire Familiarity with Different Modes of Computer-Based Learning.
Orientation and Mobility 3BB5 (A)	CO1	Describe the nature and scope of O&M as also the O&M related responsibilities of the special teacher.
	CO2	Acquire basic knowledge of human guide techniques.
	CO3	Describe pre-cane and cane travel skills and devices.
	CO4	Get acquainted with the importance and skills of training in independent living for the visually impaired.
Communication Options: Manual (Indian Sign Language) 3BB5 (B)	CO1	Discuss the two manual options with reference to Indian special schools.
	CO2	Discuss the relevant issues like literacy, inclusion and training with reference to manual options.
	CO3	Describe manual options in the light of issues like language, culture and identify.
	CO4	Exhibit beginner level hands on skills in using manual options.
	CO5	Motivate self to learn and practice more skills leading to linguistic adequacy and fluency.
VocationalRehabilitation & Transition to Job Placement	CO1	Develop an understanding of vocational education & its relevance for PWD's.
	CO2	Carry out vocational assessment and make vocational

3BB5 (C)		training plan.
	CO3	Plan for transition from School to job.
	CO4	Identify various avenues for job placement.
	CO5	Facilitate PWD's in making choice of vocational trades.
Inclusive Education 4BB6	CO1	Explain Inclusion and the progression from segregation to inclusion
	CO2	Appreciate diversity in an inclusive class
	CO3	Describe key nation and international policies and frameworks facilitating inclusive education
	CO4	Enumerate skills in adapting instructional strategies for teaching in mainstream classrooms
	CO5	Describe inclusive pedagogical practices and its relation to good teaching
	CO6	Describe strategies for collaborative working and stakeholder support in implementing inclusive education
	CO7	Explain the role of society in general for successful inclusion
Assessment and Identification of Needs of Individuals with Visual Impairment 1BC1	CO1	Assess and identify the needs of individuals with visual impairment
	CO2	Identify children who are at risk for visual impairment.
	CO3	Describe the structure of eye and common eye defects.
	CO4	Explain the etiology of visual impairment.
	CO5	Analyse the implications of visual impairment and identify their needs.
	CO6	Develop skills to identify and assess children with visual impairment.
	CO7	Develop skills to do functional vision assessment and enhance the residual vision.
	CO8	Describe the needs and develop skills to assess children with visual impairment and multiple disabilities (VIMD).
CurriculumDesigning, AdaptationandEvaluation for Individuals with Visual Impairment 2BC2	CO1	Design, adapt and evaluate the curriculum for individuals with visual impairment
	CO2	Understand of the concept of curriculum approaches to curriculum development
	CO3	Define curriculum, its types and explain its importance.
	CO4	Demonstrate techniques of teaching functional academic skills.
	CO5	Explain importance and components of independent living skills.
	CO6	Explain curricular adaptations with reasonable accommodations.
	CO7	Illustrate how physical education and creative arts activities can be adapted for the children with visual impairment.

Application of Assistive Technology for Individuals with Visual Impairment 3BC3	CO1	Get acquainted with various devices for making effective teaching- learning process.
	CO2	Relate the concept and nature of educational technology and ICT to the education of children with visual impairment.
	CO3	Acquire knowledge of the concept and nature of adaptive technology and explain underlying principles and techniques.
	CO4	Get familiar with technologies for print-access for children with visual impairment.
	CO5	Describe and use different technologies for teaching low vision children as also various school subjects.
	CO6	Demonstrate understanding of computer-based teaching-learning processes.
Interventionand Teaching Strategies for Individuals with Visual Impairment 4BC4	CO1	Identify the challenges of curriculum transaction, at par with their sighted peers.
	CO2	Explain various theoretical perspectives related to intervention & teaching strategies.
	CO3	Demonstrate techniques of teaching Mathematics to visually impaired children.
	CO4	Acquire necessary competencies and skills for teaching science and assessment of the learners with special reference to children with visual impairment.
	CO5	Acquire and apply necessary skills for adapting TLM in social science and assessment of the learners with special reference to children with visual impairment.
	CO6	Describe the process of assessment visual efficiency and classroom management for children with low vision.
PsychoSocial and Family Issues of Individuals with Visual Impairment 4BC5	CO1	Describe the effect of birth of a child with visual impairment on the family.
	CO2	Analyze the role of family and parental concerns related to their child with visual impairment from birth to adulthood.
	CO3	Explain the role of parent community partnership in the rehabilitation of a person with visual impairment.
	CO4	Develop different skills to empower families in meeting the challenges of having a child with visual impairment.
Fundamental Concepts in Educational Research & Statistics 2BD1	CO1	Describe the concept and relevance of research in education and special education.
	CO2	Develop an understanding of the research process and acquire competencies for conducting a research.
	CO3	Apply suitable measures for data organization and analysis.

Reading and Reflecting on Texts (EPC) 4BD2	CO1	Reflect on student's own current level of literacy
	CO2	Undertake practice in basic reading skills to become active readers
	CO3	Undertake practice in basic writing skills to become independent writers
	CO4	Describe strategies to facilitate development of good reading skills among students
	CO5	Describe strategies to facilitate development of good writing skills among students
	CO6	Chooses to read books or write stories or poems as leisure time activity
Drama and Art in Education (EPC) 4BD3	CO1	Explain art appreciation, art expression and art education
	CO2	Describe strategies for facilitating learning of various arts for students with and without disabilities
	CO3	Describe adaptive strategies of artistic expression
	CO4	Explain how art can enhance learning

Programme Specific Outcomes
B.Ed – Special Education
(Hearing Impairment)

Programme specific outcomes
B.Ed of Special Education (Hearing Impairment)
B.Ed.Spl.Ed (HI)

PSO1.
Understand the nature and basic concepts of core subjects like human growth and development, educational psychology, educational planning and management and educational evaluation and plan, apply, manage and evaluate the techniques.

PSO2.
Understand the different types of disabilities and educational setup such as special, integrated and inclusive educational settings as well as in home based programmes. Will be able to work in early intervention centers, all types of schools such as Special, Integrated, Inclusive in the pre-primary and primary levels and home based programmes too.

PSO3.
Develop skills to identify and assess the needs of individuals with Hearing Impairment.

PSO4.
Develop individualized educational plan/programme, lesson plans and behavior modification strategies for children with Hearing Impairment by assessing case history, case studies proforma.

PSO5.
Plan and adapt curriculum, teaching strategies and material development to teach children with Hearing Impairment.

PSO6.
Understand the applications of various methods and techniques pertaining to children with Hearing Impairment.

PSO7.
Prepare and use of various teaching aids and uses various assistive devices in classroom management in special, integrated and inclusive educational settings.

PSO8.
Able to carry out projects to solve the current issues in the class room, home environment and in the community.

PSO9.
Communicate effectively in the three communication options for hearing impaired.

PSO10.
Follows ethical principles and commit to professional ethics and responsibilities and norms of the teaching profession.

Course Outcomes
B.Ed – Special Education
(Hearing Impairment)

Course Outcomes
B.Ed of Special Education (Hearing Impairment)
B.Ed.Spl.Ed (HI)

After the completion of the course, the student trainees will be able to:

Title of the Course	No.	Course Outcomes
Human Growth and Development 1BA1	CO1	Explain the process of development during infancy
	CO2	Explain the process of development during childhood
	CO3	Explain the process of development during adolescence
	CO4	Analyze the developmental variations among children.
	CO5	Describe adolescence as a period of transition and threshold of adulthood
	CO6	Enumerate different factors affecting child development.
Contemporary India and Education 1BA2	CO1	Explain the history, nature and process of education
	CO2	Explain the philosophies and their contributions to education
	CO3	Describe the role of education in the modern context
	CO4	Explain the concept of diversity
	CO5	Enumerate the trends seen in contemporary Indian Education
	CO6	Enumerate the issues and challenges faced by contemporary Indian Education in global context
Learning, Teaching and Assessment 2BA3	CO1	Explain theories of learning and intelligence
	CO2	Enumerate the applications of theories of learning and intelligence for teaching children
	CO3	Describe the learning process
	CO4	Describe the nature and theory of motivation
	CO5	Explain stages of teaching and learning
	CO6	Describe the role of the teacher
	CO7	Narrate experiences of the teaching learning process

	CO8	Explain the scope and role of assessment in teaching learning process to introduce dynamic assessment scheme for educational set up towards enhanced learning
Pedagogy of School Subjects – Paper I 2BA4 Methodology of Teaching Tamil A4 (A)	CO1	Realize the rationale of learning Tamil language
	CO2	Explain the various methods of learning Tamil
	CO3	Illustrate the techniques in teaching prose, poem, grammar and essay
	CO4	Exemplify the fundamental skills of language
	CO5	Comprehend the principles of curriculum development
Methodology of Teaching English A4 (B)	CO1	Explain the role of English language and mother tongue
	CO2	Acquire skills and methods of teaching prose and poetry
	CO3	Demonstrate the skills and methods of teaching vocabulary and composition
	CO4	Comprehend the method of teaching the four-fold language skills
	CO5	Distinguish various approaches and techniques of teaching English
Methodology of Teaching Mathematics A4 (C)	CO1	Describe the history of mathematics and its value in day to day applications
	CO2	Apply different methods and techniques in teaching mathematics effectively
	CO3	Understand and identify influence of various psychological factors in learning
	CO4	Make out the individual differences in learning mathematics and to plan activities according to the needs of the students
	CO5	Organize learning resources and apply them appropriately in everyday teaching
Methodology of Teaching Physical Science A4 (D)	CO1	Understand the need and importance of teaching physical science in higher secondary level
	CO2	Able to prepare a lesson plan and presenting them effectively in the classroom
	CO3	Identify and apply various teaching methods for teaching of physical science
	CO4	Develop theoretical and practical understanding of the hardware and software relating to the technology of teaching.

	CO5	Apply the evaluation techniques in the classroom
Methodology of Teaching Biological Science A4 (E)	CO1	Understand the aims, objectives and challenges in teaching biology
	CO2	Obtain various skills needed for class room instruction
	CO3	Identify and prepare various aids for teaching biology
	CO4	Explain the techniques in preparing special aids for teaching biology
	CO5	Acquire the knowledge on the content of biology syllabus for IX standard
Methodology of Teaching Social Science A4 (F)	CO1	Identify the need of teaching social science in school curriculum
	CO2	Apply various instructional strategies in teaching social science
	CO3	Express the need and types of teaching aids in social science
	CO4	Develop skills in writing objectives, preparing lesson plan, unit plan and the need for developing micro teaching skills.
	CO5	Comprehend the essential qualities and functions of a teacher
Methodology of Teaching Computer Science A4 (G)	CO1	Understand the Bloom's taxonomy of educational objectives
	CO2	List out the objectives of teaching of computer science in schools
	CO3	Apply the micro teaching skills during classroom instruction & Point out the qualities of good computer science text book
	CO4	Comprehend the principles of curriculum development
	CO5	Develop skills in constructing test and evaluation
Methodology of Teaching Commerce A4 (H)	CO1	Obtain awareness on nature and scope of commerce and accountancy
	CO2	Understand the aims, objectives and values of teaching commerce and accountancy
	CO3	Plan and prepare lessons and teaching aids for teaching commerce
	CO4	Understand various methods and techniques of teaching commerce and its application to children with learning difficulties
	CO5	Develop skills in preparation and use of appropriate instructional aids

Methodology of Hindi A4 (I)	CO1	Explain Role of Hindi language and mother tongue
	CO2	Acquire skills and methods of teaching prose and poetry
	CO3	Acquire skills and methods of teaching vocabulary and composition
	CO4	Understand method of teaching the four-fold language skills
	CO5	Understand about various approaches and techniques of teaching Hindi
Methodology of Teaching Children with Learning Problems in an Inclusive Setting A4 (J)	CO1	Develop skills to screen, assess and understand the children with learning difficulties
	CO2	Organize the resource room
	CO3	Assess and plan remedial teaching in English
	CO4	Assess and plan remedial teaching in Indian language
	CO5	Assess and plan remedial teaching in mathematics
Pedagogy of School Subjects – Paper II 3BA5 Methodology of Teaching Tamil A5 (A)	CO1	Understand the origin and development of Tamil Language
	CO2	Identify the importance of language in curriculum and principles of poem
	CO3	Comprehend the structure of sound in Tamil language
	CO4	Explain the literary appreciation
	CO5	Distinguish the importance and special features of Tamil Language
Methodology of Teaching English A5 (B)	CO1	Employ various methods for teaching English language
	CO2	Clarify the nature of classroom climate and teachers' behaviour
	CO3	Identify the principles of selecting teaching aids and uses of audio visual aids
	CO4	Apply various technologies for teaching English language
	CO5	Explain various strategies, techniques of testing and evaluation in English language
Methodology of Teaching Mathematics A5(C)	CO1	Elaborate the concept, need, principles and types of curriculum construction
	CO2	Describe the stages of developing mathematics curriculum
	CO3	Construct Mathematics curriculum and make out the suggestions for its improvement

	CO4	Use various models of teaching in mathematics
	CO5	Apply and evaluate different techniques including IT in mathematics.
Methodology of Teaching Physical Science A5 (D)	CO1	Know the principles of curriculum construction and science curricular projects.
	CO2	Chalk out the problems of organising and maintaining physics and chemistry laboratories.
	CO3	Classify the individual differences and provide remedial teaching.
	CO4	Develop skills in planning for science clubs and exhibition.
	CO5	Approach the problems with scientific perspective
Methodology of Teaching Biological Science A5 (E)	CO1	Construct curriculum for various levels in school
	CO2	Obtain various skills needed for class room instruction
	CO3	Identify and prepare various aids for teaching biology
	CO4	Explain the techniques in preparing special aids for teaching biology
	CO5	Acquire the knowledge on the content of biology syllabus for IX standard
Methodology of Teaching Social Science A5 (F)	CO1	Understand the need of teaching social science in school curriculum
	CO2	Describe the structure of organizing the Social science content
	CO3	Express the need of resources and equipments in Social science subject
	CO4	Identify the issues in teaching and learning process
	CO5	Comprehend the evaluation procedure in Social science
Methodology of Teaching Computer Science A5(G)	CO1	Understand the software techniques involved in teaching learning process
	CO2	Acquire the knowledge on latest trends in information technology
	CO3	Explain the need and importance of computer laboratory in school
	CO4	Point out the qualities need for computer science teacher
	CO5	Use computer assisted instruction for teaching exceptional children
Methodology of Teaching Commerce A5 (H)	CO1	Obtain awareness on nature and scope of commerce and accountancy
	CO2	Understand the aims, objectives and values of teaching commerce and accountancy
	CO3	Plan and prepare lessons and teaching aids for teaching commerce

	CO4	Understand various methods and techniques of teaching commerce and its application to children with learning difficulties
	CO5	Develop skills in preparation and use of appropriate instructional aids in teaching commerce
Methodology of Teaching Hindi A5 (I)	CO1	Acquire knowledge about the role, status, objectives and problems of teaching Hindi as a second language in India
	CO2	Understand the nature and resources of language and issues related to language acquisition, variation and change
	CO3	Enrich the knowledge of Hindi vocabulary, structures, grammar and usage and to develop the ability to teach them
	CO4	Know, compare and analyse various methods and approaches of teaching Hindi as a second language
	CO5	Improvise and use appropriate aids for teaching Hindi
	CO6	Use various techniques for the evaluation of learner's achievement in Hindi
	CO7	Identify and analyze errors and plan and execute remedial instruction
	CO8	Use various techniques for the evaluation of learner's achievement in Hindi
Methodology of Transition of Persons with Mental Retardation from School to Work A5 A5 (J)	CO1	Define the term transition and explain various stages of Individualized Vocational Transition Plan
	CO2	Identify generic/work readiness skills and conduct job survey and prepare job analysis for persons with mental retardation
	CO3	Explain approaches to vocational assessment, select tools and conduct vocational Assessment
	CO4	Describe various types of employment and related activities to train and place the persons with mental retardation.
	CO5	Introduce the adult related needs such as sex education, self advocacy and recreation
Introduction to Sensory Disabilities	CO1	Name the different types of sensory impairments and its prevalence and describe the process of hearing & implications of various types of hearing loss.

1BB1	CO2	Explain the issues & ways to address challenges in educating students with hearing loss.
	CO3	Describe nature, characteristics & assessment of students with low vision & visual impairment.
	CO4	Suggest educational placement and curricular strategies for students with low vision& visual impairment.
	CO5	Explicate the impact of deaf-blindness & practices for functional development
Introduction to Neuro Developmental Disabilities 1BB2	CO1	Discuss the characteristics and types of learning disability.
	CO2	Describe the tools, areas of assessment and apply intervention strategies to enhance learning.
	CO3	Explain the characteristics and types of Intellectual disability.
	CO4	Describe the tools, areas of assessment and prepare and apply intervention strategies for independent living.
	CO5	Explain the characteristics and types of Autism Spectrum Disorder.
	CO6	Describe the tools, areas of assessment and apply intervention strategies.
Introduction to Locomotor and Multiple Disabilities 1BB3	CO1	Identify the persons with Locomotor disabilities such as Cerebral Palsy, Amputees, Polio, Leprosy cured, Muscular dystrophies, Neural and spinal defects and Multiple disabilities.
	CO2	Plan an effective programme for creating awareness about the persons with
	CO3	Locomotor disabilities and Multiple disabilities.
	CO4	Plan an effective therapeutic and programme for the persons with Locomotor disabilities and Multiple disabilities and to refer for medical intervention if necessary.
	CO5	Plan an effective educational programme and functional activities for the persons with Locomotor disabilities and Multiple disabilities.

Early Childhood Care And Education 3BB4(A)	CO1	Explain the biological & sociological foundations of early childhood education.
	CO2	Describe the developmental systems approach and role responsibilities of interdisciplinary teams for early education of children with disabilities.
	CO3	Enumerate the inclusive early education pedagogical practices.
Application of ICT in Classroom 3BB4(B)	CO1	Gauge the varying dimensions in respect of ICT and Applications in Special Education.
	CO2	Delineate the special roles of ICT Applications.
	CO3	Acquire Familiarity with Different Modes of Computer-Based Learning.
Orientation and Mobility 3BB5 (A)	CO1	Describe the nature and scope of O&M as also the O&M related responsibilities of the special teacher.
	CO2	Acquire basic knowledge of human guide techniques.
	CO3	Describe pre-cane and cane travel skills and devices.
	CO4	Get acquainted with the importance and skills of training in independent living for the visually impaired.
Communication Options: Manual (Indian Sign Language) 3BB5 (B)	CO1	Discuss the two manual options with reference to Indian special schools.
	CO2	Discuss the relevant issues like literacy, inclusion and training with reference to manual options.
	CO3	Describe manual options in the light of issues like language, culture and identify.
	CO4	Exhibit beginner level hands on skills in using manual options.
	CO5	Motivate self to learn and practice more skills leading to linguistic adequacy and fluency.
Vocational Rehabilitation & Transition to Job Placement	CO1	Develop an understanding of vocational education & its relevance for PWD's.
	CO2	Carry out vocational assessment and make vocational training plan.

3BB5 (C)	CO3	Plan for transition from School to job.
	CO4	Identify various avenues for job placement.
	CO5	Facilitate PWD's in making choice of vocational trades.
Inclusive Education 4BB6	CO1	Explain Inclusion and the progression from segregation to inclusion
	CO2	Appreciate diversity in an inclusive class
	CO3	Describe key nation and international policies and frameworks facilitating inclusive education
	CO4	Enumerate skills in adapting instructional strategies for teaching in mainstream classrooms
	CO5	Describe inclusive pedagogical practices and its relation to good teaching
	CO6	Describe strategies for collaborative working and stakeholder support in implementing inclusive education
	CO7	Explain the role of society in general for successful inclusion
Assessment and Identification of Needs of Individuals with Hearing Impairment 1BC1	CO1	Explain the need and techniques for early identification of hearing loss in children.
	CO2	Acquire knowledge in the area of Audiological assessment and its relevance in education.
	CO3	To discuss communicative and language related needs with the understanding of its development and assessment.
	CO4	Understand the need for assessment of various processes involved in production of speech.
	CO5	Describe and identify different components of educational assessment and analyze various educational needs of individuals with hearing impairment.
Curriculum Designing, Adaptation and Evaluation for	CO1	Familiar with concept of curriculum and explain the importance of designing it for children with hearing impairment in the context of 21st Century learning skills.
	CO2	Develop capacity of developing literacy skills of reading

Individuals with Hearing Impairment 2BC2		and writing in children with hearing impairment.
	CO3	Describe the need for curricular adaptation and decide suitable adaptation and undertake it.
	CO4	Appreciate the need for curricular evaluation and describe the tools and methods for evaluating it.
Application of Assistive Technology for Individuals with Hearing Impairment 3BC3	CO1	Enumerate various listening devices and describe ways of effective usage and maintenance.
	CO2	Create awareness and basic exposure to state-of-the-art technology for management of various aspects of speech.
	CO3	Narrate the range of technological applications that can be used for facilitating communication and language.
	CO4	Explain the present and future technologies facilitating the education of children with hearing impairment.
	CO5	Identify different resources (financial & human) to obtain technology.
Intervention and Teaching Strategies for Individuals with Hearing Impairment 4BC4	CO1	To understand about programmes for early intervention of infants and children with Hearing Impairment.
	CO2	Describe the need, stages and importance of auditory listening & Speech reading for facilitating development of spoken language of children with hearing impairment.
	CO3	Explain various approaches to teaching, strategies for speech intervention.
	CO4	Describe methods, techniques and options to facilitate language and communication.
	CO5	Explain the concept, principles and practices, linkages and outcomes of educational intervention.
Psycho Social and Family Issues of Individuals with Hearing Impairment 4BC5	CO1	Explain psycho social development of early childhood and role of family.
	CO2	To understand the family needs and find self-ready to support families for empowering the child with disability.
	CO3	Ensure family involvement in educational programs.

Fundamental Concepts in Educational Research & Statistics 2BD1	CO1	Describe the concept and relevance of research in education and special education.
	CO2	Develop an understanding of the research process and acquire competencies for conducting a research.
	CO3	Apply suitable measures for data organization and analysis.
Reading and Reflecting on Texts (EPC) 4BD2	CO1	Reflect on student's own current level of literacy
	CO2	Undertake practice in basic reading skills to become active readers
	CO3	Undertake practice in basic writing skills to become independent writers
	CO4	Describe strategies to facilitate development of good reading skills among students
	CO5	Describe strategies to facilitate development of good writing skills among students
	CO6	Chooses to read books or write stories or poems as leisure time activity
Drama and Art in Education (EPC) 4BD3	CO1	Explain art appreciation, art expression and art education
	CO2	Describe strategies for facilitating learning of various arts for students with and without disabilities
	CO3	Describe adaptive strategies of artistic expression
	CO4	Explain how art can enhance learning

Programme Specific Outcomes
B.Ed – Special Education
(Mental Retardation)

Programme Specific Outcomes
Programme: Bachelors in Special Education (Mental Retardation)
B.Ed Special Education (MR)

PSO1

Understand the nature and basic concepts of core subjects like Developments in Special Education, Research Methodology and Statistics, Psychology of Development and Learning, Curriculum Design & Development, Inclusive Education, Perspectives in Teacher Education and Educational Evaluation.

PSO2

Build theoretical knowledge and skills in research methodologies and conducting research in order to enhance inclusive education for children with disabilities.

PSO3

Apply leadership skills in advocating and meeting educational needs of children with disabilities in various settings.

PSO4

Develop specialized capacity for leadership in curriculum, pedagogy and universal design.

PSO5

Understand the curriculum and teaching strategies for individuals with mental retardation.

PSO6

Apply advanced technology for individuals with mental retardation.

Course Outcomes

B.Ed – Special Education (Mental Retardation)

Course Outcomes

Programme: Bachelors in Special Education (Mental Retardation)

B.Ed Special Education (MR)

After the completion of the course, the student trainees will be able to:

Title of the Course	No.	Course Outcomes
Human Growth and Development 1BA1	CO1	Explain the process of development during infancy
	CO2	Explain the process of development during childhood
	CO3	Explain the process of development during adolescence
	CO4	Analyze the developmental variations among children.
	CO5	Describe adolescence as a period of transition and threshold of adulthood
	CO6	Enumerate different factors affecting child development.
Contemporary India and Education 1BA2	CO1	Explain the history, nature and process of education
	CO2	Explain the philosophies and their contributions to education
	CO3	Describe the role of education in the modern context
	CO4	Explain the concept of diversity
	CO5	Enumerate the trends seen in contemporary Indian Education
	CO6	Enumerate the issues and challenges faced by contemporary Indian Education in global context
Learning, Teaching and Assessment 2BA3	CO1	Explain theories of learning and intelligence
	CO2	Enumerate the applications of theories of learning and intelligence for teaching children
	CO3	Describe the learning process
	CO4	Describe the nature and theory of motivation
	CO5	Explain stages of teaching and learning
	CO6	Describe the role of the teacher
	CO7	Narrate experiences of the teaching learning process
	CO8	Explain the scope and role of assessment in teaching learning process to introduce dynamic assessment scheme for educational set up towards enhanced learning
Pedagogy of School Subjects – Paper I 2BA4 Methodology of Teaching Tamil A4 (A)	CO1	Realize the rationale of learning Tamil language
	CO2	Explain the various methods of learning Tamil
	CO3	Illustrate the techniques in teaching prose, poem, grammar and essay
	CO4	Exemplify the fundamental skills of language
	CO5	Comprehend the principles of curriculum development
Methodology of Teaching English A4 (B)	CO1	Explain the role of English language and mother tongue
	CO2	Acquire skills and methods of teaching prose and poetry

	CO3	Demonstrate the skills and methods of teaching vocabulary and composition
	CO4	Comprehend the method of teaching the four-fold language skills
	CO5	Distinguish various approaches and techniques of teaching English
Methodology of Teaching Mathematics A4 (C)	CO1	Describe the history of mathematics and its value in day to day applications
	CO2	Apply different methods and techniques in teaching mathematics effectively
	CO3	Understand and identify influence of various psychological factors in learning
	CO4	Make out the individual differences in learning mathematics and to plan activities according to the needs of the students
	CO5	Organize learning resources and apply them appropriately in everyday teaching
Methodology of Teaching Physical Science A4 (D)	CO1	Understand the need and importance of teaching physical science in higher secondary level
	CO2	Able to prepare a lesson plan and presenting them effectively in the classroom
	CO3	Identify and apply various teaching methods for teaching of physical science
	CO4	Develop theoretical and practical understanding of the hardware and software relating to the technology of teaching.
	CO5	Apply the evaluation techniques in the classroom
Methodology of Teaching Biological Science A4 (E)	CO1	Understand the aims, objectives and challenges in teaching biology
	CO2	Obtain various skills needed for class room instruction
	CO3	Identify and prepare various aids for teaching biology
	CO4	Explain the techniques in preparing special aids for teaching biology
	CO5	Acquire the knowledge on the content of biology syllabus for IX standard
Methodology of Teaching Social Science A4 (F)	CO1	Identify the need of teaching social science in school curriculum
	CO2	Apply various instructional strategies in teaching social science
	CO3	Express the need and types of teaching aids in social science
	CO4	Develop skills in writing objectives, preparing lesson

		plan, unit plan and the need for developing micro teaching skills.
	CO5	Comprehend the essential qualities and functions of a teacher
Methodology of Teaching Computer Science A4 (G)	CO1	Understand the Bloom's taxonomy of educational objectives
	CO2	List out the objectives of teaching of computer science in schools
	CO3	Apply the micro teaching skills during classroom instruction & Point out the qualities of good computer science text book
	CO4	Comprehend the principles of curriculum development
	CO5	Develop skills in constructing test and evaluation
Methodology of Teaching Commerce A4 (H)	CO1	Obtain awareness on nature and scope of commerce and accountancy
	CO2	Understand the aims, objectives and values of teaching commerce and accountancy
	CO3	Plan and prepare lessons and teaching aids for teaching commerce
	CO4	Understand various methods and techniques of teaching commerce and its application to children with learning difficulties
	CO5	Develop skills in preparation and use of appropriate instructional aids
Methodology of Hindi A4 (I)	CO1	Explain Role of Hindi language and mother tongue
	CO2	Acquire skills and methods of teaching prose and poetry
	CO3	Acquire skills and methods of teaching vocabulary and composition
	CO4	Understand method of teaching the four-fold language skills
	CO5	Understand about various approaches and techniques of teaching Hindi
Methodology of Teaching Children with Learning Problems in an Inclusive Setting A4 (J)	CO1	Develop skills to screen, assess and understand the children with learning difficulties
	CO2	Organize the resource room
	CO3	Assess and plan remedial teaching in English
	CO4	Assess and plan remedial teaching in Indian language
	CO5	Assess and plan remedial teaching in mathematics
PedagogyofSchoolSubjects – Paper II 3BA5 Methodology of Teaching Tamil A5 (A)	CO1	Understand the origin and development of Tamil Language
	CO2	Identify the importance of language in curriculum and principles of poem
	CO3	Comprehend the structure of sound in Tamil language

	CO4	Explain the literary appreciation
	CO5	Distinguish the importance and special features of Tamil Language
Methodology of Teaching English A5 (B)	CO1	Employ various methods for teaching English language
	CO2	Clarify the nature of classroom climate and teachers' behaviour
	CO3	Identify the principles of selecting teaching aids and uses of audio visual aids
	CO4	Apply various technologies for teaching English language
	CO5	Explain various strategies, techniques of testing and evaluation in English language
Methodology of Teaching Mathematics A5(C)	CO1	Elaborate the concept, need, principles and types of curriculum construction
	CO2	Describe the stages of developingmathematics curriculum
	CO3	Construct Mathematics curriculum and make out the suggestions for its improvement
	CO4	Use various models of teaching in mathematics
	CO5	Apply and evaluate different techniques including IT in mathematics.
Methodology of Teaching Physical Science A5 (D)	CO1	Know the principles of curriculum construction and science curricular projects.
	CO2	Chalk out the problems of organising and maintaining physics and chemistry laboratories.
	CO3	Classify the individual differences and provide remedial teaching.
	CO4	Develop skills in planning for science clubs and exhibition.
	CO5	Approach the problems with scientific perspective
Methodology of Teaching Biological Science A5 (E)	CO1	Construct curriculum for various levels in school
	CO2	Obtain various skills needed for class room instruction
	CO3	Identify and prepare various aids for teaching biology
	CO4	Explain the techniques in preparing special aids for teaching biology
	CO5	Acquire the knowledge on the content of biology syllabus for IX standard
Methodology of Teaching Social Science A5 (F)	CO1	Understand the need of teaching social science in school curriculum
	CO2	Describe the structure of organizing the Social science content
	CO3	Express the need of resources and equipments in Social science subject
	CO4	Identify the issues in teaching and learning process
	CO5	Comprehend the evaluation procedure in Social science
Methodology of Teaching Computer Science A5(G)	CO1	Understand the software techniques involved in teaching learning process

	CO2	Acquire the knowledge on latest trends in information technology
	CO3	Explain the need and importance of computer laboratory in school
	CO4	Point out the qualities need for computer science teacher
	CO5	Use computer assisted instruction for teaching exceptional children
Methodology of Teaching Commerce A5 (H)	CO1	Obtain awareness on nature and scope of commerce and accountancy
	CO2	Understand the aims, objectives and values of teaching commerce and accountancy
	CO3	Plan and prepare lessons and teaching aids for teaching commerce
	CO4	Understand various methods and techniques of teaching commerce and its application to children with learning difficulties
	CO5	Develop skills in preparation and use of appropriate instructional aids in teaching commerce
Methodology of Teaching Hindi A5 (I)	CO1	Acquire knowledge about the role, status, objectives and problems of teaching Hindi as a second language in India
	CO2	Understand the nature and resources of language and issues related to language acquisition, variation and change
	CO3	Enrich the knowledge of Hindi vocabulary, structures, grammar and usage and to develop the ability to teach them
	CO4	Know, compare and analyse various methods and approaches of teaching Hindi as a second language
	CO5	Improvise and use appropriate aids for teaching Hindi
	CO6	Use various techniques for the evaluation of learner's achievement in Hindi
	CO7	Identify and analyze errors and plan and execute remedial instruction
	CO8	Use various techniques for the evaluation of learner's achievement in Hindi
Methodology of Transition of Persons with Mental Retardation from School to Work A5 A5 (J)	CO1	Define the term transition and explain various stages of Individualized Vocational Transition Plan
	CO2	Identify generic/work readiness skills and conduct job survey and prepare job analysis for persons with mental retardation
	CO3	Explain approaches to vocational assessment, select tools and conduct vocational Assessment
	CO4	Describe various types of employment and related activities to train and place the persons with mental retardation.
	CO5	Introduce the adult related needs such as sex education, self advocacy and recreation

Introductionto SensoryDisabilities 1BB1	CO1	Name the different types of sensory impairments and its prevalence and describe the process of hearing & implications of various types of hearing loss.
	CO2	Explain the issues & ways to address challenges in educating students with hearing loss.
	CO3	Describe nature, characteristics & assessment of students with low vision & visual impairment.
	CO4	Suggest educational placement and curricular strategies for students with low vision& visual impairment.
	CO5	Explicate the impact of deaf-blindness & practices for functional development
Introduction to Neuro Developmental Disabilities 1BB2	CO1	Discuss the characteristics and types of learning disability.
	CO2	Describe the tools, areas of assessment and apply intervention strategies to enhance learning.
	CO3	Explain the characteristics and types of Intellectual disability.
	CO4	Describe the tools, areas of assessment and prepare and apply intervention strategies for independent living.
	CO5	Explain the characteristics and types of Autism Spectrum Disorder.
	CO6	Describe the tools, areas of assessment and apply intervention strategies.
Introduction to Locomotor and Multiple Disabilities 1BB3	CO1	Identify the persons with Locomotor disabilities such as Cerebral Palsy, Amputees, Polio, Leprosy cured, Muscular dystrophies, Neural and spinal defects and Multiple disabilities.
	CO2	Plan an effective programme for creating awareness about the persons with
	CO3	Locomotor disabilities and Multiple disabilities.
	CO4	Plan an effective therapeutic and programme for the persons with Locomotor disabilities and Multiple disabilities and to refer for medical intervention if necessary.
	CO5	Plan an effective educationalprogramme and functional activities for the persons with Locomotor disabilities and Multiple disabilities.
Early Childhood Care And Education 3BB4(A)	CO1	Explain the biological & sociological foundations of early childhood education.
	CO2	Describe the developmental systems approach and role responsibilities of interdisciplinary teams for early education of children with disabilities.
	CO3	Enumerate the inclusive early education pedagogical practices.
Application of ICT in Classroom	CO1	Gauge the varying dimensions in respect of ICT and Applications in Special Education.

3BB4(B)	CO2	Delineate the special roles of ICT Applications.
	CO3	Acquire Familiarity with Different Modes of Computer-Based Learning.
Orientation and Mobility 3BB5 (A)	CO1	Describe the nature and scope of O&M as also the O&M related responsibilities of the special teacher.
	CO2	Acquire basic knowledge of human guide techniques.
	CO3	Describe pre-cane and cane travel skills and devices.
	CO4	Get acquainted with the importance and skills of training in independent living for the visually impaired.
Communication Options: Manual (Indian Sign Language) 3BB5 (B)	CO1	Discuss the two manual options with reference to Indian special schools.
	CO2	Discuss the relevant issues like literacy, inclusion and training with reference to manual options.
	CO3	Describe manual options in the light of issues like language, culture and identify.
	CO4	Exhibit beginner level hands on skills in using manual options.
	CO5	Motivate self to learn and practice more skills leading to linguistic adequacy and fluency.
VocationalRehabilitation & Transition to Job Placement 3BB5 (C)	CO1	Develop an understanding of vocational education & its relevance for PWD's.
	CO2	Carry out vocational assessment and make vocational training plan.
	CO3	Plan for transition from School to job.
	CO4	Identify various avenues for job placement.
	CO5	Facilitate PWD's in making choice of vocational trades.
Inclusive Education 4BB6	CO1	Explain Inclusion and the progression from segregation to inclusion
	CO2	Appreciate diversity in an inclusive class
	CO3	Describe key nation and international policies and frameworks facilitating inclusive education
	CO4	Enumerate skills in adapting instructional strategies for teaching in mainstream classrooms
	CO5	Describe inclusive pedagogical practices and its relation to good teaching
	CO6	Describe strategies for collaborative working and stakeholder support in implementing inclusive education
	CO7	Explain the role of society in general for successful inclusion
Assessment and Identification of Needs of Individuals with Mental Retardation1BC1	CO1	Comprehend historical perspective, nature and needs and characteristics of persons with Intellectual Disability
	CO2	Understand various procedures, areas and approaches of assessment and their relevance

	CO3	Gain insight into importance of assessment at Pre School and school level and become familiar with development and adaptive behavioural assessment and assessment tools at preschool level
	CO4	Get familiarized with the assessment tools for independent living, provisions
	CO5	Understand the schemes for vocational skills development and implication of assessment
	CO6	Develop understanding about significance of different types of family needs their assessment and implications for extending support to their families, demonstration
Curriculum Designing, Adaptation and Evaluation for Individuals with MR/ID 2BC2	CO1	Understand the nature of curriculum, principles and steps of curriculum designing, domains and curriculum evaluation
	CO2	Develop insight into importance of early childhood special education, its domains and school readiness programme and their implications.
	CO3	Acquire about curriculum domains at secondary, prevocational and vocational level and understand its implications
	CO4	Understand different strategies for curriculum adaptation, accommodation, modification and their significance.
	CO5	Write down the significance of evaluation of the curriculum taught
	CO6	Explain evaluation and make effective use of different techniques
Application of Assistive Technology for Individuals with MR/ID 3BC3	CO1	Comprehend role of technology in educating children with ID and acquire knowledge about its various approaches and modes
	CO2	Understand nature of ICT, its basis, development and use
	CO3	Use computer programme and software for the benefit of children with ID
	CO4	DevelopskillsandcompetenciesinuseofPunarjaniandC-DACandintegrate technology for instructions and inclusion

	CO5	Apply technology for developing lesson plan and adapted assistive devices
Intervention and Teaching Strategies for Individuals with MR/ID 4BC4	CO1	Understand, plan and use interventional techniques appropriately and demonstrate
	CO2	Realize the importance of developing IEP, acquire the required competencies for its development, implementation and evaluation
	CO3	Understand basic of learning and teaching
	CO4	Demonstrate appropriate teaching strategies for teaching in different curriculum areas
	CO5	Understand nature and identification maladaptive behaviour and learn various modes of its management.
	CO6	Develop understanding of various therapeutics interventions, their objectives, scope, modalities, and require intervention
Psycho Social and Family Issues of Individuals with MR/ID 4BC5	CO1	Realise importance and role of family in rehabilitation of children with ID
	CO2	Develop insight into various Psycho-social issues and their impact on rehabilitation on PwID, misconception and social practices and develop based approach
	CO3	To realize importance of family involvement in rehabilitation process by forming parentsself help group and parent association
	CO4	Understand various Adolescent related issues and challenges their implication for rehabilitation of PwIDs and to explore probable employment opportunities for them
	CO5	Comprehend role of community and community participation and models, advantages / disadvantages of CBR programme for PwIDs
Fundamental Concepts in Educational Research & Statistics 2BD1	CO1	Describe the concept and relevance of research in education and special education.
	CO2	Develop an understanding of the research process and acquire competencies for conducting a research.
	CO3	Apply suitable measures for data organization and analysis.
Reading and Reflecting on Texts (EPC) 4BD2	CO1	Reflect on student's own current level of literacy
	CO2	Undertake practice in basic reading skills to become active readers
	CO3	Undertake practice in basic writing skills to become independent writers
	CO4	Describe strategies to facilitate development of good reading skills among students

	CO5	Describe strategies to facilitate development of good writing skills among students
	CO6	Chooses to read books or write stories or poems as leisure time activity
Drama and Art in Education (EPC) 4BD3	CO1	Explain art appreciation, art expression and art education
	CO2	Describe strategies for facilitating learning of various arts for students with and without disabilities
	CO3	Describe adaptive strategies of artistic expression
	CO4	Explain how art can enhance learning

Faculty of Disability Management and Special Education (FDMSE)

Ramakrishna Mission Vivekananda Educational and Research Institute (RKMVERI) Coimbatore Campus

Programme Outcomes
M.Ed Special Education

Programme Outcomes
Programme: Masters in Special Education
(M.Ed Special Education)

PO1.Teaching knowledge: Apply the knowledge of teaching skills in special, integrated and inclusive educational settings as well as in higher educational institutions.

PO2. Problem Solving: Develop problem solving skills, analytical and critical thinking skills required to be a good problem solver.

PO3. Leadership: Apply leadership skills in advocating and meeting educational needs of children with disabilities in various settings.

PO4.Design/development of solutions: Design solutions to address the unique individual challenges of diverse learners by preparing adapted and modified teaching learning materials and equipments by applying the principles of research.

PO5.Conduct projects on emerging issues: Carry out projects / investigations / action research to address developing issues in the field of special education and contribute innovative teaching techniques and strategies.

PO6.Assistive technology usage: Select, assess and apply appropriate assistive technological devices and customize the services considering the individual limitations.

PO7.The teacher and society: Apply leadership skills in advocating and meeting educational needs of children with disabilities in various social settings.

PO8.Environment and sustainability: Apply professional knowledge and skill for the sustainable development of the society.

PO9.Ethics: Imbibe values required for personal and national development.

PO10.Individual and collaborative work: Learn and apply skills pertaining to individual and collaborative work.

PO11.Communication: Acquire effective communication skills for conducive classroom interaction and work environment.

PO12.Life-long learning: Understand and apply skills to update knowledge throughout life.

Programme Specific Outcomes
M.Ed – Special Education
(Visual Impairment)

Programme: Masters in Special Education (Visual Impairment)
M.Ed Special Education (Visual Impairment)

PSO1. Understand the nature and basic concepts of core subjects like Developments in Special Education, Research Methodology and Statistics, Psychology of Development and Learning, Curriculum Design & Development, Inclusive Education, Perspectives in Teacher Education and Educational Evaluation.

PSO2. Build theoretical knowledge and skills in research methodologies and conducting research in order to enhance inclusive education for children with disabilities.

PSO3. Identify and analyse critically the emerging challenges in the society and create solutions using structured method.

PSO4. Identify the existing problems pertaining to special education and disability management and initiate appropriate measures to solve them.

PSO5.Develop leadership abilities that help them to learn to collaborate and communicate while working in team projects.

PSO6.Equip with the leadership qualities such as decision making skills, communication and delegation skills that are required while working as teacher educators/ administrators.

PSO7. Develop specialized capacity for leadership in designing and implementing curriculum by applying universal design.

PSO8. Use their research aptitude in planning, developing and adaptating the curriculum, teaching strategies and materials based on the individualized needs of children with visual impairment.

PSO9. Apply innovative methods to teach the expanded core curricular skills such as compensatory academic skills (Braille, use of mathematical devices such as Abacus, Taylor frame etc…), Orientation and Mobility, Sensory Training and Daily Living Skills for children with visual impairment.

PSO10. Grasping the concept of project phases such as initiation, planning, execution, and closure and systematically apply in the research work.

PSO11. Acquire mastery over skills to assess and apply the current technological devices and services for individuals with visual impairment and customize based on their unique needs.

PSO12.Acquire 21st century teaching skills to encounter the real time challenges of diverse learners in the classroom as well as in the society.

PSO13.Understand the impact of the solution evolved from teaching profession in societal and environmental contexts, demonstrate the knowledge, and need for sustainable development.

PSO14. Apply ethical principles to carry out research which promotes moral and social values, such as social responsibility and human rights.

PSO15. Acquire skills to work effectively as an individual/leader in interdisciplinary, trans-disciplinary and multidisciplinary settings as well as in higher educational institutions to enhance productive working relationships.

PSO16. Learn to communicate effectively and efficiently to transact the curricular content, prepare research proposals/reports and convey appropriate and suitable suggestions for their professional development.

PSO17. Realize the need for life-long learning and update their knowledge continuously on emerging developments in the respective fields through various sources including online.

Course Outcomes
M.Ed – Special Education
(Visual Impairment)

Course Outcomes
Programme: Masters in Special Education (Visual Impairment)
M.Ed Special Education (VI)

Title of the Course	No.	Course Outcomes
Developments in Education and Special Education 1MA1	CO1	Explain the developments of general and special education in India
	CO2	Explain implications of recommendations of various committees and commissions for educational developments in India
	CO3	Describe the issues in the present day educational system
	CO4	Describe the challenges in the present day educational system
	CO5	Describe the important quality related issues which need to be considered for revision/development of new education policy
Research Methodology and Statistics 1MA2	CO1	Explain the concept and need for research
	CO2	Enumerate the ethical research practices
	CO3	Explain the types of research
	CO4	Describe the methods and processes of research
	CO5	Describe the application of statistical techniques for analysis of data
	CO6	Explain the methods and techniques of qualitative research
	CO7	Write a research proposal and a research report
Psychology of Development and Learning 2MA3	CO1	Explain the psychological principles and their application in specific context of education and special education.
	CO2	Explain the principles and their implication for growth and development.
	CO3	Critically analyse the process from the point of view of cognitive psychology.
	CO4	Explain role of motivation in learning, learning processes and theories of personality.
	CO5	Apply psychological aspects to teaching - learning situations.
Curriculum Design & Development 2MA4	CO1	Define and identify different components of curriculum.
	CO2	Understand and analyse various approaches to curriculum development.
	CO3	Explain and demonstrate curriculum differentiation.
Inclusive Education 2MA5	CO1	Explain the philosophical, sociological and rights perspective of inclusive education.
	CO2	Develop skills in using a wide range of tools, instructional strategies, and social supports to assist students with disabilities learn effectively.
	CO3	Develop the skills associated with inter-personal relationships, managing relations in educational settings, problem-solving in educational settings, leadership and working in teams to promote inclusion.

Perspectives in Teacher Education – In-service and Pre-service 3MA6	CO1	Explain development of teacher education with reference to education of children with disabilities
	CO2	Describe issues and problems related to teacher preparation for education of children with disabilities
	CO3	Enumerate the different organizations working to prepare teachers for children with disabilities
	CO4	Explain the responsibilities of these organizations and critically examine them
	CO5	Describe the importance of in-service programmes
	CO6	Demonstrate planning and execution of in-service programme as per specific need and purpose
	CO7	Appraise the existing teacher education curriculum and its relevance, issues and challenges
Educational Evaluation 3MA7	CO1	Explain the key concepts of evaluation
	CO2	Describe the developments in evaluation
	CO3	Describe the scope of evaluation in education
	CO4	Explain the use of evaluation as an effective tool in teaching-learning process
	CO5	Describe the ways and means of evaluation of programmes
	CO6	Explain the current trends in evaluation
Identification, Assessment and Needs of Individuals with Visual Impairment 1MB1	CO1	Trace the historical development of visual impairment and discuss the attitudinal change of society over time.
	CO2	Describe the causes and implications of different eye disorders.
	CO3	Critically examine the needs arising at different stages of persons with visual impairment.
	CO4	Develop skills to identify and assess children with blindness, low vision, and children with VIMD.
	CO5	Develop skills to plan and implement vision efficiency training for children with low vision.
Curriculum And Teaching Strategies for Individuals with Visual Impairment 1MB2	CO1	Appreciate the importance of various basis to curriculum development.
	CO2	Develop an expanded core curriculum for children with visual impairment on the basis of situational analysis.
	CO3	Adapt the school curriculum keeping in mind the principles of curriculum adaptation in different curricular skill areas.
	CO4	Demonstrate appropriate teaching strategy in teaching reading, writing, and math
	CO5	Critically examine approaches to curriculum development for VIAD

Application of Advanced Technology and Individuals with Visual Impairment 2MB3	CO1	Explain the relevance of technology for persons with visual impairment.
	CO2	Illustrate various devices to facilitate the education of persons with visual impairment.
	CO3	Describe various technological devices for promoting quality of life of persons with visual impairment.
	CO4	Critically analyse suitability/ appropriateness for various technological devices for persons with visual impairment.
	CO5	Discuss various trends in research on technology for persons with visual impairment
Adulthood and Family Issues of Individuals with Visual Impairment 3MB4	CO1	Understand the challenges that are often associated with a family of a person with visual impairment
	CO2	Analyze the role of family as a support system from birth to adulthood.
	CO3	Discuss the concerns of the family of a person with visual impairment.
	CO4	Meet the challenges faced at different stages of transition of a person with visual impairment.
	CO5	Develop the skills to prepare an Individualized Transition Plan (ITP) and Individualized Family Support Plan (IFSP).
	Co6	Develop a critical understanding of schemes for equal opportunities
Educational Management 3MC1	CO1	Explain the basic fundamental areas of management.
	CO2	Describe the skills required for enhancing institutional quality for sustained development.
	CO3	Enumerate the skills required for capacity building of human resources.
	CO4	Explain the skills needed to manage data for various information management processes.
	CO5	Prepare cost effective budgets, proposals and describe ways of managing financial resources
Educational Technology 3M C2	CO1	Discuss roles of Educational Technologists in various contexts.
	CO2	Apply appropriate instructional strategies.
	CO3	Develop appropriate instructional media.
	CO4	Integrate suitable ICT effectively in teaching-learning-evaluation.
	CO5	Suggest suitable modality of instruction (Online, Blended, etc.).
Guidance and Counseling 3M C3	CO1	State the basic concepts in Guidance & Counseling.
	CO2	Discuss Educational, Vocational and Personal Guidance.
	CO3	Describe testing devices and non-testing techniques of guidance.
	CO4	Analyze the problems faced by students in the contemporary world.
	CO5	Discuss the problems faced by children with disabilities.

Programme Specific Outcomes
M.Ed – Special Education
(Hearing Impairment)

Programme: Masters in Special Education (Hearing Impairment)

PSO1. Understand the nature and basic concepts of core subjects like Developments in Special Education, Research Methodology and Statistics, Psychology of Development and Learning, Curriculum Design & Development, Inclusive Education, Perspectives in Teacher Education and Educational Evaluation.

PSO2. Build theoretical knowledge and skills in research methodologies and conducting research in order to enhance inclusive education for children with disabilities.

PSO3. Identify and analyse critically the emerging challenges in the society and create solutions using structured method.

PSO4. Identify the existing problems pertaining to special education and disability management and initiate appropriate measures to solve them.

PSO5.Develop leadership abilities that help them to learn to collaborate and communicate while working in team projects.

PSO6.Equip with the leadership qualities such as decision making skills, communication and delegation skills that are required while working as teacher educators/ administrators.

PSO7. Develop specialized capacity for leadership in designing and implementing curriculum by applying universal design.

PSO8. Use their research aptitude in planning, developing and adaptating the curriculum, teaching strategies and materials based on the individualized needs of children with hearing impairment.

PSO9. Grasping the concept of project phases such as initiation, planning, execution, and closure and systematically apply in the research work.

PSO10. Acquire mastery over skills to assess and apply the current technological devices and services for individuals with hearing impairment and customize based on their unique needs.

PSO11.Acquire 21st century teaching skills to encounter the real time challenges of diverse learners in the classroom as well as in the society.

PSO12.Understand the impact of the solution evolved from teaching profession in societal and environmental contexts, demonstrate the knowledge, and need for sustainable development.

PSO13.Apply ethical principles to carry out research which promotes moral and social values, such as social responsibility and human rights.

PSO15. Acquire skills to work effectively as an individual/leader in interdisciplinary, trans-disciplinary and multidisciplinary settings as well as in higher educational institutions to enhance productive working relationships.

PSO16. Learn to communicate effectively and efficiently to transact the curricular content, prepare research proposals/reports and convey appropriate and suitable suggestions for their professional development.

PSO17. Realize the need for life-long learning and update their knowledge continuously on emerging developments in the respective fields through various sources including online.

Course Outcomes

M.Ed – Special Education (Hearing Impairment)

Course Outcomes
Programme: Masters in Special Education (Hearing Impairment)

Title of the Course	No.	Course Outcomes
Developments in Education and Special Education 1MA1	CO1	Explain the developments of general and special education in India
	CO2	Explain implications of recommendations of various committees and commissions for educational developments in India
	CO3	Describe the issues in the present day educational system
	CO4	Describe the challenges in the present day educational system
	CO5	Describe the important quality related issues which need to be considered for revision/development of new education policy
Research Methodology and Statistics 1MA2	CO1	Explain the concept and need for research
	CO2	Enumerate the ethical research practices
	CO3	Explain the types of research
	CO4	Describe the methods and processes of research
	CO5	Describe the application of statistical techniques for analysis of data
	CO6	Explain the methods and techniques of qualitative research
	CO7	Write a research proposal and a research report
Psychology of Development and Learning 2MA3	CO1	Explain the psychological principles and their application in specific context of education and special education.
	CO2	Explain the principles and their implication for growth and development.
	CO3	Critically analyse the process from the point of view of cognitive psychology.
	CO4	Explain role of motivation in learning, learning processes and theories of personality.
	CO5	Apply psychological aspects to teaching - learning situations.
Curriculum Design & Development 2MA4	CO1	Define and identify different components of curriculum.
	CO2	Understand and analyse various approaches to curriculum development.
	CO3	Explain and demonstrate curriculum differentiation.
Inclusive Education 2MA5	CO1	Explain the philosophical, sociological and rights perspective of inclusive education.
	CO2	Develop skills in using a wide range of tools, instructional strategies, and social supports to assist students with disabilities learn effectively.
	CO3	Develop the skills associated with inter-personal relationships, managing relations in educational settings, problem-solving in educational settings, leadership and working in teams to promote inclusion.

Perspectives in Teacher Education – In-service and Pre-service 3MA6	CO1	Explain development of teacher education with reference to education of children with disabilities
	CO2	Describe issues and problems related to teacher preparation for education of children with disabilities
	CO3	Enumerate the different organizations working to prepare teachers for children with disabilities
	CO4	Explain the responsibilities of these organizations and critically examine them
	CO5	Describe the importance of in-service programmes
	CO6	Demonstrate planning and execution of in-service programme as per specific need and purpose
	CO7	Appraise the existing teacher education curriculum and its relevance, issues and challenges
Educational Evaluation 3MA7	CO1	Explain the key concepts of evaluation
	CO2	Describe the developments in evaluation
	CO3	Describe the scope of evaluation in education
	CO4	Explain the use of evaluation as an effective tool in teaching-learning process
	CO5	Describe the ways and means of evaluation of programmes
	CO6	Explain the current trends in evaluation
Identification, Assessment and Needs of Individuals with Hearing Impairment 1MB1	CO1	Explain Audiological evaluation and reflect its application in education of CWHI.
	CO2	Explain the practices in educational assessment including the setting up of an educational assessment centre.
	CO3	Describe speech of children and reflect its use in evaluation of children with hearing impairment.
	CO4	Explain various issues related to assessment of language and communication of CWHI
	CO5	Describe the importance of team approach and reflect on their role in assessment and identification of needs.
Curriculum And Teaching Strategies for Individuals with Hearing Impairment 1MB2	CO1	Describe the curricular needs, framework and practices emerged out of the paradigm shift in education
	CO2	Explain the bases, types and strategies of curricular adaptations
	CO3	Understand the concept and strategies in differentiated instructions
	CO4	Explain the processes and theories of literacy development
	CO5	Explain the multiple literacy and their applications in curriculum
Assistive Devices & Services for Individuals with Hearing Impairment 2MB3	CO1	Describe the available schemes and reflect on status of services for individuals with hearing impairment and suggest ways to improve
	CO2	Understanding about individual and group listening devices used by CWHI in schools.

	CO3	Discuss role of technology in facilitating communicative educational and social functioning of language
	CO4	Understanding about use of assistive devices & methods in the management of CWHI in schools/ clinics.
	CO5	Explain the present and future technologies, research developments and evidence based practices facilitating the education of CWHI
Adulthood and Family Issues of Individuals with Hearing Impairment 3MB4	CO1	Appreciate the importance of planning and implementing transition services for preparing adolescents towards adulthood.
	CO2	Explain strategies of developing independent living skills and preparing them for gainful employment.
	CO3	Describe communication, cultural and family issues to reflect in planning of services.
Educational Management 3MC1	CO1	Explain the basic fundamental areas of management.
	CO2	Describe the skills required for enhancing institutional quality for sustained development.
	CO3	Enumerate the skills required for capacity building of human resources.
	CO4	Explain the skills needed to manage data for various information management processes.
	CO5	Prepare cost effective budgets, proposals and describe ways of managing financial resources
Educational Technology 3M C2	CO1	Discuss roles of Educational Technologists in various contexts.
	CO2	Apply appropriate instructional strategies.
	CO3	Develop appropriate instructional media.
	CO4	Integrate suitable ICT effectively in teaching-learning-evaluation.
	CO5	Suggest suitable modality of instruction (Online, Blended, etc.).
Guidance and Counseling 3M C3	CO1	State the basic concepts in Guidance & Counseling.
	CO2	Discuss Educational, Vocational and Personal Guidance.
	CO3	Describe testing devices and non-testing techniques of guidance.
	CO4	Analyze the problems faced by students in the contemporary world.
	CO5	Discuss the problems faced by children with disabilities.

Programme Specific Outcomes
M.Ed – Special Education
(Mental Retardation)

Programme: Masters in Special Education (Mental Retardation)

PSO1. Understand the nature and basic concepts of core subjects like Developments in Special Education, Research Methodology and Statistics, Psychology of Development and Learning, Curriculum Design & Development, Inclusive Education, Perspectives in Teacher Education and Educational Evaluation.

PSO2. Build theoretical knowledge and skills in research methodologies and conducting research in order to enhance inclusive education for children with disabilities.

PSO3. Identify and analyse critically the emerging challenges in the society and create solutions using structured method.

PSO4. Identify the existing problems pertaining to special education and disability management and initiate appropriate measures to solve them.

PSO5.Develop leadership abilities that help them to learn to collaborate and communicate while working in team projects.

PSO6.Equip with the leadership qualities such as decesion making skills, communication and delegation skills that are required while working as teacher educators/ administrators.

PSO7. Develop specialized capacity for leadership in designing and implementing curriculum by applying universal design.

PSO8. Use their research aptitude in planning, developing and adaptating the curriculum, teaching strategies and materials based on the individualized needs of children with mental retardation.

PSO10. Acquire mastery over skills to assess and apply the current technological devices and services for children with mental retardation and customize based on their unique needs.

PSO11.Acquire 21st century teaching skills to encounter the real time challenges of diverse learners in the classroom as well as in the society.

PSO12.Understand the impact of the solution evolved from teaching profession in societal and environmental contexts, demonstrate the knowledge, and need for sustainable development.

PSO13.Apply ethical principles to carry out research which promotes moral and social values, such as social responsibility and human rights.

PSO15. Acquire skills to work effectively as an individual/leader in interdisciplinary, trans-disciplinary and multidisciplinary settings as well as in higher educational institutions to enhance productive working relationships.

PSO16. Learn to communicate effectively and efficiently to transact the curricular content, prepare research proposals/reports and convey appropriate and suitable suggestions for their professional development.

PSO17. Realize the need for life-long learning and update their knowledge continuously on emerging developments in the respective fields through various sources including online.

Course Outcomes
M.Ed – Special Education
(Mental Retardation)

Course Outcomes
Programme: Masters in Special Education (Mental Retardation)

Title of the Course	No.	Course Outcomes
Developments in Education and Special Education 1MA1	CO1	Explain the developments of general and special education in India
	CO2	Explain implications of recommendations of various committees and commissions for educational developments in India
	CO3	Describe the issues in the present day educational system
	CO4	Describe the challenges in the present day educational system
	CO5	Describe the important quality related issues which need to be considered for revision/development of new education policy
Research Methodology and Statistics 1MA2	CO1	Explain the concept and need for research
	CO2	Enumerate the ethical research practices
	CO3	Explain the types of research
	CO4	Describe the methods and processes of research
	CO5	Describe the application of statistical techniques for analysis of data
	CO6	Explain the methods and techniques of qualitative research
	CO7	Write a research proposal and a research report
Psychology of Development and Learning 2MA3	CO1	Explain the psychological principles and their application in specific context of education and special education.
	CO2	Explain the principles and their implication for growth and development.
	CO3	Critically analyse the process from the point of view of cognitive psychology.
	CO4	Explain role of motivation in learning, learning processes and theories of personality.
	CO5	Apply psychological aspects to teaching - learning situations.
Curriculum Design & Development 2MA4	CO1	Define and identify different components of curriculum.
	CO2	Understand and analyse various approaches to curriculum development.
	CO3	Explain and demonstrate curriculum differentiation.
Inclusive Education 2MA5	CO1	Explain the philosophical, sociological and rights perspective of inclusive education.
	CO2	Develop skills in using a wide range of tools, instructional strategies, and social supports to assist students with disabilities learn effectively.
	CO3	Develop the skills associated with inter-personal relationships, managing relations in educational settings, problem-solving in educational settings, leadership and working in teams to promote inclusion.

Perspectives in Teacher Education – In-service and Pre-service 3MA6	CO1	Explain development of teacher education with reference to education of children with disabilities
	CO2	Describe issues and problems related to teacher preparation for education of children with disabilities
	CO3	Enumerate the different organizations working to prepare teachers for children with disabilities
	CO4	Explain the responsibilities of these organizations and critically examine them
	CO5	Describe the importance of in-service programmes
	CO6	Demonstrate planning and execution of in-service programme as per specific need and purpose
	CO7	Appraise the existing teacher education curriculum and its relevance, issues and challenges
Educational Evaluation 3MA7	CO1	Explain the key concepts of evaluation
	CO2	Describe the developments in evaluation
	CO3	Describe the scope of evaluation in education
	CO4	Explain the use of evaluation as an effective tool in teaching-learning process
	CO5	Describe the ways and means of evaluation of programmes
	CO6	Explain the current trends in evaluation
Identification, Assessment and Needs of Individuals with Mental Retardation/ Intellectual Disability 1MB1	CO1	Understand the concept, etiology and characteristics of Persons with Intellectual Disability (PwID).
	CO2	Use appropriate instruments for assessment of PwID.
	CO3	Describe the programming needs across different age levels of PwID.
	CO4	Utilize assessment information for educational programming, referral services and placement.
	CO5	Comprehend the emerging future needs of PwID.
Curriculum And Teaching Strategies for Individuals with Mental Retardation/ Intellectual Disability 1MB2	CO1	Explain the principles and approaches to curriculum development and instructional program.
	CO2	Describe the various approaches for teaching students with Intellectual Disability
	CO3	Develop Curriculum for Pre-Primary, Primary, Secondary, Pre- Vocational and Vocational Level
	CO4	Use Instructional Program and methods in Inclusive Set ups
	CO5	Use teaching strategies and TLMs for PwID
Therapeutics and Assistive Devices for Individuals with Mental Retardation 2MB3	CO1	Gain knowledge about speech and language therapy
	CO2	Understand the meaning and interventions of physiotherapy
	CO3	Use occupational therapy for PwID
	CO4	Comprehend and apply behavioural techniques for interventions
	CO5	Select and use appropriate assistive devices for PwID

Adulthood and Family Issues of Individuals with Intellectual Disability 3MB4	CO1	Develop understanding of stages of development in adulthood
	CO2	Appreciate importance of family attitude and involvement
	CO3	Understand the Gender, marriage and sexuality related issues..
	CO4	Understand the disability issues related to community
	CO5	Appreciate the importance of adulthood and family training
Educational Management 3MC1	CO1	Explain the basic fundamental areas of management.
	CO2	Describe the skills required for enhancing institutional quality for sustained development.
	CO3	Enumerate the skills required for capacity building of human resources.
	CO4	Explain the skills needed to manage data for various information management processes.
	CO5	Prepare cost effective budgets, proposals and describe ways of managing financial resources
Educational Technology 3M C2	CO1	Discuss roles of Educational Technologists in various contexts.
	CO2	Apply appropriate instructional strategies.
	CO3	Develop appropriate instructional media.
	CO4	Integrate suitable ICT effectively in teaching-learning-evaluation.
	CO5	Suggest suitable modality of instruction (Online, Blended, etc.).
Guidance and Counseling 3M C3	CO1	State the basic concepts in Guidance & Counseling.
	CO2	Discuss Educational, Vocational and Personal Guidance.
	CO3	Describe testing devices and non-testing techniques of guidance.
	CO4	Analyze the problems faced by students in the contemporary world.
	CO5	Discuss the problems faced by children with disabilities.

Programme Specific Outcomes (Integrated B.EdM.Ed Special Education - Intellectual Disability)

Programme Specific Outcomes
Programme: Masters in Special Education
Integrated B.EdM.Ed Special Education - Intellectual Disability

PSO1. Understand the nature and basic concepts of core subjects like Developments in Special Education, Research Methodology and Statistics, Psychology of Development and Learning, Curriculum Design & Development, Inclusive Education, Perspectives in Teacher Education and Educational Evaluation.

PSO2. Build theoretical knowledge and skills in research methodologies and conducting research in order to enhance inclusive education for children with disabilities.

PSO3. Identify and analyse critically the emerging challenges in the society and create solutions using structured methods.

PSO4. Identify the existing problems pertaining to special education and disability management and initiate appropriate measures to solve them.

PSO5.Develop leadership abilities that help them to learn to collaborate and communicate while working in team projects.

PSO6. Equip with the leadership qualities such as decision making skills, communication and delegation skills that are required while working as teacher educators/ administrators.

PSO7. Develop specialized capacity for leadership in designing and implementing curriculum by applying universal design.

PSO8. Understand the curriculum and teaching strategies for individuals with mental retardation.

PSO9. Apply advanced technology for individuals with mental retardation.

Course Outcomes
(Integrated B.EdM.Ed Special Education - Intellectual Disability)

Course Outcomes
Programme: Masters in Special Education
Integrated B.EdM.Ed Special Education - Intellectual Disability

After the completion of the course, the student trainees will be able to:

Title of the Course	No.	Course Outcomes
Psychology of Human Growth and Development 1IA1	CO1	Explain the process of development during infancy
	CO2	Explain the process of development during childhood
	CO3	Explain the process of development during adolescence
	CO4	Analyze the developmental variations among children.
	CO5	Describe adolescence as a period of transition and threshold of adulthood
	CO6	Enumerate different factors affecting child development.
Development of Education and Special Education 1IA2	CO1	Explain the history, nature and process of education
	CO2	Explain the philosophies and their contributions to education
	CO3	Describe the role of education in the modern context
	CO4	Explain the concept of diversity
	CO5	Enumerate the trends seen in contemporary Indian Education
	CO6	Enumerate the issues and challenges faced by contemporary Indian Education in global context
Introductionto SensoryDisabilities 1IB1	CO1	Name the different types of sensory impairments and its prevalence and describe the process of hearing & implications of various types of hearing loss.
	CO2	Explain the issues & ways to address challenges in educating students with hearing loss.
	CO3	Describe nature, characteristics & assessment of students with low vision & visual impairment.
	CO4	Suggest educational placement and curricular strategies for students with low vision& visual impairment.
	CO5	Explicate the impact of deaf-blindness & practices for functional development
Introduction to Neuro Developmental Disabilities 1IB2	CO1	Discuss the characteristics and types of learning disability.
	CO2	Describe the tools, areas of assessment and apply intervention strategies to enhance learning.
	CO3	Explain the characteristics and types of Intellectual disability.
	CO4	Describe the tools, areas of assessment and prepare and apply intervention strategies for independent living.
	CO5	Explain the characteristics and types of Autism Spectrum Disorder.
Introduction to Locomotor and Multiple Disabilities 1IB3	CO1	Identify the persons with Locomotor disabilities such as Cerebral Palsy, Amputees, Polio, Leprosy cured, Muscular dystrophies, Neural and spinal defects and Multiple disabilities.
	CO2	Plan an effective programme for creating awareness about the persons with

	CO3	Locomotor disabilities and Multiple disabilities.
	CO4	Plan an effective therapeutic and programme for the persons with Locomotor disabilities and Multiple disabilities and to refer for medical intervention if necessary.
	CO5	Plan an effective educational programme and functional activities for the persons with Locomotor disabilities and Multiple disabilities.
Identification and Assessment of Children with Intellectual Disability 1IC1	CO1	Comprehend historical perspective, nature and needs and characteristics of persons with Intellectual Disability
	CO2	Understand various procedures, areas and approaches of assessment and their relevance
	CO3	Gain insight into importance of assessment at Pre School and school level and become familiar with development and adaptive behavioural assessment and assessment tools at preschool level
	CO4	Get familiarized with the assessment tools for independent living, provisions
	CO5	Understand the schemes for vocational skills development and implication of assessment
	CO6	Develop understanding about significance of different types of family needs their assessment and implications for extending support to their families, demonstration
Inclusive Education 2IA3	CO1	Explain Inclusion and the progression from segregation to inclusion
	CO2	Appreciate diversity in an inclusive class
	CO3	Describe key nation and international policies and frameworks facilitating inclusive education
	CO4	Enumerate skills in adapting instructional strategies for teaching in mainstream classrooms
	CO5	Describe inclusive pedagogical practices and its relation to good teaching
	CO6	Describe strategies for collaborative working and stakeholder support in implementing inclusive education
	CO7	Explain the role of society in general for successful inclusion
Pedagogy of School Subjects 2IA4 Methodology of Teaching Tamil – Paper I	CO1	Realize the rationale of learning Tamil language
	CO2	Explain the various methods of learning Tamil
	CO3	Illustrate the techniques in teaching prose, poem, grammar and essay
	CO4	Exemplify the fundamental skills of language
	CO5	Comprehend the principles of curriculum development
Pedagogy of School Subjects 2IA4	CO1	Explain the role of English language and mother tongue

Methodology of Teaching English	CO2	Acquire skills and methods of teaching prose and poetry
	CO3	Demonstrate the skills and methods of teaching vocabulary and composition
	CO4	Comprehend the method of teaching the four-fold language skills
	CO5	Distinguish various approaches and techniques of teaching English
Pedagogy of School Subjects 2IA4 Methodology of Teaching Mathematics	CO1	Describe the history of mathematics and its value in day to day applications
	CO2	Apply different methods and techniques in teaching mathematics effectively
	CO3	Understand and identify influence of various psychological factors in learning
	CO4	Make out the individual differences in learning mathematics and to plan activities according to the needs of the students
	CO5	Organize learning resources and apply them appropriately in everyday teaching
Pedagogy of School Subjects 2IA4 Methodology of Teaching Physical Science	CO1	Understand the need and importance of teaching physical science in higher secondary level
	CO2	Able to prepare a lesson plan and presenting them effectively in the classroom
	CO3	Identify and apply various teaching methods for teaching of physical science
	CO4	Develop theoretical and practical understanding of the hardware and software relating to the technology of teaching.
	CO5	Apply the evaluation techniques in the classroom
Pedagogy of School Subjects 2IA4 Methodology of Teaching Biological Science	CO1	Understand the aims, objectives and challenges in teaching biology
	CO2	Obtain various skills needed for class room instruction
	CO3	Identify and prepare various aids for teaching biology
	CO4	Explain the techniques in preparing special aids for teaching biology
	CO5	Acquire the knowledge on the content of biology syllabus for IX standard
Pedagogy of School Subjects 2IA4 Methodology of Teaching Social Science	CO1	Identify the need of teaching social science in school curriculum
	CO2	Apply various instructional strategies in teaching social science
	CO3	Express the need and types of teaching aids in social science
	CO4	Develop skills in writing objectives, preparing lesson plan, unit plan and the need for developing micro teaching skills.

	CO5	Comprehend the essential qualities and functions of a teacher
Pedagogy of School Subjects 2IA4 Methodology of Teaching Computer Science	CO1	Understand the Bloom's taxonomy of educational objectives
	CO2	List out the objectives of teaching of computer science in schools
	CO3	Apply the micro teaching skills during classroom instruction & Point out the qualities of good computer science text book
	CO4	Comprehend the principles of curriculum development
	CO5	Develop skills in constructing test and evaluation
Pedagogy of Teaching Language – Tamil-II 2IA5	CO1	Understand the origin and development of Tamil Language
	CO2	Identify the importance of language in curriculum and principles of poem
	CO3	Comprehend the structure of sound in Tamil language
	CO4	Explain the literary appreciation
	CO5	Distinguish the importance and special features of Tamil Language
Pedagogy of Teaching Language English- II 2IA5	CO1	Employ various methods for teaching English language
	CO2	Clarify the nature of classroom climate and teachers' behaviour
	CO3	Identify the principles of selecting teaching aids and uses of audio visual aids
	CO4	Apply various technologies for teaching English language
	CO5	Explain various strategies, techniques of testing and evaluation in English language
Special Module- II 2IA5	CO1	Define the term transition and explain various stages of Individualized Vocational Transition Plan
	CO2	Identify generic/work readiness skills and conduct job survey and prepare job analysis for persons with mental retardation
	CO3	Explain approaches to vocational assessment, select tools and conduct vocational Assessment
	CO4	Describe various types of employment and related activities to train and place the persons with mental retardation.
	CO5	Introduce the adult related needs such as sex education, self advocacy and recreation
Curriculum Development and Evaluation of Intellectual Disability 2IC2	CO1	Understand the nature of curriculum, principles and steps of curriculum designing, domains and curriculum evaluation
	CO2	Develop insight into importance of early childhood special education, its domains and school readiness programme and their implications.
	CO3	Acquire about curriculum domains at secondary, prevocational and vocational level and understand its implications
	CO4	Understand different strategies for curriculum

		adaptation, accommodation, modification and their significance.
	CO5	Write down the significance of evaluation of the curriculum taught
	CO6	Explain evaluation and make effective use of different techniques
Reading and Reflecting on Texts 2ID1	CO1	Reflect on student's own current level of literacy
	CO2	Undertake practice in basic reading skills to become active readers
	CO3	Undertake practice in basic writing skills to become independent writers
	CO4	Describe strategies to facilitate development of good reading skills among students
	CO5	Describe strategies to facilitate development of good writing skills among students
	CO6	Chooses to read books or write stories or poems as leisure time activity
Learning Teaching and Assessment 3IA6	CO1	Explain theories of learning and intelligence
	CO2	Enumerate the applications of theories of learning and intelligence for teaching children
	CO3	Describe the learning process
	CO4	Describe the nature and theory of motivation
	CO5	Explain stages of teaching and learning
	CO6	Describe the role of the teacher
	CO7	Narrate experiences of the teaching learning process
	CO8	Explain the scope and role of assessment in teaching learning process to introduce dynamic assessment scheme for educational set up towards enhanced learning
Technology and children with intellectual disability 3IC3	CO1	Comprehend role of technology in educating children with ID and acquire knowledge about its various approaches and modes
	CO2	Understand nature of ICT, its basis, development and use
	CO3	Use computer programme and software for the benefit of children with ID
	CO4	DevelopskillsandcompetenciesinuseofPunarjaniandC-DACandintegrate technology for instructions and inclusion
	CO5	Apply technology for developing lesson plan and adapted assistive devices
Early Childhood Care And Education 3IB4 (A)	CO1	Explain the biological & sociological foundations of early childhood education.
	CO2	Describe the developmentalsystems approach and role responsibilities of interdisciplinary teams

		for early education of children with disabilities.
	CO3	Enumerate the inclusive early education pedagogical practices.
Application of ICT in Classroom 3IB4 (B)	CO1	Gauge the varying dimensions in respect of ICT and Applications in Special Education.
	CO2	Delineate the special roles of ICT Applications.
	CO3	Acquire Familiarity with Different Modes of Computer-Based Learning.
Orientation and Mobility 3IB5 (A)	CO1	Describe the nature and scope of O&M as also the O&M related responsibilities of the special teacher.
	CO2	Acquire basic knowledge of human guide techniques.
	CO3	Describe pre-cane and cane travel skills and devices.
	CO4	Get acquainted with the importance and skills of training in independent living for the visually impaired.
Communication Options: Manual (Indian Sign Language) 3IB5 (B)	CO1	Discuss the two manual options with reference to Indian special schools.
	CO2	Discuss the relevant issues like literacy, inclusion and training with reference to manual options.
	CO3	Describe manual options in the light of issues like language, culture and identify.
	CO4	Exhibit beginner level hands on skills in using manual options.
	CO5	Motivate self to learn and practice more skills leading to linguistic adequacy and fluency.
VocationalRehabilitation & Transition to Job Placement 3IB5 (C)	CO1	Develop an understanding of vocational education & its relevance for PWD's.
	CO2	Carry out vocational assessment and make vocational training plan.
	CO3	Plan for transition from School to job.
	CO4	Identify various avenues for job placement.
	CO5	Facilitate PWD's in making choice of vocational trades.
Research methodology and statistics 4IA7	CO1	Explain Inclusion and the progression from segregation to inclusion
	CO2	Appreciate diversity in an inclusive class
	CO3	Describe key nation and international policies and frameworks facilitating inclusive education
	CO4	Enumerate skills in adapting instructional strategies for teaching in mainstream classrooms
	CO5	Describe inclusive pedagogical practices and its relation to good teaching
	CO6	Describe strategies for collaborative working and stakeholder support in implementing inclusive education
	CO7	Explain the role of society in general for successful inclusion
Educational intervention and teaching strategies for children with ID 4IC4	CO1	Understand, plan and use interventional techniques appropriately and demonstrate
	CO2	Realize the importance of developing IEP, acquire the required competencies for its development, implementation and evaluation

	CO3	Understand basic of learning and teaching
	CO4	Demonstrate appropriate teaching strategies for teaching in different curriculum areas
	CO5	Understand nature and identification maladaptive behaviour and learn various modes of its management.
	CO6	Develop understanding of various therapeutics interventions, their objectives, scope, modalities, and require intervention
Adulthood and family issues of students with intellectual disability 4IC5		CO1 Develop understanding of stages of development in adulthood
		CO2 Appreciate importance of family attitude and involvement
		CO3 Understand the Gender, marriage and sexuality related issues.
		CO4 Understand the disability issues related to community
		CO5 Appreciate the importance of adulthood and family training
Psycho social and family issues for ID 4IC6	CO1	Realise importance and role of family in rehabilitation of children with ID
	CO2	Develop insight into various Psycho-social issues and their impact on rehabilitation on PwID, misconception and social practices and develop based approach
	CO3	To realize importance of family involvement in rehabilitation process by forming parents self help group and parent association
	CO4	Understand various Adolescent related issues and challenges their implication for rehabilitation of PwIDs and to explore probable employment opportunities for them
	CO5	Comprehend role of community and community participation and models, advantages / disadvantages of CBR programme for PwIDs
Drama and Art in Education (EPC) 4BD3	CO1	Explain art appreciation, art expression and art education
	CO2	Describe strategies for facilitating learning of various arts for students with and without disabilities
	CO3	Describe adaptive strategies of artistic expression

	CO4	Explain how art can enhance learning
Educational evaluation 5IA8	CO1	Explain the key concepts of evaluation
	CO2	Describe the developments in evaluation
	CO3	Describe the scope of evaluation in education
	CO4	Explain the use of evaluation as an effective tool in teaching-learning process
	CO5	Describe the ways and means of evaluation of Programmes
	CO6	Explain the current trends in evaluation
Therapeutics and assistive devices for children with intellectual disability 5IC7	CO1	Gain knowledge about speech and language therapy
	CO2	Understand the meaning and interventions of physiotherapy
	CO3	Use occupational therapy for PwID
	CO4	Comprehend and apply behavioural techniques for interventions
	CO5	Select and use appropriate assistive devices for PwID
Educational management 5IJA	CO1	Explain the basic fundamental areas of management.
	CO2	Describe the skills required for enhancing institutional quality for sustained development.
	CO3	Enumerate the skills required for capacity building of human resources
	CO4	Explain the skills needed to manage data for various information management processes
	CO5	Prepare cost effective budgets, proposals and describe ways of managing financial resources
Educational technology 5IJB	CO1	Discuss roles of Educational Technologists in various contexts.
	CO2	Apply appropriate instructional strategies.
	CO3	Develop appropriate instructional media.
	CO4	Integrate suitable ICT effectively in teaching-learning-evaluation.
	CO5	Suggest suitable modality of instruction (Online, Blended, etc.).
Guidance and counseling 5IJC	CO1	State the basic concepts in Guidance & Counseling.
	CO2	Discuss Educational, Vocational and Personal Guidance.
	CO3	Describe testing devices and non-testing techniques of guidance.
	CO4	Analyze the problems faced by students in the contemporary world
	CO5	Discuss the problems faced by children with disabilities.

Faculty of Disability Management and Special Education

(FDMSE)

Ramakrishna Mission Vivekananda
Educational and Research Institute (RKMVERI)
Coimbatore Campus

Programme Outcomes
Ph.D in Special Education

Programme: Integrated M.PhilPh.D in Special Education

(Visual Impairment/ Hearing Impairment/ Mental Retardation)

PO1. Knowledge: Gain a thorough knowledge of the literature and a comprehensive understanding of scientific methods and techniques applicable to their own research

PO2. Application: Be able to demonstrate originality in the application of knowledgewith a practical understanding of how research and enquiry are used to create and interpret knowledge in their respective specialization areas.

PO3. Critical Evaluation: Developthe ability to critically evaluate current research and research techniques and methodologies.

PO4. Problem Solving: Be able to have self-direction and originality in tackling and solving problems.

PO5. Researching skills: Be able to act autonomously in the planning and implementation of research and gainoral presentation and scientific writing skills.

PO6.Leadership: Apply leadership skills in advocating and meeting educational needs of children with disabilities in various settings.

PO7.Ethics: Able to identify areas where ethical issues may arise in their work or discipline, and articulate strategies for dealing with ethical issues in the profession.

Programme Specific Outcomes

Programme Specific Outcomes

Programme: Integrated M.PhilPh.D in Special Education (Visual Impairment/ Hearing Impairment/ Mental Retardation)

PSO1. Able to summarize major themes and current research problems in their area of specialization.

PSO2. Able to communicate the major tenets of their field and their work orally and in writing for students, peers and the lay public.

PSO3. Identify problems and areas needing development in their respective specialization areas.

PSO4.Build theoretical knowledge and skills in research methodologies and conducting research in order to enhance inclusive education for children with disabilities.

PSO5.Develop skills in making and testing hypotheses, in developing new theories, and in planning and conducting experiments; developing practical research skills and learn new state of the art techniques used in Special Education research

PSO6.Develop leadership abilities that help them to learn to collaborate and communicate while working in team projects.

PSO7. Use their research aptitude in planning, developing and adapting the curriculum, teaching strategies and materials based on the individualized needs of individuals with visual impairment/ hearing impairment/ mental retardation.

PSO8. Acquire mastery over skills to assess and apply the current technological devices and services for individuals with visual impairment/ hearing impairment/ mental retardation and customize based on their unique needs.

Course Outcomes

Course Outcomes
Programme: Ph.D in Special Education

Title of the Course	No.	Course Outcomes
Methods of Research In Education 1TP1	CO1	Enhance basic knowledge in Educational Research
	CO2	Equip with the knowledge required for review, sampling and instrumentation
	CO3	Encourage the scholars in preparing research proposals and research reports
	CO4	Enable the scholars to apply the SPSS package in data analysis
	CO5	Understand the need for inter-disciplinary approach to educational research
Practices and Issues in Special Education 1TP2	CO1	Examine the current scenario of education.
	CO2	Understand the learning theories and its implication in current learning trends.
	CO3	Deal with the recent evaluation methods in inclusion.
	CO4	Examine the changing roles of teacher in current scenario
	CO5	Focus on value development and related aspects of character building
	CO6	Deal with issues and perspectives of future education.
Background Paper 1TP3	CO1	Examine the emerging issues and problems in the field of special education
	CO2	Understand the available review of literature in the emerging issues.
	CO3	Able to find out the solutions

Faculty of General and Adapted Physical Education & Yoga (GAPEY)

Ramakrishna Mission Vivekananda Educational and Research Institute (RKMVERI) Coimbatore Campus

Programme: Bachelor of Physical Education, Health Education and Sports

Programme Outcomes

PO1. By learning and understanding the languages namely **Tamil, Hindi and English**, the students are able to acquire the skills to communicate fluently. Various prose and poems are also taught to the students and they learn the ideals of great men. This attributes to their language enhancement.

PO2. The theoretical knowledge of **track and field** events helps the students to learn the various techniques along with the international rules of the events. Since they learn the rules, they can become qualified state, national and international officials. This definitely will elevate their professional career. They will be of great demand in their professional circle.

PO3. Present day technological developments have paved a clear way to the sports performance enhancement. Hence the **Foundation of Physical education** is introduced to the students. The history of both physical education and Olympics helps the students to know the background of the events. Towards the further improvement, it is apt to say that Young Men Christian Association (YMCA), Sports Authority of India (SAI), Sports Development Authority of Tamil Nadu (SDAT), National and International competitions and sports festivals contribute to the present day sports performance improvement..

PO4. **Anatomy and Physiology** are the sports science subjects deal with the structure and functions of the human body. Since, the knowledge about human body is very essential to understand the muscular and skeletal involvements of various joints, the students learn this mechanism with lot of interest to perfect the sports movements. It is useful to learn about the internal organs like heart,

lungs and nervous system as they are the primary supporters of all body movements. This knowledge will assure the students the ratio of physical work and recovery.

PO5. Health and safety education is another branch of science that gives knowledge about the personal health and safety education. The students show a lot of interest to know the meaning, principles, components of personal and community hygiene. By understanding the communicable diseases, the students are able to lead a diseases free life. As they are involved in regular physical training, safety education plays a dominant role. They also learn to be safe at home, on the play field, inside a gym and in the public. They act as health ambassadors and carry the adage namely "Prevention is better than cure".

PO6. All students understood that **Gymnastics** is the mother of all sports. Hence they learn all gymnastic movements and will teach the same to the children at an early age. The process of transferring the knowledge will definitely help the children to improve sensory motor balance, neuromuscular coordination, muscular agility and joint mobility. They also learn to use different gymnastic apparatus along with the rules to use them efficiently.

PO7. The study of **foundation of yoga** helps the students to understand the historical background, need and importance. This branch of knowledge helps to know the various limbs of yoga, asanas, paranayama, kriyas and banda.

PO8. The branch of science namely **biomechanics and kinesiology** deal with movements of the human body using mechanical principles. The competitive techniques of various games and sports activities demand for perfect movements. In order to enhance sports performance, it is necessary to execute the movements with accurate and appropriate body mechanics. That's why students show a great deal of importance to learn this subject.

PO9. Methods of physical education deals with appropriate methods to present the scientific inputs effectively. Serious planning is required for teaching various sports techniques effectively. The scientific inputs will reach the students fully when the teacher uses appropriate teaching methods. All the students learn from this branch of science the system of conducting intramural and extramural competitions. This knowledge will widen the scope of the future teacher's professional career.

PO10. The subject namely **"Nutrition"** gives scope to the students to understand "healthy diet". Students also learn the importance of vitamins and minerals. This knowledge will definitely improve the health of the sports persons, family health and in turn the health of the whole society.

PO11. The branch of science namely **General Theory and Methods of Sports Training (GTMT)** imparts scientific knowledge about training of sports persons. The general and specific fitness is the outcome of sports training. The students learn various sports training methodology which could be used to develop all the fitness components and sports performance. Students also find this science to be very useful to prepare short, medium and long term training plans.

PO12. Another branch of sports science is **"Tests and Measurements".** Students understand the meaning and importance of this science. They use this knowledge for anthropometric, physical, physiological, psychological and game specific evaluation of sports persons.

PO13. The sport science subject namely **"Psychology and Sociology"** has found a very important place in sports training. Students become familiar with laws of learning, theories of learning and learning curve. Students are also aware of the relationship with others, leadership qualities and their own personality improvement.

PO14. The subject namely **"Communicative English"** plays a vital role in the modern educational system. Enhancement of communication skill will definitely improve the quality of interaction between the individuals. This skill will add to the total personality of the individual. Hence all the students try their level best to improve the communication skill at the earliest.

PO15. The subject namely **"Test of Reasoning"** is included in the curriculum because of its quality to induce the students to reason out correctly in various situations. Hence the students are motivated to learn and understand this subject.

PO16. "Applications of Computer" is of vital importance in the modern society. Surfing net gives a lot of professional inputs. Students can use them to enhance their professional competency. They can store huge volume of professional information on various issues. Students are able to get the latest information instantly.

PO17. The subject namely **"Personality Development and Career Guidance"** is found to be very useful for the present day students. Students are in need of acceptable personality development and appropriate career guidance. This subject caters to the need of the present day students population. They get definite inputs to improve their own personality and get quality career guidance. This helps them to settle down in life without facing serious difficulties.

PO18. The study of **"Value Education and Human Rights"** gives the actual educational values and to understand the "human rights". Both help for leading a productive life. Being the members of the next generation, all the students learn the subjects with a positive motivation. This would definitely make them good natured members of the society.

PO19. The subject namely **"Environmental studies"** has found its way into the society recently. Students become aware of their own environment and decide to keep up the same in future. They are able to understand to protect the forest and water resources. They are also aware of various kinds of polluting agents and help the society to minimize using polluting agents. Thereby it is believed to have a pollution free environment and a healthy society.

PO20. By completing an appropriate **project**, the students learn making proper mapping concepts, flow charts, sequencing, reporting, creative writing and model making.

PO21. The understanding of **"First aid"** along with its meaning, values and uses give the students a broad knowledge to use this technology on and off the field injury management.

PO22. The practical classes in **track and field** events help the students to learn the various techniques of performing competitive track and field events. Students who are able to improve their sports specific performance will continue their practice to improve their competitive performance in their specialized events.

PO23. The knowledge of **gymnastics** helps the students the process of transferring the knowledge in a practical way. This will definitely help the children to improve sensory motor balance, neuromuscular coordination, muscular agility and joint mobility.

PO24. The learning of **major games** (practical) namely Basketball, Football, Hockey, Kabaddi, Tennis and Volleyball helps to stabilize the fundamental skills by doing drills for development. They can also learn the rules of the games for efficient teaching and officiating.

PO25. Involving and conducting **project sport meets** by themselves will certainly update their knowledge about planning and organizational skills.

PO26. By learning this subject namely **care and maintenance**, all the students learn the methods to maintain the play fields, playing kits and playing equipments.

PO27. Unified play day celebration is one of the interesting activities in our curriculum and by which students get an opportunity to guide intellectually disabled persons, to improve their understanding and communicating process so as to help the disabled students to attain individual wholesome development and improve their life skills.

PO28. Studying and understanding the **science of Yoga** helps the students to become familiarized with asanas, pranayama, Kriyas, mudras and bandhas. Learning and practicing yoga bring the mind and body together and to lead a whole some, healthy and disease free life.

PO29. The special practical program in our curriculum namely **Leadership camp** which is conducted regularly in a natural environment away from our campus and that will develop for sure the leadership qualities by self-involvement and being friendly with the nature.

PO30. Practice teaching helps students to get firsthand information about the effective teaching methodology being used to make learning of game skill easy and effective.

PO31. Participating in **National Service Scheme (NSS) or National Cadet Corps (NCC)** helps the students to prepare themselves smart, to be social, to maintain green and healthy environment.

Programme Specific Outcomes

PSO1. Languages (Tamil, Hindi and English): To use the languages fluently according to the demand of the situation during the professional career.

PSO2. Track and Field: The knowledge of track and field elevates the professional competency.

PSO3. Foundation of physical education: To understand the progressive development of physical education and Olympics.

PSO4. Theories of specialization games: To understand the Rules, their interpretations, basic skills and their drills of basketball, football, hockey, kabaddi, tennis and volleyball.

PSO5. Anatomy and Physiology: Understanding anatomy and physiology helps to learn sports movements correctly and execute them in a perfect way.

PSO6. Health education and safety education: To be aware of diseases and to lead a healthy life.

PSO7. Gymnastics: Learning gymnastics will improve sensory motor balance, neuromuscular coordination, muscular agility and joint mobility.

PSO8. Foundation of Yoga: Yoga focuses on establishing harmony between mind and body, thoughts and actions, restraint and fulfillment and men and nature.

PSO9. Biomechanics and Kinesiology: To execute the sports movements with accurate and appropriate body mechanics.

PSO10. Methods of physical education: To improve the ability to use appropriate teaching methods for effective teaching and to organize sports and games competitions flawlessly.

PSO11. Nutrition: The knowledge of nutrition will definitely improve the health of the sports persons, family health and in turn the health of the whole society.

PSO12. General theory and methods of sports training: All the students learn the various sports training methodology which could be used to develop all the fitness components and sports performance.

PSO13. Test and measurements: The students use this knowledge for anthropometric, physical, physiological, psychological and game specific evaluation for both sports persons and non-sports persons.

PSO14. Psychology and Sociology: The Students are aware of a balanced mind and body development. They also develop social relationship with others, leadership qualities and their own personality improvement.

PSO15. Communicative English: Enhancement of communication skill will definitely improve the quality of interaction and understanding between the individuals.

PSO16. Test of reasoning: Test of Reasoning is included in the curriculum because of its quality to induce the students to reason out the issues correctly in various situations.

PSO17. Application of computer: Application of computer is a unique subject that helps the students to use the computer technology in their research work.

PSO18. Personality development and career guidance: This subject caters to the need of the present day students because they are in need of acceptable personality development and appropriate career guidance.

PSO19. Value education and human rights: The knowledge about value education and human rights help the students to lead a productive life. Being the members of the next generation, all the students learn these subjects and practice them to grow as a worthy member of the society.

PSO20. Environmental studies: Students become aware of their own environment and decide to keep up the same in future. They are able to understand to protect the forest and water resources. They are also aware of various kinds of polluting agents and help the society to minimize using polluting agents.

PSO21. Project: By completing an appropriate project, the students learn making proper mapping concepts, flow charts, sequencing, reporting, creative writing and model making.

PSO22. First Aid: The understanding of "First aid" along with its meaning, values and uses give the students a broad knowledge to use this technology on and off the field injury management.
Practical:

PSO23. Track and Field (6 Semesters): Students learn all the techniques to perform all the competitive track and field events along with the international rules. This helps them to prepare for becoming officials of state, national and international levels.

PSO24. Gymnastics (2 Semesters): Learning gymnastics will improve sensory motor balance, neuromuscular coordination, muscular agility and joint mobility which help them to stabilize other competitive techniques of games and track and field events.

PSO25. Specialization games: To understand the Rules, their interpretations, basic skills and their drills of basketball, football, hockey, kabaddi, tennis and volleyball. The students may become efficient coaches in these games.

PSO26. Unified play day: This event has proved its efficacy in improving social interaction, confidence and self-esteem of special children. A normal child is motivated to team up with a special child and carry out all activities as joint enterprise. This helps to attain individual whole some development and improve their own life style modifications.

PSO27. Yoga: To become familiarized with asanas, pranayama Kriyas, mudras and bandas. Learning and practicing yoga bring the mind and body together and to lead a whole some disease free life.

PSO28. Leadership training camp: To develop the leadership qualities by self-involvement and friendly with the nature.

PSO29. Practice teaching: To get firsthand information about effective teaching methodology. To find out the effectiveness of various teaching methodology.

PSO30. Project sports meet: To get firsthand knowledge about planning and organizing sports meet.

PSO31. Care and Maintenance: To learn the methods to maintain the play field and playing equipments.

PSO32. NSS / NCC: To preparing oneself smart, social and maintain green environment.

Course Outcomes

After the completion of the course, the student trainees will be able to:

Title of the Course	No.	Course Outcomes
Tamil I/ Hindi I	CO1	To learn the prehistoric life through poem.
	CO2	To learn the translated historical literature.
	CO3	To learn the modern poetic nature.
	CO4	To use the language as per the need.
	CO5	To learn the history of literature.
English I	CO1	To understand the thoughts of great writers.
	CO2	To understand the thoughts of great poets.
	CO3	To understand English in a methodical way.
	CO4	To understand the events in a poetic way.
	CO5	To learn parts of speech, active, passive voice and types of sentences.
Foundations of physical education	CO1	To understand the meaning of physical education
	CO2	Understand the foundation of physical education
	CO3	To know about allied sciences, camping and recreation.
	CO4	To learn history of Olympics and physical education.
	CO5	To know the contribution of various agencies, awards and scholarships.
Track and Field - I	CO1	To learn the rules and techniques of Sprint events.
	CO2	To learn the rules and techniques of middle distance events.
	CO3	To learn the rules and techniques of Long jump.
	CO4	To learn the rules and techniques of High jump.
	CO5	To learn the rules and techniques of Shot put.
Communicative English	CO1	To learn and make sentences
	CO2	Learn to frame simple questions for an effective conversation.
	CO3	Learn to speak using mike.
	CO4	To face the committee members in an interview.
	CO5	To develop reading and writing abilities.
Track and field (Sprints, Middle distance, Long jump, high jump and shot put)	CO1	To learn the technique of Sprinting, Jumping and Shot putting
Gymnastics (Floor exercise, Rhythmic exercise and Horizontal bar exercises)	CO1	To become familiarized with floor and bar exercises.
Specialization Games (Basketball, Football, Hockey, Kabaddi, Tennis and Volleyball)	CO1.	To learn the fundamental skills of major games
	CO2.	To learn the rules of the games for efficient officiating
	CO3.	To know the various drills for optimum skill development.
Project sport meet	CO1.	To get firsthand knowledge about planning and organizing sports meet.
Care and maintenance	CO1.	To learn the methods to maintain the play fields.
	CO2.	To learn the methods to maintain the playing equipments.

Tamil II / Hindi II	CO1	To learn epics namely Silappathigaram and Manimegalai.
	CO2	To learn epics like Kambaramayanam and Periyapuranam.
	CO3	To learn Barathiar poems.
	CO4	To learn history of tamil/ hindi language.
	CO5	To learn short stories.
English II	CO1	To understand the thoughts of great writers.
	CO2	To understand the thoughts of great poets.
	CO3	To understand English in a methodical way.
	CO4	To understand the events in a poetic way.
	CO5	To learn paragraph writing, formal and informal letter writing.
Theory of specialization game	CO1	To learn the history of basketball, football, hockey, kabaddi, tennis and volleyball.
	CO2	To understand layout of play fields and major trophies of basketball, football, hockey, kabaddi, tennis and volleyball.
	CO3	To understand the Rules and their interpretations of basketball, football, hockey, kabaddi, tennis and volleyball.
	CO4	To learn the Basics skills and their drills of basketball, football, hockey, kabaddi, tennis and volleyball.
	CO5	Duties of officials and officiating mechanism of basketball, football, hockey, kabaddi, tennis and volleyball.
Human anatomy and Physiology	CO1	To understand the need and importance of Anatomy and Physiology.
	CO2	To understand the Classification and functions of skeleton
	CO3	To understand the structure and function of heart and lungs.
	CO4	To learn the structure and functions of digestive and nervous systems.
	CO5	To get familiarized Different glands and their functions in the body.
Test of reasoning	CO1	To understand number series, matrix, alphabetical direction and blood relation tests.
	CO2	To learn Venn diagram, set, coding, best reason, measures of quantity, conversion of measurements and age calculation tests.
	CO3	To understand the Figures and system to find out the odd man out.
	CO4	To know the awards and awardees and the names of national and international federations.
	CO5	To know the year, venue and country where the Olympic, commonwealth and Asian games were held.
Track and field (Sprints, Middle distance, Long jump, high jump and shot put)	CO1	To learn the technique of Sprinting, Jumping and Shot putting
Gymnastics (Floor exercise, Rhythmic exercise and Horizontal bar exercises	CO1	To become familiarized with Trampoline and bar exercises.
Specialization	CO1	To learn the fundamentals of major games.

Games (Basketball, Football, Hockey, Kabaddi, Tennis and Volleyball)	CO2	To learn the rules of the games for efficient officiating
	CO3	To know the various drills for optimum skill development.
Unified Play day (UPD)	CO1	To get an opportunity to guide intellectually disabled persons.
	CO2	To help the intellectually disabled persons to improve their understanding and communicating process.
	CO3	To attain individual whole some development.
Project sport meet	CO1	To get firsthand knowledge about planning and organizing sports meet.
Care and maintenance	CO1	To learn the methods to maintain the play fields.
	CO2	To learn the methods to maintain the playing equipments
Tamil III / Hindi III	CO1	To learn the epics written by Thirugnanasambandar, Thrunavukkarasar and Sundharar.
	CO2	To learn the epics written by Maanikavasagar, Periyhalvar and Aandavar.
	CO3	To learn the epics written by Thayumanavar, Arunagirinadher and Vallalar.
	CO4	To learn short stories by PudumaiPithan.
	CO5	To learn history of literature.
English III	CO1	To understand the thoughts of great writers.
	CO2	To understand the thoughts of great poets.
	CO3	To understand English in a methodical way.
	CO4	To understand the events in a poetic way.
	CO5	To learn application and paragraph writing.
Health education and safety education	CO1	To become aware of a positive attitude about health.
	CO2	To acquire the knowledge of safety education.
	CO3	To know about communicable and non-communicable diseases.
	CO4	To learn principles and importance of safety.
	CO5	To learn safety at home, Swimming pool, Gymnasium, play field and use of play equipments.
Track and field - II	CO1	To know about starting techniques of all track events.
	CO2	To learn the rules and their interpretation of 800m, 1500m 3000m, 5000m, 10,000m, marathon and race walking.
	CO3	To learn the rules and their interpretations of long jump, triple jump, high jump and pole vault.
	CO4	To learn the rules and interpretations of heptathlon and decathlon.
	CO5	To know the records of all events in national and international levels.
Application of computers	CO1	Know the basics of computer.
	CO2	Understand the basics of Microsoft office.
	CO3	Understand the MS word operations.
	CO4	Understand the MS Excel and PowerPoint operations.
	CO5	To learn about internet for effective networking and communication.
Track and field (Long distance race, Triple jump, Discus throw, Relays and Race walking)	CO1	To learn the techniques of Long distance race, Triple jump, Discus throw, Relays and Race walking

Yoga (Basic level asanas, Pranayama and Mudras)	CO1	To become familiarized with basic level asanas, pranayama and mudras.
Specialization Games (Basketball, Football, Hockey, Kabaddi, Tennis and Volleyball)	CO1	To learn the fundamentals of major games.
	CO2	To learn the rules of the games for efficient officiating
	CO3	To know the various drills for optimum skill development.
Leadership training camp	CO1	To learn leadership qualities by self-involvement.
	CO2	To become friendly with the nature.
	CO3	To become efficient future leaders.
Project sport meet	CO1	To get firsthand knowledge about planning and organizing sports meet.
Care and maintenance	CO1	To learn the methods to maintain the play fields.
	CO2	To learn the methods to maintain the playing equipments.
Tamil IV / Hindi IV	CO1	To learn selected events from Purananuru.
	CO2	To learn the selected events from Ainkurunuru, Kurundhohai and Nattinai.
	CO3	To learn the selected events from Naaladiyar, Aratthuppal and Thuravaraeyal.
	CO4	To learn short stories by Parthasarathi.
	CO5	To learn history of literature from Yettuthogai and Pathupattu, and traditional games.
English IV	CO1	To understand the thoughts of great writers.
	CO2	To understand the thoughts of great poets.
	CO3	To understand English in a methodical way.
	CO4	To understand the events in a poetic way.
	CO5	To learn active, passive voice, expansion of proverbs and creative writing.
Gymnastics	CO1	To learn history, meaning and classifications of gymnastics.
	CO2	To learn about artistic gymnastics.
	CO3	To understand rhythmic gymnastics.
	CO4	To learn rights and duties of gymnasts, judges and coaches.
	CO5	To evaluate the degree of difficulty of various exercises and the rules of using equipments.
Foundation of yoga	CO1	To know the need and importance of different types of yoga.
	CO2	To understand the eight limbs of yoga.
	CO3	To understand the correct procedure of doing asanas
	CO4	To understand the correct procedure of doing pranayama.
	CO5	To gain knowledge about kriyas.
Personality development and career guidance	CO1	To develop various aspects of personality.
	CO2	To improve students' self–esteem and self–confidence.
	CO3	Using personality in the day to day life.
	CO4	To make the students aware of their career and opportunities.
	CO5	To develop various personality tests.
Track and field (Long distance race, Triple jump, Discus throw, Relays and Race walking)	CO1	To learn the techniques of Long distance race, Triple jump, Discus throw, Relays and Race walking.
Yoga (Advanced level asanas,	CO1	To become familiarized with advanced level asanas, pranayama, Kriyas and bandhas

Pranayama, Kriyas and Bhandhas.)		
Specialization Games (Basketball, Football, Hockey, Kabaddi, Tennis and Volleyball)	CO1	To learn the fundamentals of major games.
	CO2	To learn the rules of the games for efficient officiating
	CO3	To know the various drills for optimum skill development
Unified Play day (UPD)	CO1	To get an opportunity to guide intellectually disabled persons.
	CO2	To help the intellectually disabled persons to improve their understanding and communicating process.
	CO3	To attain individual wholesome development.
Project sports meet	CO1	To get firsthand knowledge about planning and organizing sports meet
Care and maintenance	CO1	To learn the methods to maintain the play fields.
	CO2	To learn the methods to maintain the playing equipments.
Biomechanics and Kinesiology	CO1	To learn the meaning of biomechanics.
	CO2	To learn kinematics.
	CO3	To understand Newton's Laws and their applications.
	CO4	To understand brief history and objective of kinesiology.
	CO5	To learn the origin, insertion, action and location of important skeletal muscles
Methods of physical education	CO1	To understand the meaning, method, presentation and class management.
	CO2	To understand the types and values of lesson plan and different commands.
	CO3	To understand various teaching methods, games and other activities.
	CO4	To understand the meaning and types of fixtures to conduct various types of tournaments.
	CO5	To learn the objectives, benefits and the methods to conduct intramural, extramural, standard and nonstandard sports meets.
Nutrition	CO1	To learn the balanced diet and importance of carbohydrates for various sports and games.
	CO2	To learn the importance and sources of protein.
	CO3	To learn the types, importance and sources of fat.
	CO4	To learn the types, importance and sources of vitamins.
	CO5	To learn the types, importance and sources of minerals.
Value education and human rights	CO1	To understand the aim and value of education.
	CO2	To understand the self-analysis and brief introspection of family members and society.
	CO3	To inculcate positive personality.
	CO4	To understand the meaning, concept and classification of human rights.
	CO5	To understand the human rights of women and children.
Environmental studies	CO1	To be aware of scope, need and importance of environmental science.
	CO2	To be aware of forest resources.
	CO3	To learn the causes of environmental pollution.
	CO4	To understand the social issues and the environment.
	CO5	To understand human population and the environment.

National service scheme (NSS)	CO1	To understand the origin and development of NSS.
	CO2	To learn the administrative set-up of NSS.
	CO3	To develop personality awareness and improve social service attitude.
Track and field (Hammer throw, Javelin throw, Pole vault and Hurdles)	CO1	To learn the techniques of Hammer throw, Javelin throws Pole vault and Hurdles
Specialization Games (Basketball, Football, Hockey, Kabaddi, Tennis and Volleyball)	CO1	To learn the fundamentals of major games.
	CO2	To learn the rules of the games for efficient officiating
	CO3	To know the various drills for optimum skill development.
Project sports meet	CO1	To get firsthand knowledge about planning and organizing sports meet
Care and maintenance	CO1	To learn the methods to maintain the play fields.
	CO2	To learn the methods to maintain the playing equipments
Practice Teaching	CO1	To get firsthand information about effective teaching methodology
	CO2	To find out the effectiveness of various teaching methodology
NSS/NCC	CO1	To be prepare oneself for social activities
	CO2	To develop smart personality
	CO3	To maintain green environment.
General theory and methods of sports training	CO1	To learn the aim, meaning and principles of sports training.
	CO2	To learn the meaning, types and principles of training lode.
	CO3	To learn the types and methods to develop strength and endurance.
	CO4	To learn the types and methods to develop speed, flexibility and coordinative abilities.
	CO5	To understand the types of training plans, types of periodization, techniques, tactics and strategy.
Tests and measurements	CO1	To learn the meaning, need and importance of tests, measurements and evaluation.
	CO2	To learn the criteria of test selection, classification of tests, rating scales and test administration.
	CO3	To learn motor fitness, cardio vascular, strength and postural tests.
	CO4	To learn SDAT tests.
	CO5	To learn and use games skill tests in Basketball, Hockey, Soccer, Volleyball, Badminton and Tennis
Psychology and sociology	CO1	Understand the importance of psychology and sports psychology.
	CO2	Understand the theories and laws of learning.
	CO3	Importance of perception and motivation.
	CO4	Types of anxiety, aggression and personality.
	CO5	Role of sociology in physical education and sports
Project	CO1	To understand concept mapping and flow chart.
	CO2	To learn graphical representation and sequencing.
	CO3	To maintain album and scrap book.
	CO4	To improve reporting and creative writing ability.
	CO5	To improve the skill of model making
	CO1	To learn the meaning and values of first aid.

First aid	CO2	To learn the meaning, importance and classification of wound.
	CO3	To learn the system of specific injury management namely muscle cramp, fracture, bleeding and heart attack.
	CO4	To learn the system of specific injury management namely poisoning, drowning, dog bite, snake bite, fainting and burns.
	CO5	To learn the meaning and classification of various therapy techniques namely hydrotherapy, thermotherapy and cryotherapy
Track and field (Hammer throw, Javelin throw, Pole vault and Hurdles)	CO1	To learn the techniques of Hammer throws, Javelin throws Pole vault and Hurdles.
Specialization Games (Basketball, Football, Hockey, Kabaddi, Tennis and Volleyball)	CO1	To learn the fundamentals of major games.
	CO2	To learn the rules of the games for efficient officiating
	CO3	To know the various drills for optimum skill development
	CO4	To learn the fundamentals of major games.
Project sports meet	CO1	To get firsthand knowledge about planning and organizing sports meet.
Care and maintenance	CO1	To learn the methods to maintain the play fields.
	CO2	To learn the methods to maintain the playing equipments.
Unified Play day (UPD)	CO1	To get an opportunity to guide intellectually disabled persons.
	CO2	To help the intellectually disabled persons to improve their understanding and communicating process.
	CO3	To attain individual wholesome development.
Practice Teaching	CO1	To get firsthand information about effective teaching methodology
	CO2	To find out the effectiveness of various teaching methodology

Faculty of General and Adapted Physical Education & Yoga (GAPEY)

Ramakrishna Mission Vivekananda Educational and Research Institute (RKMVERI) Coimbatore Campus

Programme: Bachelor of Physical Education

Programme Outcomes

PO1. Present day technological developments have paved a clear way to the sports performance enhancement. Hence the **History, Principles and Foundation of Physical education** are introduced to the students. The history of both physical education and Olympics helps the students to know the background of the events.

PO2. Anatomy and Physiology are the sports science subjects deal with the structure and functions of the human body. Since, the knowledge about human body is very essential to understand the muscular and skeletal involvements of various joints, the students learn this mechanism with lot of interest to perfect the sports movements. It is useful to learn about the internal organs like heart, lungs and nervous system as they are the primary supporters of all body movements. This knowledge will assure the students the ratio of physical work and recovery.

PO3. The subject namely **Education technology and methods of teaching physical education** improves the ability to use appropriate teaching methods for effective teaching and to organize sports and games competitions flawlessly. They also learn the latest teaching and evaluation technology.

PO4. Studying about **Olympic movement**, all the students understand the progressive development of both ancient and modern Olympic movements.

PO5. Health and Environmental studies is another branch of science that gives knowledge about the personal health and safety education. The students show a lot of interest to know the meaning, principles, components of personal and community hygiene. By understanding the communicable diseases, the students are able to lead a diseases free life.

PO6. The study of **foundation of yoga** helps the students to understand the historical background, need and importance. This branch of knowledge helps to know the various limbs of yoga, asanas, paranayama, kriyas and bandhas.

PO7. The branch of science namely **Sports Training** imparts scientific knowledge about training of sports persons. The general and specific fitness is the outcome of sports training. The students learn various sports training methodology which could be used to develop all the fitness components and sports performance. Students also find this science to be very useful to prepare short, medium and long term training plans.

PO8. From the subject namely **Organization and administration in physical education**, the students learn the concept of organization and administration of office management, record and register maintenance, time management along with budget preparation. They are also able to know the methods to organize competitions at various levels

PO9. From the subject namely **Contemporary issues in physical education, Fitness and wellness** the students learn the basics of fitness and wellness, along with its issues and challenges.

PO10. This knowledge helps to know the problems of modern life style and to follow suitable lifestyle to escape from the modern lifestyle challenges

PO11. From this science namely **Sports nutrition and weight management**, students learn the basic nutritional guidelines and plans related to macro, micro nutrients and the healthy diet to control obesity to lead a happy and healthy life.

PO12. Another branch of sports science is **"Tests and Measurements and Evaluation in physical education".** Students understand the meaning and importance of this science. They use this knowledge for anthropometric, physical, physiological, psychological and game specific evaluation of sports and non-sports persons.

PO13. The subject namely **Computer Applications in physical education** is of vital importance in the modern society. Surfing net gives a lot of professional inputs. Students can use them to enhance their professional competency. They can store huge volume of professional information on various sports related issues. Students are able to get the latest information instantly.

PO14. From **Sports medicine, Physiotherapy and Rehabilitation**, the students learn the basics of sports medicine, athletic injuries, injury management techniques, Understand the applications of various therapies along with therapeutic exercises and their applications.

PO15. This subject namely **Sports management and curriculum design**, students learn the basics of sports management, leadership and its forms. They also learn the modern concept of curriculum in various levels.

PO16. From **Adapted Physical Education**, the students learn the importance of adapted physical education, classification of disability, facilities and equipments for adapted sports activities and to organize adapted games and sports for persons with disabilities. To be able to give academic instructions, adaptations and modifications in the inclusive education setup.

PO17. Theories of Sports and Games help the students to learn the history, development of games and sports, ground marking technology, to know the standardized play equipments along with their specifications, understand ethics of sports and sportsmanship and to Interpret rules and regulations of various sports and games.

PO18. Kinesiology and Biomechanics deal with movements of the human body using mechanical principles. The competitive techniques of various games and sports activities demand for perfect movements. In order to enhance sports performance, it is necessary to execute the movements with accurate and appropriate body mechanics. That's why students show a great deal of importance to learn this subject.

PO19. From this subject namely **Officiating and Coaching**, the students are able to understand the basics of officiating and coaching, duties of officials, qualities and qualifications of coach & officials and to follow the scientific principles used in modern sports coaching.

PO20. Methods of physical education deals with appropriate methods to present the scientific inputs effectively. Serious planning is required for teaching various sports techniques effectively. The scientific inputs will reach the students fully when the teacher uses appropriate teaching methods. All the students learn from this branch of science the system of conducting intramural and extramural competitions. This knowledge will widen the scope of the future teacher's professional career.

PO21. The sport science subject namely **"Psychology and Sociology"** has found a very important place in sports training. Students become familiar with laws of learning, theories of learning and learning curve. Students are also aware of the relationship with others, leadership qualities and their own personality improvement.

PO22. From this science namely **Research and Statistics in Physical Education**, all the students know the basics of research, its classifications and types. The preparation of a project report shows that the student Know the system of data analysis and the statistical versions used in physical education research.

Programme Specific Outcomes

PSO1. History, Principles and Foundation of Physical Education: To understand the progressive development of physical education and Olympic movement. Know the psychological and sociological principles followed in physical education.

PSO2. Anatomy and Physiology: Understanding anatomy and physiology help to learn sports movements correctly and execute them in a perfect way in relation to the functional aspect of various systems.

PSO3. Education technology and methods of teaching physical education: To improve the ability to use appropriate teaching methods for effective teaching and to organize sports and games competitions flawlessly. They also learn the latest teaching and evaluation technology.

PSO4. Olympic movement: To understand the progressive development of both ancient and modern Olympic movements.

PSO5. Health education and environmental studies: To learn the basic concepts of health services provided, health problems faced and to understand the natural resources along with its issues.

PSO6. Yoga education: Yoga focuses on establishing harmony between mind and body, thoughts and actions, restraint and fulfillment and men and nature.

PSO7. Sports training: All the students learn the various sports training methodology which could be used to develop different fitness components and ultimately the sports performance.

PSO8. Organization and administration in physical education: Learn the concept of organization and administration of office management, record and register maintenance, time management along with budget preparation. There are also able to Know the methods to organize competitions of various levels.

PSO9. Contemporary issues in physical education, Fitness and wellness: TO learn the basics of fitness and wellness, along with its issues and challenges.This knowledge helps to know the problems of modern life style and to follow suitable lifestyle to escape from the modern lifestyle challenges.

PSO10. Sports nutrition and weight management: Students learn the basic nutritional guidelines and plans related to macro, micro nutrients and the healthy diet to control obesity to lead a healthy life.

PSO11. Measurement and Evaluation in physical education: The students use this knowledge for anthropometric, physical, physiological, psychological and game specific evaluation for both sports persons and non-sports persons.

PSO12. Computer application in physical education: Application of computer is a unique subject that helps the students to use the computer technology in their research work

PSO13. Sports medicine, Physiotherapy and Rehabilitation To learn the basics of sports medicine, athletic injuries, injury management techniques, Understand the applications of various therapies along with therapeutic exercises and their applications.

PSO14. Adapted Physical Education To learn the importance of adapted physical education, classification of disability, facilities and equipments for adapted sports activities and to organize adapted games and sports for persons with disabilities. To be able to give academic instructions, adaptations and modifications in the inclusive education setup.

PSO15. Sports management and curriculum design: To learn the basics of sports management, leadership and its forms. They also learn the modern concept of curriculum in various levels.

PSO16. Theories of Sports and Games: To learn the history, development of games and sports, ground marking technology, to know the standardized play equipments along with their specifications, understand ethics of sports and sportsmanship and to Interpret rules and regulations of various sports and games.

PSO17. Kinesiology and Biomechanics: To execute the sports movements using accurate and appropriate body mechanics.

PSO18. Officiating and Coaching: All the students are able to understand the basics of officiating and coaching, duties of officials, qualities and qualifications of coach & officials and to follow the scientific principles used in modern coaching.

PSO19. Sports Psychology and Sociology: Students are aware of a balanced mind and body development. They also develop social relationship with others, leadership qualities and their own personality improvement.

PSO20. Research and Statistics in Physical Education: All the students know the basics of research, its classifications and types. The preparation of a project report shows that the student Know the system of data analysis and the statistical versions used in physical education research.

Practicum

PSO21. Track and Field (Running, Jumping and Throwing) : All the students learn the basic techniques of running namely short, medium and long distance competitive runs, throwing and jumping events. They are also encouraged to learn and interpret the international rules.

PSO22. Indigenous sports (Malkhambh, Lezium and March past): Students learn the basics of indigenous sports and perform the techniques in a synchronized way and in turn they will teach the techniques correctly in future.

PSO23. Leadership training: All the students develop the leadership qualities by self-involvement and learn to be friendly with the nature.

PSO24. Yoga: To become familiarized with basic level asanas, pranayama Kriyas, bandas and Surya namaskara and to lead a healthy life to popularize yogic practices.

PSO25. Aerobics: To develop neuromuscular coordination and strong endurance base.

PSO26. Gymnastics: To learn the basic movements of floor and apparatus gymnastic exercises along with their interpretation of rules.

PSO27. Calisthenics and Mass demonstration activities (Dumbbells, Flags, Wands, Hoops and Indian clubs) To develop group coordination and graceful movements with and without apparatus.

PSO28. First aid and injury management: To learn about the First aid kit, Sports injuries, Dressing using Bandages and Different Therapies to manage injuries both on and off the play field.

PSO29. Combative sports (Kalari, Silambam, Judo and Wrestling): To learn self-defensive arts namely Kalaripayattu, Silambam, Judo and Wrestling. Students are found to be very much interested in learning defensive arts.

PSO30. Games: (Hockey, Basketball, Badminton, Table tennis, Tennis, Ball Badminton, Kabaddi, Handball, Throw ball, Kho-Kho, Volleyball, Softball, Tennikoit, Cricket and Football): All the

students learn these major games showing lot of enthusiasm and interest. all these games are played in the district, state and national level both in school and above the school level. These variety of games give the students an overall knowledge to know the techniques and rules along with their interpretations.

Internship

PSO31. Teaching practice (General and Particular lesson plans): To experience an actual teaching situation using appropriate and effective teaching methodology.

PSO32. Organization and Participation: To get firsthand knowledge about planning, organizing sports meet, conducting tournaments and Participating in both intramural and extramural competitions.

PSO33. Unified Play day: To get an opportunity to guide intellectually disabled persons and to improve their understanding and communicating process to attain individual wholesome development. This will certainly help the challenged children to come into the inclusive setup and the abled children will have a mind to serve the society.

PSO34. Sports specialization: The students gain the coaching experience in their game of choice along with appropriate coaching methodology.

Course Outcomes

After the completion of the course, the student trainees will be able to:

Title of the Course	No.	Course Outcomes
History, Principles and Foundation of Physical Education	CO1	Understand the basic concepts of physical education.
	CO2	Know the historical development of physical education in India.
	CO3	Understand the foundation of physical education.
	CO4	Know the principles of physical education.
	CO5	Know the psychological and sociological principles.
Anatomy and Physiology	CO1	Know the basics of anatomy and physiology.
	CO2	Understand the circulatory, respiratory and digestive system.
	CO3	Understand the excretory, endocrine, nervous system & sense organs
	CO4	Know the concept of physiology and neuromuscular physiology.
	CO5	Understand feet exercise on various system of our body.
Educational Technology and Methods of Teaching in Physical Education	CO1	Understand the basics of educational technology.
	CO2	Know the various topics teaching techniques.
	CO3	Know the various types of teaching aids.
	CO4	Know lesson planning methods and teaching innovations.
	CO5	Understand and application of movement education.
Health Education and Environmental Studies	CO1	Understand the basic concepts in health education.
	CO2	Know the health problem in India.
	CO3	Know the health services provided.
	CO4	Understand the Concept of environmental science.

	CO5	Know the natural resources and its issues.
Olympic Movement	CO1	Know the origin and development of Olympics.
	CO2	Know the modern Olympic games
	CO3	Know about different types of Olympic games.
	CO4	Know about Olympic games for the disabled.
	CO5	Know the structure and function of International Olympic committee (IOC).
Track and Field (Running events)	CO1	To learn the basic methods of running events
Hockey	CO1	To learn the basic skills and method of playing hockey.
Basketball	CO1	To learn the basic skills and method of playing Basketball.
Indigenous sports (Malkhambh, Lezium and March past)	CO1	To learn the basics and perform in a synchronized way.
Leadership training camp	CO1	To learn leadership qualities by self-involvement.
	CO2	To become friendly with the nature.
	CO3	To become efficient future leaders.
Teaching practice	CO1	To gain the actual teaching experience.
	CO2	To learn the basic method of teaching in a school.
Organization and Participation	CO1	To get firsthand knowledge about planning, organizing sports meet, tournaments and Participating in extramural competitions.
Yoga Education	CO1	Know the basic concept of yoga.
	CO2	Know the various paths of yoga.
	CO3	Understand about Asanas, Pranayama and Dhandas.
	CO4	Understand about Kriyas and meditation
	CO5	Understand the yogic diet.
Sports Training	CO1	Understand the basics of sports training.
	CO2	Understand the concept of training components.
	CO3	Know the methods of training process.
	CO4	Know the training planning.
	CO5	Know the various types of training methods.
Organization and Administration in Physical Education	CO1	Understand the concept of organization and administration.
	CO2	Know the office management, record and register maintenance along with budget preparation.
	CO3	Know the facilities and time management.
	CO4	Know the methods in organizing competition.
	CO5	Know various tournaments and schemes.
Contemporary Issues in Physical Education, Fitness and Wellness	CO1	Know the basics of fitness and wellness.
	CO2	Know the issues and challenges of fitness and wellness.
	CO3	Know the problems of modern life style.
	CO4	Understand the modern lifestyle challenges.
	CO5	Understand the lifestyle management tips.
Sports nutrition and weight management	CO1	Know the basic nutritional guidelines and plans.
	CO2	Understand the facts of macro nutrients.
	CO3	Understand the facts of micro nutrients.
	CO4	Know the diet for obesity.
	CO5	Know the weight management diet.
Track and field(Jumping events)	CO1	To learn the basic methods of jumping events

Yoga	CO1	To become familiarized with basic level asanas, pranayama, Kriyas, bandhas and Surya namaskara.
Aerobics	CO1	To develop neuromuscular coordination and strong endurance base.
Racquet sports (Badminton, Table tennis, Tennis and Ball badminton)	CO1	To learn the basic skills and method of playing Racquet sports.
Gymnastics	CO1	To learn the basic movements in gymnastic exercise
Calisthenics and Mass demonstration activities (Dumbbells, Flags, Wands, Hoops and Indian clubs)	CO1	To develop coordination and graceful movement in a group with and without apparatus.
Unified play day	CO1	To get an opportunity to guide intellectually disabled persons.
	CO2	To help the intellectually disabled persons to improve their understanding and communicating process.
	CO3	To attain individual wholesome development
Organization and participation	CO1	To get firsthand knowledge about planning, organizing sports meet, tournaments and Participating in extramural competitions.
Measurement and Evaluation in Physical Education	CO1	Understand the basics of Test, Measurement & Evaluation.
	CO2	Classify and administer the below tests.
	CO3	Know the physical fitness tests.
	CO4	Know the sports skill tests for badminton, basketball & soccer.
	CO5	Know the sports skill tests for volleyball, hockey & tennis
Computer Applications in Physical Education	CO1	Know the basics of computer.
	CO2	Understand the MS Word operations.
	CO3	Understand the MS Excel operations.
	CO4	Understand the MS PowerPoint operations.
	CO5	Know the e-sources and applications.
Sports Medicine, Physiotherapy and Rehabilitation	CO1	Know the basics of sports medicine and athletic injuries.
	CO2	Know the injury management techniques.
	CO3	Know the physiotherapy and its applications.
	CO4	Understand the applications of various therapies.
	CO5	Know about therapeutic exercises and its applications.
Adapted Physical Education	CO1	Know the importance of the adapted physical education
	CO2	Know the classification of disability.
	CO3	Know the facilities and equipments for adapted sports activities.
	CO4	Know the adapted games and sports for persons with disabilities.
	CO5	Understand the academic instructions, adaptations and modifications in inclusive education.
Sports management and curriculum design	CO1	Know the basics of sports management.
	CO2	Know the leadership and its forms.
	CO3	Know the sports management in educational institutions.
	CO4	Know the modern concept of curriculum.
	CO5	Prepare curriculum for various levels.

Track and field (Throwing events)	CO1	To learn the basic methods of throwing events
First aid and injury management	CO1	To learn about the First aid kit, Sports injuries, Dressing, Bandages and Different Therapies.
Combative sports (Kalari, Silambam, Judo and Wrestling)	CO1	To learn self-defensive arts like Kalaripayattu, Silambam, Judo and Wrestling
Kabaddi	CO1	To learn the basic skills and method of playing Kabaddi.
Handball	CO1	To learn the basic skills and method of playing Handball.
Throw ball	CO1	To learn the basic skills and method of playing Throw ball
Kho – Kho	CO1	To learn the basic skills and method of playing Kho - Kho.
Teaching practices	CO1	To gain the actual teaching experience.
	CO2	To learn the basic method of teaching in a school
Organization and participation	CO1	To get firsthand knowledge about planning, organizing sports meet, tournaments and Participating in extramural competitions.
Theories of Sports and Games	CO1	Know the history and development of game and sports.
	CO2	Prepare the ground with all markings.
	CO3	Know about the standard equipments and their specifications.
	CO4	Understand ethics of sports and sportsmanship.
	CO5	Interpret rules and regulations of the sports and games
Kinesiology and Biomechanics	CO1	Know the basics of kinesiology and biomechanics.
	CO2	Understand postures and muscles.
	CO3	Know the origin, insertion of skeletal muscles.
	CO4	Know the mechanical concepts.
	CO5	Understand kinematics and kinetics of human movement.
Officiating and Coaching	CO1	Understand the basics of officiating and coaching.
	CO2	Understand the coach as a mentor.
	CO3	Know the duties of official.
	CO4	Understand the qualities and qualifications of coach & officials.
	CO5	Understand the scientific principles of coaching
Sports Psychology and Sociology	CO1	Know the basics of sports psychology and sociology.
	CO2	Understand personality.
	CO3	Know the components of psychology.
	CO4	Know sociology and its application in physical education.
	CO5	Understand the importance of culture and its effects
Research and Statistics in Physical Education	CO1	Know the basics of research and its classifications.
	CO2	Know the research types.
	CO3	Prepare a project report.
	CO4	Know the system of data analysis.
	CO5	Know the statistical versions used in physical education
Volleyball	CO1	To learn the basic skills and method of playing Volleyball
Softball	CO1	To learn the basic skills and method of playing Softball.
Tennikoit	CO1	To learn the basic skills and method of playing Tennikoit
Cricket	CO1	To learn the basic skills and method of playing Cricket
Football	CO1	To learn the basic skills and method of playing Football.
Sports specialization	CO1	To gain the coaching experience in his game of choice.
	CO2	To learn the basic method of coaching at school level
Unified play day	CO1	To get an opportunity to guide intellectually disabled persons.
	CO2	To help the intellectually disabled persons to improve their

		understanding and communicating process.
	CO3	To attain individual wholesome development
Organization and participation	CO1	To get firsthand knowledge about planning, organizing sports meet, tournaments and Participating in extramural competitions.

Faculty of General and Adapted Physical Education & Yoga (GAPEY)

Ramakrishna Mission Vivekananda Educational and Research Institute (RKMVERI) Coimbatore Campus

Programme: Master of Physical Education

Programme Outcomes

PO1. **Research Process in Physical Education and Sports Sciences:** This knowledge will accelerate their thinking and analyzing abilities to conduct research in physical education.

PO2. **Physiology of Exercise:** Students understand the effect of exercises on various vital systems of the body along with the system of metabolism, energy transfer and sports performance.

PO3. **Test, Measurement and Evaluation in Physical Education:** It is important for the students to use this knowledge to assess the fitness by conducting the scientific tests and the preparation of sports training plan is based on this crucial information.

PO4. **Adapted Physical Education:** Students understand the importance of adapted physical education, classification of disability, facilities and equipments for adapted sports activities and to organize adapted games and sports for persons with disabilities.

PO5. **Sports technology and Sports engineering:** students learn this branch of science to improve sports skills, preparation of sports kit, creating sports infrastructures and officiating technology.

PO6. **Applied Statistics in Physical Education and Sports:** All the students show lot of interest to know the basics of research, its classifications and types. The preparation of a project report shows that the student knows the system of data analysis and the statistical versions used in physical education research.

PO7. **Sports Biomechanics and Kinesiology:** This science is very useful for the students to teach and execute the sports movements using accurate and appropriate body mechanics

PO8. **Athletic Care and Rehabilitation:** Students learn the basics of Sports injuries, therapies namely Hydrotherapy, Electrotherapy and massage techniques. They also understand the protective equipments & human Posture.

PO9. **Yogic Science:** Yoga focuses on establishing harmony between mind and body, thoughts and actions, restraint and fulfillment and men and nature.

PO10. **Sports management and curriculum design in physical education:** Students learn the basics of sports management, leadership and its forms and the concept of curriculum for various levels.

PO11. **Scientific Principles of Sports Training:** All the students learn the various sports training methodology which could be used to develop different fitness components with the help of suitable training plans and ultimately the sports performance.

PO12. **Sports Psychology and Sports Sociology:** This science makes students to be aware of a balanced mind and body development. They also develop social relationship with others, leadership qualities and their own personality improvement especially through participation in sports.

PO13. **Dissertation/ Thesis:** Students gain a research temperament while writing Thesis/ Dissertation for the enhancement of sports performance. They also understand that the scope of research is enormous.

PO14. **Physical Fitness and Wellness:** Students learn appropriate nutrition to maintain fitness, types of exercises namely aerobic and anaerobic along with their components.

PO15. **Health education and sports nutrition:** The knowledge of nutrition will definitely improve the health of the sports persons, family health and in turn the health of the whole society and be aware of diseases and to lead a healthy life will be the ultimate goal.

PO16. **Information & Communication Technology (ICT) and Educational Technology in Physical Education:** This branch of science deals with the technology involved in the development of communication, sports skills, sports kit, sports infrastructures and officiating technology.

PO17. **Theories of Track and Field:** The knowledge of track and field events elevates the professional competency both as teacher and an official.

PO18. **Theory of Game of Specialization:** This subject helps to understand the Rules, their interpretations, basic skills and drills of various games of specialization. This will elevate the professional competency both as teacher and an official.

PO19. **Value and Environmental Education:** The knowledge about value education helps the students to lead a productive life. Being the members of the next generation, all the students learn these subjects and practice them to grow as a worthy member of the society. Students become aware of their own environment and decide to keep up the same in future. They are able to understand to protect the forest and water resources. They are also aware of various kinds of polluting agents and help the society to minimize using polluting agents.

PO20. **Sports Journalism and Mass Media:** Students try to understand this subject of sports journalism, mass media and sports bulletin concepts. This branch of knowledge also helps them in report writing on sports.

Practicum

PO21. **Track and Field events:** All the students learn the basic techniques of running namely short, medium and long distance competitive runs, throwing and jumping events. They are also encouraged to learn and interpret the international rules.

PO22. **Gymnastics:** To learn the basic movements of floor and apparatus gymnastic exercises along with their interpretation of rules.

PO23. **Yoga:** To become familiarized with basic level asanas, pranayama, Kriyas, bandhas and Surya namaskara and to lead a healthy life to popularize yogic practices.

PO24. **Aerobics:** To develop neuromuscular coordination and strong endurance base.

PO25. **Game of Specialization:** The students gain the coaching experience in their game of choice along with appropriate coaching methodology

PO26. **Combative sports:** To learn self-defensive arts namely Kalaripayattu, Silambam, Judo and Wrestling. Students are found to be very much interested in learning defensive arts.

PO27. **Fitness Training:** Students learn with great enthusiasm the various training methodology and can use them both for general and specific fitness development.

Internship

PO28. **Field/ Laboratory work:** All the students get first-hand information of conducting laboratory scientific evaluation in all sports science subjects. This experience will expose them to carryout independent scientific work more confidently.

PO29. **Teaching / Coaching / Officiating:** This outside experience gives them more exposure to teaching techniques, coaching teams and officiating matches.

PO30. **Classroom teaching:** This experience gives them more exposure to teaching techniques, learning coaching skills and rules along with their interpretation.

PO31. **Officiating, Organization and Participation:** To get firsthand knowledge about planning, organizing sports meet, conducting tournaments and Participating in both intramural and extramural competitions.

Programme Specific Outcomes

PSO1. Research Process in Physical Education and Sports Sciences: Students understand the concept, methods, types, proposal and report writing of a good research. This knowledge will accelerate their thinking and analyzing abilities to conduct research in physical education.

PSO2. Physiology of Exercise: Students understand the effect of exercises on various vital systems of the body along with the system of metabolism, energy transfer and sports performance.

PSO3. Test, Measurement and Evaluation in Physical Education: The students use this knowledge for anthropometric, physical, physiological, psychological and game specific evaluation for both sports persons and non-sports persons. Talented sports persons can be identified by conducting the above scientific tests and the preparation of sports training plan is based on this crucial information.

PSO4. Adapted Physical Education: To learn the importance of adapted physical education, classification of disability, facilities and equipments for adapted sports activities and to organize adapted games and sports for persons with disabilities. To be able to give academic instructions, adaptations and modifications in the inclusive educational setup.

PSO5. Sports technology and Sports engineering: This branch of science deals with the technology involved in sports skills, sports kit, sports infrastructures and officiating technology. The students learn this subject showing lot of interest.

PSO6. Applied Statistics in Physical Education and Sports: All the students know the basics of research, its classifications and types. The preparation of a project report shows that the student Know the system of data analysis and the statistical versions used in physical education research.

PSO7. Sports Biomechanics and Kinesiology: To execute the sports movements using accurate and appropriate body mechanics.

PSO8. Athletic Care and Rehabilitation: Students learn the basics of Sports injuries, therapies namely Hydrotherapy, Electrotherapy and massage techniques. They also understand the protective equipments & human Posture.

PSO9. Yogic Science: Yoga focuses on establishing harmony between mind and body, thoughts and actions, restraint and fulfillment and men and nature.

PSO10. Sports management and curriculum design in physical education: To learn the basics of sports management, leadership and its forms and the concept of curriculum in various levels.

PSO11. Scientific Principles of Sports Training: All the students learn the various sports training methodology which could be used to develop different fitness components with the help of suitable training plans and ultimately the sports performance.

PSO12. Sports Psychology and Sports Sociology: Students are aware of a balanced mind and body development. They also develop social relationship with others, leadership qualities and their own personality improvement especially through participation in sports.

PSO13. Dissertation/ Thesis: Students gain a research temperament while writing Thesis/ Dissertation for the enhancement of sports performance. They also understand that the scope of research is enormous.

PSO14. Physical Fitness and Wellness: Students learn appropriate nutrition for fitness, types of exercises namely aerobic and anaerobic along with their components.

PSO15. Health education and sports nutrition: The knowledge of nutrition will definitely improve the health of the sports persons, family health and in turn the health of the whole society. To be aware of diseases and to lead a healthy life is the ultimate goal.

PSO16. Information & Communication Technology (ICT) and Educational Technology in Physical Education: This branch of science deals with the technology involved in communication, sports skills, sports kit, sports infrastructures and officiating technology. The students learn this subject showing a lot of interest.

PSO17. Theories of Track and Field: The knowledge of track and field events elevates the professional competency both as teacher and an official.

PSO18. Theory of Game of Specialization: To understand the Rules, their interpretations, basic skills and drills of various games of specialization. This will elevate the professional competency both as teacher and an official.

PSO19. Value and Environmental Education: The knowledge about value education helps the students to lead a productive life. Being the members of the next generation, all the students learn these subjects and practice them to grow as a worthy member of the society. Students become aware of their own environment and decide to keep up the same in future. They are able to understand to protect the forest and water resources. They are also aware of various kinds of polluting agents and help the society to minimize using polluting agents.

PSO20. Sports Journalism and Mass Media: Students try to understand the sports journalism, mass media and sports bulletin concepts. This branch of knowledge also helps them in report writing on sports.

Practicum

PSO21. Track and Field events: All the students learn the basic techniques of running namely short, medium and long distance competitive runs, throwing and jumping events. They are also encouraged to learn and interpret the international rules.

PSO22. Gymnastics: To learn the basic movements of floor and apparatus gymnastic exercises along with their interpretation of rules.

PSO23. Yoga: To become familiarized with basic level asanas, pranayama Kriyas, bandas and Surya namaskara and to lead a healthy life to popularize yogic practices.

PSO24. Aerobics: To develop neuromuscular coordination and strong endurance base.

PSO25. Game of Specialization: The students gain the coaching experience in their game of choice along with appropriate coaching methodology

PSO26. Combative sports: To learn self-defensive arts namely Kalaripayattu, Silambam, Judo and Wrestling. Students are found to be very much interested in learning defensive arts.

PSO27. Fitness Training: Students learn with great enthusiasm the various training methodology and can use them both for general and specific fitness development.

Internship

PSO28. Field/ Laboratory work: All the students get firsthand information on conducting laboratory scientific evaluation in all sports science subjects. This experience will expose them to carryout independent scientific work more confidently.

PSO29. Teaching / Coaching / Officiating: This outside experience gives them more exposure to teaching techniques, coaching teams and officiating matches.

PSO30. Classroom teaching: This experience gives them more exposure to teaching techniques, learning coaching skills and rules along with their interpretation.

PSO31. Officiating, Organization and Participation: To get firsthand knowledge about planning, organizing sports meet, conducting tournaments and Participating in both intramural and extramural competitions.

Course Outcomes

After the completion of the course, the student trainees will be able to:

Title of the Course	No.	Course Outcomes
Research Process in Physical Education and Sports Sciences	CO1	To know the basic concept of research.
	CO2	To know about the methods of research.
	CO3	To understand the experimental research.
	CO4	To know sampling methods.
	CO5	To understand writing research proposal and report
Physiology of Exercise	CO1	To know the effect of exercise on skeletal system.
	CO2	To know the effect of exercise on cardiovascular system.
	CO3	To know the effect of exercise on Respiratory system.
	CO4	To understand metabolism and energy transfer.
	CO5	To understand the climatic conditions, sports performance & ergogenic aids
Test, Measurement and Evaluation in Physical Education	CO1	To know the basics of Test, measurement & Evaluation.
	CO2	To know the coordinative ability tests.
	CO3	To know the physical fitness tests.
	CO4	To know the Anthropometric, Aerobic & Anaerobic tests.
	CO5	To know the specific skill tests
Adapted Physical Education	CO1	To know the basics of Adapted Physical Education.
	CO2	To understand the Adapted Physical Education Program.
	CO3	To understand the Classification of disability.
	CO4	To know the Adapted Facilities and equipments.
	CO5	To understand the basic physical fitness and motor development.
Sports technology and Sports engineering	CO1	To know the basics of sports technology
	CO2	To know the various playing surfaces.
	CO3	To know the modern equipments.
	CO4	To know the training gadgets and their uses.
	CO5	To understand the sports infrastructures and its maintenance.
Track and Field (Running events)	CO1	To learn the advanced techniques of different “starts”.
	CO2	To learn the different body movements during start, course of run and at the finish
Gymnastics (Floor exercises)	CO1	To learn the advanced technique in Floor exercises
Game of specialization (Kabaddi/ Kho-Kho/ Badminton/ Tennis/ Volleyball/ Basketball/ Cricket/ Football/ Handball/ Hockey)	CO1	To learn the fundamental skills drills and rules of the game.
	CO2	To learn the strategy, lead up games, officiating and coaching skills.
Aerobics	CO1	To learn different types of movements.
	CO2	To learn in fixing different intensity according to the individual.
Fields / Laboratory work (Test measurement and evaluation, Fitness training, Sports	CO1	To understand the operation of laboratory equipments

psychology and Physiology of exercises laboratory)		
Teaching/ Coaching/ Officiating (School, College and University)	CO1	To develop proficiency in teaching, coaching and officiating at different level.
Class room teaching	CO1	To gain confidence opportunity is given to handle class
Applied Statistics in Physical Education and Sports	CO1	To understand the basics of statistics.
	CO2	To know the Data Classification, Tabulation and Measures of Central Tendency.
	CO3	To know measures of Dispersions and Scales.
	CO4	To know about probability distributions & groups.
	CO5	To understand about inferential & comparative statistics.
Sports Biomechanics and Kinesiology	CO1	To know the basics of Sports biomechanics & kinesiology.
	CO2	To understand the muscle action.
	CO3	To know the concept of Motion and Force.
	CO4	To know the concept of Projectile and Lever
	CO5	To know about Movement Analysis.
Athletic Care and Rehabilitation	CO1	To know the basics & Sports injuries.
	CO2	To know about Wound, Hydrotherapy & Electrotherapy.
	CO3	To understand massage techniques & effects.
	CO4	To know about exercises and approaches.
	CO5	To understand about protective equipments & Posture.
Yogic Science	CO1	To understand the concept of Yogasana.
	CO2	To know about Asanas & Pranayama.
	CO3	To understand Kriyas.
	CO4	To understand Mudras.
	CO5	To know the concept of Yogic Therapy.
Sports management and curriculum design in physical education	CO1	To know the concepts of sports management.
	CO2	To understand program management.
	CO3	To understand the use of modern equipments.
	CO4	To develop public relationship.
	CO5	To know the concept of curriculum preparation and its sources.
Track and Field (Jumping and Hurdles)	CO1	To learn the advance techniques various jumping events.
	CO2	To learn the approach, takeoff and landing of jumping events.
Yoga (Asanas, Pranayama, Kriyas, Bandhas, Mudras and Suryanamaskar)	CO1	To understand the procedure of performing asanas, pranayams, Kriyas, Bandhas, Mudras and suryanamaskar.
Game of specialization (Kabaddi/ Kho-Kho/ Badminton/ Tennis/ Volleyball/ Basketball/ Cricket/ Football/ Handball/ Hockey)	CO1	To learn the fundamental skills drills and rules of the game.
	CO2	To learn the strategy, lead up games, officiating and coaching skills.
Teaching/ Coaching/ Officiating (Track and field)	CO1	To gain confidence, opportunity is given to handle class in a progressive manner.

Teaching/ Coaching/ Officiating (School, College and University)	CO1	To develop proficiency in teaching, coaching and officiating at different level.
Class room teaching	CO1	To gain confidence to handle classes.
Scientific Principles of Sports Training	CO1	To understand Sports Training Concept.
	CO2	To know the Components of Physical fitness.
	CO3	To understand Flexibility.
	CO4	To understand Training Plan.
	CO5	To understand Coaching methodology.
Sports Psychology and Sports Sociology	CO1	To understand the Psychological concepts.
	CO2	To understand about motivation.
	CO3	To know about Goal setting.
	CO4	To understand the Sociology concepts.
	CO5	To understand about Group Cohesion.
Dissertation/ Thesis	CO1	
	CO2	
	CO3	
	CO4	
	CO5	
Physical Fitness and Wellness	CO1	To know an introduction of Physical fitness.
	CO2	To know nutrition for fitness.
	CO3	To understand about Aerobic exercise.
	CO4	To understand about Anaerobic exercise.
	CO5	To understand about fitness and wellness
Health education and sports nutrition	CO1	To understand health education concepts.
	CO2	To know the health problems in India.
	CO3	To understand about hygiene and health.
	CO4	To know an introduction of sports nutrition.
	CO5	To know the nutrition and weight management relations.
Track and Field (Throwing events)	CO1	To learn the advanced techniques of various Throwing events.
	CO2	To learn the correct hold and execution of various throwing implements.
Gymnastics (With apparatus)	CO1	To learn the advanced techniques of using various gymnastic apparatus.
Combative sports (Boxing, Fencing, Judo, Taekwondo, Karate and Kalari)	CO1	To learn the skills of combative sports
Fitness (Conditioning exercises, General and Specific training methods)	CO1	To become more aware of using the principle of various training methods.
Game of specialization (Kabaddi/ Kho-Kho/ Badminton/ Tennis/ Volleyball/ Basketball/ Cricket/ Football/ Handball/ Hockey)	CO1	To learn the fundamental skills, drills and rules of the game.
	CO2	To learn the strategy, lead up games and improve coaching skills.

Field / Laboratory work (Athletic care, Physiotherapy and rehabilitation, Sports medicine and Kinesiology and biomechanics Laboratory)	CO1	To transfer the theoretical knowledge into practical knowledge.
Class room teaching	CO1	To gain confidence to handle classes.
Coaching lessons of Specialization games (School / Colleges)	CO1	To improve the teaching and coaching skills.
Information & Communication Technology (ICT) and Educational Technology in Physical Education	CO1	To understand the concept of Communication & Classroom interaction.
	CO2	To know the fundamentals of Computer.
	CO3	To know MS-Office & E-Learning concepts.
	CO4	To know the Nature and Scope of Educational technology.
	CO5	To understand the Instructional design.
Theories of Track and Field	CO1	To know the Planning, Construction, Marking of 200 & 400 m track.
	CO2	To know the duties of various officials.
	CO3	To know the rules and interpretations of Track events.
	CO4	To know the rules and interpretations of Throwing and Combined Events.
	CO5	To know the rules and interpretations of Jumping Events.
Theory of Game of Specialization	CO1	To know the origin and development of the game.
	CO2	To know the fundamental skills and drills.
	CO3	To understand the tactics and strategies.
	CO4	To interpret the rules and regulations.
	CO5	To Plan the training and skill evaluation methods.
Value and Environmental Education	CO1	To know the Introduction of value education.
	CO2	To understand the value systems.
	CO3	To understand Environmental Education.
	CO4	To understand Rural Sanitation and Urban Health problems.
	CO5	To know Natural Resources & related environmental issues.
Sports journalism and mass media	CO1	To know the sports journalism and mass media concepts.
	CO2	To know the concept of sports bulletin.
	CO3	To know the effect of mass media in journalism.
	CO4	To know report writing on sports.
	CO5	To understand sports organization and sports journalism.
Track and field (Combined events)	CO1	To learn the advanced techniques of combined events.
Game of specialization (Kabaddi/ Kho-Kho/ Badminton/ Tennis/ Volleyball/ Basketball/ Cricket/	CO1	To learn the fundamental skills, drills and rules of the game.
	CO2	To learn the strategy, lead up games and improve coaching skills.

Football/ Handball/ Hockey)		
Teaching / Coaching / Officiating (Track and field events)	CO1	To improve the teaching and coaching skills in track and field events.
Teaching / Coaching / Officiating (Game of specialization)	CO1	To improve the teaching and coaching skills in game of specialization.
Officiating, Organization and Participation (Project sports meet, Intramural and Extramural tournaments)	CO1	To improve the skills of organizing sports meet and other competition
	CO2	To learn the rules of the games and sports events for effective officials.
Coaching (Game of specialization / Track and field events)	CO1	To improve the skills of the games
	CO2	To improve the technique of the track and field events.
	CO3	To improve specific physical fitness of both team players and athletes.

Programme Outcomes, Programme Specific Outcomes and Course Outcomes of all Academic Programmes offered at RKMVERI – FAR

Programme Name: B.Sc. (Hons.) Agriculture

Programme Outcome:

1. To impart firsthand knowledge on agriculture and allied sciences
2. To impart in-depth practical knowledge in agriculture and allied sciences
3. To provide extensive knowledge on agri-allied sectors like livestock, Poultry
4. To disseminate different technologies through various extension activities
5. To identify and overcome the problems encountered in day-to-day agriculture
6. To provide knowledge on commercial agricultural production practices
7. To make students competitive in pursuing higher studies

Programme Specific Outcome:

1. To provide knowledge from ancient to modern agricultural practices
2. To impart in-depth practical knowledge in crop cultivation practices
3. To give detailed knowledge about agri-allied sectors
4. To provide knowledge on working of different farm implements
5. To serve the rural agricultural population
6. To disseminate recent agricultural technologies through extension.
7. Detailed knowledge on various agri-business activities
8. Detailed knowledge on horticulture and sericulture practices

Course Outcome:

Semester – I		
Course Code	**Course Name**	**Course Outcomes**
VU AGR 101	Fundamentals of Agronomy and Agricultural Heritage	❖ To know the basics of the agriculture, tillage and evolution of agriculture from different periods from veda to modern agriculture.
VU BIC 101	Fundamentals of Plant Biochemistry	❖ To gain basic knowledge of the biomolecules viz., carbohydrates, proteins and lipids – their properties, structure and metabolism. ❖ To learn basics of enzymes and their industrial uses.
VU SAC 101	Fundamentals of Soil Science	❖ To impart knowledge on concepts and principles of analytical techniques in soil science among under graduate students. ❖ Further, the knowledge gained will form as building block to pursue many research works.
VU FOR 111	Introduction to Forestry	❖ To impart knowledge about the basic facts of Forestry as well as agroforestry and familiarize the students with important trees suitable for agroforestry and various agroforestry systems. ❖ The students will learn about the silviculture and nursery technology of important agroforestry tree species.
VU ENG 101	Comprehension & Communication Skills in English	❖ To make the students competent in the following skills. ❖ **Writing** - Understand the genre of writing, mechanics of writing, article writing (essay), abstract writing (précis) and letter writing. The students will gain competence in skills viz., ❖ **Listening** - Understanding the kinds of listening and acquire the techniques of active listening followed by note-taking and the art of asking questions. ❖ **Speaking** - Acquire the correct pronunciation and the art of

		speaking in a forum. ❖ **Reading**: Know the types of reading, the techniques of reading, reading for comprehension and note-making.
VU HOR 111	Fundamentals of Horticulture	❖ Students will gain knowledge on the fundamentals of horticulture ❖ Hands on training on various propagation methods and important cultural practices for major fruit and plantation crops will be provided (Practical)
VU MAT 113	Elementary Mathematics	❖ To understand and apply fundamental concepts of mathematics applicable in agriculture and ❖ To acquire knowledge on theoretical concepts of Algebra, Calculus and Mathematical Modeling. ❖ Further the course will provide them good introduction to various mathematical models used in Biological sciences.
VU PBG 101	Introduction to Agricultural Botany	❖ To expose the students to the basic features of botanical description, economic parts and economic importance of different field and horticultural crops ❖ Botanical features and economic importance of different crop plants belonging to 20 families will be exposed.
VU AEX101	Rural Sociology & Educational Psychology	❖ Imparting skills required for entrepreneurship development among the students for self-employment ❖ Imparting managerial training among the young students to build entrepreneurial skills Imparting skills necessary to prepare a model village plan ❖ Learning techniques for establishing and managing micro project for the upliftment of rural people ❖ Skills imparting for preparation of detailed project report (DPR) for availing loans and grants
VU TAM 101	,yf;fpa';fspy; ntshz;ika[k;	❖ To make student understand the ancient literatures in tamil to

/ENG 102	mwptpay; jkpH; gadhf;fKk; / Development Education	know in-depth about the need of agriculture. ❖ And also to make them understand the terms involved in the agriculture in Tamil which make them to get connected with the local farmers. ❖ To make students well verse in communication in english and soft skill development.
VU NSS/NCC 101	National Social Service /National Cadet Corps	❖ Students will do social work to the society like "Swach bharat", "Blood donation", Clean India campaign.
VU PED 101	Physical Education	❖ Student will play different games to maintain physical health.
VU PED102	Yoga for human excellence	❖ Student will learn different yoga practices to get excellence in mental health value.

Semester – II		
Course Code	**Course Name**	**Course Outcome**
VU SWE 101	Soil and Water Conservation Engineering	❖ To gain knowledge and skills on soil and water engineering concepts like measurement of land, surveying and leveling, different irrigation methods, pumping of water, soil and water engineering concepts
VU CRP 101	Fundamentals of crop Physiology	❖ To impart basic knowledge on various functions and processes related to crop production, mineral nutrition, plant growth regulators and environmental stresses. ❖ Students will come to know the various functions and processes related to crop production, mineral nutrition, plant growth regulators and environmental stresses.

		❖ In addition, hands on exposure to estimate growth parameters, diagnosis and correction of nutrient deficiencies and enzyme assays.
VU AEC 101	Fundamentals of Agricultural Economics	❖ This course aims to introduce the basic principles of economics including the problem of economic decision - making, and deals with concepts of micro and macroeconomics in-depth.
VU PAT 101	Fundamentals of Plant Pathology	❖ Study of important taxonomic characters and symptoms produced by important microorganisms in order to manage them.
VU AEX 102	Fundamentals of Agricultural Extension Education	❖ The course intends to expose students to the fundamentals of extension education, extension systems in India, programme planning and rural development efforts. ❖ The course will also provide an opportunity to students to visit different organizations involved in extension activities and rural development work.
VU FSN 111	Principles of Food Science and Nutrition	❖ Preservation of food and processing of fruits and vegetables which will enable students to start agro based processing units.
VU FMP 111	Farm Machinery and Power	❖ Students will be equipped with sufficient theoretical knowledge with practical skills on farm power sources like handling of tractor, power tillers and various implements used in land preparation, sowing, inter cultivation, plant protection and harvesting operations.
VU AGR 102	Introductory Agro-meteorology & Climate Change	❖ To learn different metrological parameters like rainfall, temperature, RH and other weather parameters; ❖ To make short-range and long-range weather forecasts.
VU HOR 112	Production Technology for Fruit and Plantation Crops	❖ To impart knowledge on the principles of horticulture, propagation and production techniques of tropical, sub tropical, temperate fruit and plantation crops.

		❖ Students will be imparted with wide knowledge on major tropical, sub-tropical and temperate fruit and plantation crops ❖ Hands on training on various propagation methods and important cultural practices for major fruit and plantation crops will be provided.
VU RSG 101	Geo- informatics for Precision Farming	❖ Students will know about applications of GIS in agriculture which will help them to forecast for precision farming.
VU NSS/NCC 101	NSS/NCC	❖ Students will do social work to the society like "Swach bharat", "Blood donation", Clean India campaign.
VU PED 101	Physical Education	❖ Student will play different games to maintain physical health.

Semester - III		
Course Code	**Course Name**	**Course Outcome**
VU AGM 201	Fundamentals of Microbiology	❖ To enlighten the students with the knowledge of microbial diversity in soils ❖ To highlight the role of soil microorganisms in soil fertility and plant growth promotion ❖ To develop experimental skills in soil microbiology which includes isolation of beneficial microorganisms from soil and their mass production ❖ To make students gain expertise in practical aspects of production of industrial products
VU AEN 201	Fundamentals of Entomology	❖ The students gain knowledge on external morphology of insects, appendages and functions. ❖ This course imparts knowledge on basic aspects of anatomy of different systems, physiology, classification and identification of

		insects up to family level.
VU SST 201	Principles of Seed Technology	❖ The students will gain knowledge about the various techniques of quality seed production, processing and seed quality enhancement.
VU AGR 201	Crop Production Technology – I (Kharif crops)	❖ To impart knowledge on various cultivation practices of different Kharif crops
VU HOR 211	Production Technology for Vegetables and Spices	❖ To impart knowledge on the principles of horticulture, propagation and production techniques of tropical, sub tropical, temperate vegetable and spice crops.
VU ENS 201	Environmental Studies & Disaster Management	❖ To learn about different ecosystems and natural resources and environmental pollution and monitoring ❖ To gain the knowledge on climate change and disaster management.
VU AMP 201	Livestock and Poultry Management	❖ Students will gain knowledge about livestock, Poultry management ❖ To get knowledge on caring of livestock, Poultry
VU AEC 201	Farm Management, Production & Resource Economics	❖ Students will know the concepts of farm management. ❖ To get knowledge on resource allocation in the farm level ❖ To get to know about resource economic concepts
VU SAC 201	Soil Resource Inventory	❖ The students of undergraduate will gain knowledge on chemical composition and nutritional quality of various field and horticultural crops. ❖ Proper understanding of chemistry of pesticides will be inculcated among the students. ❖ The students will acquire the skills on quality monitoring of crops and pesticides through practices.
VU AGR 202	Study tour	❖ The students will undertake the short tour covering KVK's, Research stations, Sister Campuses and ICAR institutes in the

		southern part of Tamil Nadu. ❖ The study tour will provide an exposure to the students to know about the soil, climatic conditions and cropping patterns in the respective agro-climatic zones. ❖ The students will also have first-hand information on latest technologies on various crops and allied activities.
VU NSS/NCC 101	NSS/NCC	❖ Students will do social work to the society like "Swach bharat", "Blood donation", Clean India campaign.
VU PED 101	Physical Education	❖ Student will play different games to maintain their physical health.

Semester – IV		
Course Code	**Course Name**	**Course Outcome**
VU PBG 201	Fundamentals of Genetics	❖ To expose the students on basic concepts of genetics. ❖ To impart knowledge on genetic engineering and technologies like tissue-culture, GMO etc.,
VU AEX 201	Communication Skills and Personality Development	❖ Imparting skills required for entrepreneurship development among the students for self-employment. ❖ To make them competitive by imparting personal skills
VU MAT 211	Statistical Methods	❖ Students will acquire knowledge in basis statistical techniques that are applicable to agricultural sciences. ❖ Further the course will provide them good introduction to various statistical analysis used in biological sciences.
VU PAT 201	Principles of plant disease management	❖ Study of important taxonomic characters and symptoms produced by important microorganisms in order to manage them. ❖ To impart knowledge on plant disease management by different

		methods.
VU AEN 202	Beneficial insects and Principles of Insect pest management	❖ To impart knowledge on the economically important insects and principles of insect pest management, including concept and components of IPM
VU AGR 203	Crop Production Technology – II (Rabi crops)	❖ Students will get knowledge on crop production technologies of different Rabi crops.
VU ERG 211	Renewable Energy	❖ Students will gain practical aspects of utilizing various renewable energy like solar energy, wind energy and other energy efficient technologies, etc.
VU AGR 204	Farming System & Sustainable Agriculture	❖ Students will know different cropping and farming system like integrated farming system (IFS). ❖ To get knowledge on sustainable agricultural practices such as organic farming.
VU SAC 202	Problematic soils and their management	❖ The students of undergraduate will gain knowledge on chemical composition and nutrient requirement of various field and horticultural crops. ❖ Proper understanding of problematic soils like salinity, alkalinity, acidity etc., and their reclamation practices.
VU HOR 212	Production Technology for Ornamental Crops, MAP and Landscaping	❖ Students will learn different production technology for ornamental Crops, ❖ To learn the techniques in Landscaping
VU ANM 201	Introductory Nematology	❖ This course will give an introduction about nematodes, its diversity, extent of its damage caused in crops and the necessity to manage them in agriculture. ❖ The course aims at imparting basic, fundamental and applied aspects of the science of Nematology at UG level.

VU NST 201	Fundamentals and Applications of Nanotechnology	❖ Students will get to know the applications of Nanotechnology in Energy, Environment, Health and Agriculture.
VU NSS/NCC 101	NSS/NCC	❖ Students will do social work to the society like "Swach bharat", "Blood donation", Clean India campaign.
VU PED 101	Physical Education	❖ Student will play different games in order to maintain physical health.

Semester – V		
Course Code	**Course Name**	**Course Outcome**
VU PBG 301	Fundamentals of Plant Breeding	❖ The plant breeding methodologies and applications employed for self, cross and vegetatively propagated crops will be exposed.
VU AEC 301	Agricultural Marketing Trade & Prices	❖ The aim of the course is to give exposure on market concepts, marketing of agricultural commodities, intermediaries involved, domestic and export trade, risk in agricultural marketing, price dynamics and the role of Government in regulation of markets.
VU AGM 301	Soil and Applied Microbiology	❖ To enlighten the students with the knowledge of microbial diversity in soils ❖ To high lighten the role of soil microorganisms in soil fertility and plant growth promotion ❖ To develop experimental skills in soil microbiology which includes isolation of beneficial microorganisms from soil and plant
VU PAT 301	Diseases of Field and Horticultural crops and their management	❖ To gain the knowledge on different diseases in field and horticultural crops ❖ Mass multiplication of biocontrol agents like *Trichoderma viride,*

		Pseudomons fluorescens and Bacillus subtilis and also learn about the method of applications
VU AEX 301	Entrepreneurship Development and Business Communication	❖ To impart knowledge on different extension methods and approaches used for transfer of agricultural technology. ❖ The course will also enable to develop practical skills on preparation of different extension teaching methods.
VU AGR 301	Practical Crop Production - I (Kharif crops)	❖ Each student will be allotted a minimum land area of 10 cents and he will do all field operations in the allotted land from field preparation to harvest and processing. ❖ Under exigencies like water scarcity to raise wetland rice of the crop production programme shall be with two irrigated dry crops, with an area of not less than five cents. ❖ Irrigated puddled lowland rice will be cultivated.
VU HOR 311	Post harvest management and value addition of fruits and vegetable crops	❖ Students will get to know about different processing techniques of fruits and vegetable crops and they make value added products like jam, jelly, squash, juice etc.
VU SAC 301	Manures, Fertilizers and Soil Fertility Management	❖ To impart knowledge on soil essential nutrients and nutrient transformations in soil ❖ To know the soil fertility management. ❖ The knowledge gained by students through this course will be useful in making decisions on nutrient dose, choice of fertilizers/manures and method of application etc. ❖ The students will also gain confidence in managing soil health for sustained productivity.
VU ABT 301	Plant Bio technology	❖ To impart knowledge on basic and applied aspects of plant biotechnology.

VU AGR 302	Rainfed Agriculture & Watershed Management	❖ Student will study about rainfed agriculture which is predominant in all over India and develop watersheds to manage agricultural practices during off-season.

Semester – VI		
Course Code	**Course Name**	**Course Outcome**
VU AEC 302	Agricultural Finance and Co-Operation	❖ This course aims at imparting knowledge on principles of finance, banking and co –operation and farm financial analyses. ❖ This course will also help in understanding the functions of various institutions involved in farm financing and different crop insurance products.
VU PAT 302	Diseases of Field crops and Horticultural crops and their management	❖ Students will learn diseases of various Field crops and Horticultural crops and to know their management practices.
VU COM 311	Agriculture Informatics	❖ Students will get to know about basics of agricultural informatic softwares and applications.
VU ENS 301	Environmental Pollution and Management	❖ It deals with the scientific study of environmental pollution in different systems like air, water, soil and land due to environmental damages as a result of human interaction with the environment. ❖ To study the different pollution management practices.
VU APE 311	Post-Harvest and Food Engineering	❖ Students will get to know about different processing techniques of agricultural products such as parboiling, oil extraction etc.
VU AEN 301	Pests of Crops and Stored grain and their Management	❖ Students will know about pest of crops and stored grains like cereals, pulses, oilseeds and their management.

VU AGR 303	Practical Crop Production - II (Rabi crops)	❖ Each student will be allotted a minimum land area of 10 cents and he will do all field operations in the allotted land from field preparation to harvest and processing. ❖ The dryland crops like sunflower, gingelly etc., or the garden land crops like maize, finger millet etc., will be cultivated.
VU AGR 304	Principles of Organic Farming	❖ Students get to know about the oragnic farming practices and procedure for obtaining organic certificates.
VU PBG 302	Crop Improvement	❖ Students will deploy different methods of plant breeding like pure line selection, mass selection, pedigree method and other hybrid crop varieties production for special crop improvement. ❖ Crop improvement may be for drought resistance, high yield, pest and disease resistance.
VU OPT 301	Optional course	❖ Student will select a set of optional courses offered during the semester based on their own interest.

Semester – VII		
Course Code	**Course Name**	**Course Outcome**
VU AEX 401	Rural Agricultural Work Experience and Agro-industrial Attachment(RAWE &AIA)	
VU AEX 401	General orientation & On campus training by different faculties	❖ Students will get an on campus training from various faculties before step into the village attachment and Agro-industrial attachment.
VU AEX 401	Village attachment/ Unit attachment in Univ./ College. KVK/ Res. Stn.	❖ To enable the students to learn and understand issues related to farming and rural development in a natural setting on real-time basis. The course also provides opportunities for the students to learn about the functioning of the extension organisations viz., state

		agricultural departments, KVK's, and research stations
VU AEX 401	Agro-Industrial Attachment	❖ Course provides opportunities for the students to attach with the agri related industries and make them know about the functioning them.
VU AEX 401	Project Report Preparation, Presentation and Evaluation	❖ Students will propose a project based on his interest and concerned specialists will assist them to complete their project.

Semester – VIII		
Course Code	**Course Name**	**Course Outcome**
VU EXP 401 - Experiential Learning Programme/ HOT		
VU EXP 401	Bio-agents and Bio-fertilizer production	❖ Students will produce biocontrol agents like Trichoderma, Pseudomonas and bio fertilsers like phosphobacteria for commercial marketing.
VU EXP 401	Hybrid Seed Production in Vegetables Crops	❖ Students will produce hybrid seeds of vegetables for commercial production and marketing.
VU EXP 401	On Farm Advisory for Soil Health, Water Quality & Plant Nutrition	❖ Students will analyze soil health and provide management solutions to farmers.
VU EXP 401	Commercial Beekeeping	❖ Student will produce honey using their practical knowledge on commercial bee keeping.
VU EXP 401	Commercial Cocoon Production	❖ Students will produce commercial silk cocoon both white and yellow to market.
VU EXP 401	Commercial Plant Tissue Culture	❖ Students will produce commercial crops like tomato, banana, sugarcane etc., through plant tissue culture.

VU EXP 401	Commercial Nursery Technology of Horticultural Crops	❖ Students will raised the nurseries of different vegetables crops for commercial sale.
VU EXP 401	Commercial Landscape Gardening	❖ Students can make landscape and gardening and interior lanscaping plans.
VU EXP 401	Commercial production of Bio-control agents	❖ Students will produce biocontrol agents like Trichoderma, Pseudomonas for commercial marketing.
VU EXP 401	Commercial mushroom production	❖ Pleurotus / button mushrom will be produced by students for commercial marketing.
VU EXP 401	Commercial broiler and layer production	❖ Students will produce broiler and layer birds commercially.
VU EXP 401	Commercial seed production	❖ Students will produce hybrid seeds of vegetables for commercial production and marketing.
VU EXP 401	Hybrid pearl millet seed production	❖ Students will produce hybrid seeds of pearl millet for commercial production and marketing.
VU EXP 401	Hybrid rice parental line seed production	❖ Students will produce hybrid seeds of rice using parental line selection for commercial production and marketing.
VU EXP 401	Managerial skill for Agribusiness	❖ Students will know the different agribusiness opportunities and will get necessary managerial skills.
VU EXP 401	Export Import and Protection of Property Rights in Agriculture	❖ Students will be aware of Intellectual Property Rights for ensuring rights for their products.
VU EXP 401	Development of Integrated Farming system Model	❖ Student will prepare an IFS model to the location specific.
VU EXP 401	Protected cultivation of Vegetable crops	❖ Students will produce different vegetables under poly house/ protected cultivation.

VU EXP 401	Composting technology	❖ Students will gain skill in compost-making.
VU EXP 401	Utilization of Rearing Bed Refuse, Pupae and Unreelable Cocoons	❖ Students will utilize the waste products from sericulture to make it worthy for the market.
VU EXP 401	Agri-business management	❖ Students will know the different agribusiness opportunities and will get necessary managerial skills.

Programmes Outcomes, Programme Specific Outcomes and Course Outcomes of all programmes

IRDM Faculty Centre

Ramakrishna Mission Vivekananda Educational and Research Institute

Programme Name: MSc in Agriculture and Rural Development

Programme Outcome:

1. To impart practical based knowledge on agriculture and allied sectors
2. To impart in-depth practical knowledge in rural development
3. To provide hand hold exposure on agriculture -allied sectors like Diary, Apiculture, Fishery, Poultry science etc.
4. To disseminate different rural technologies through various extension activities
5. To identify and overcome the problems encountered in day-to-day life in agriculture and social sector
6. To provide knowledge on commercial agricultural production practices
7. To make students competitive in pursuing higher studies

Programme Specific Outcome:

1. To get an exposure to a new rural area and the socio-economic condition of people
2. To provide knowledge from ancient to modern agricultural practices
3. To face the rural reality during the rural living and learning experience
4. To impart in-depth practical knowledge in crop cultivation practices
5. To cope with adverse situations during their rural staying at different remote parts of rural Bengal.
6. To provide knowledge on working of different farm implements
7. Detailed knowledge on various agri-business activities
8. To build the manpower for serving the rural community
9. To disseminate recent agricultural technologies through extension.

10. To have a hand on experience in some rural project related to their curriculum. The project work will be given by the organisation according to their requirement. The students will learn through this assignment while organization may be benefitted with the results of the project.

Course Outcome

SEMESTER-I		
Course Code	**Course Name**	**Course Outcomes**
ARD 101	Rural Sociology and Integrated Rural Development	The students become familiar with the typical life of the rural mass and their livelihood patterns.
ARD 102	Basic Economics	➢ The students have basic idea on Indian economy and the root of rural poverty in India. ➢ The students are able to know how to measure the poverty through different tools and techniques ➢ They can prepare the action plan to combat the poverty
ARD 103	Extension Education-I	➢ The students can perceive the importance of extension education in respect to technology transfer among the famers' ➢ They can prepare different audio-visual aids to provide informal education among the farmers ➢ The students came to know the different strategies to disseminate and diffuse demand driven technologies among the farmers' and provide location specific solutions to solve farmers problem
ARD 104	Fundamentals of Crop Production	➢ Basic idea about Agro-climatic zones of west Bengal ➢ Basic concept on soil sampling, soil quality testing (pH, EC, C, N, P estimation), organic farming and vegetative plant propagation methods(theoretical knowledge). ➢ Basic idea about seasonal cropping patterns ➢ Basic idea on use of fertilizers, common agricultural practices
ARD 105	Research Methodology-I	➢ To impart the different tools and techniques used in social research ➢ To know the data collections method through Participatory Research Appraisal (PRA) ➢ To gain the knowledge on data analysis and interpretation through Statistical Package of Social Science (SPSS) and MS Excel

ARD 106	Indian Culture and Spiritual Heritage-I	➢ The students are acquainted with the rich cultural and spiritual heritage of India that exist and is traditionally maintained in the rural India. ➢ The students are familiar with value based education system which helps them to work under extreme pressure and deals with any problems empathically

SEMESTER-II		
ARD 201	Human Resources and Organisational Management	➢ The students develop their management skills and leadership quality. ➢ They grow their team building capacity and negotiation skill. ➢ They are able to prepare training schedule, budget and to conduct recruitment process.
ARD 202	Demography, Social Problem and Intervention	➢ The students acquired the skills to intervene the various social problems using casework method, group work method, community organisation, social welfare administration.
ARD 203	Rural Economics, Cooperation & Microfinance	➢ The students have in-depth knowledge on rural employment generation schemes, Govt. poverty alleviation and employment-generation scheme, rural development in annual budget, Price index; Rules, regulation, impact of WTO in Indian and rural economy. ➢ To gain the strategies to form Self Help Group for empowerment generation
ARD 204	Fundamentals of Crop Protection	➢ One will be able to know about all types of diseases associated with crops ➢ One can understand about all the causative organisms behind the damages caused to crops ➢ One will have a vivid knowledge about the pesticides: dosage, types and mechanism of action of the same ➢ Furthermore, a clear understanding of Integrated Pest Management can be achieved ➢ One can know about weeds: biology, ecology, classification and diversification ➢ One will be able to know about herbicides: chemical nature. classification, dosage and mode of action ➢ Practical implications of many of the above gained knowledge will be possible
ARD 205	Research Methodology-II	➢ To learn the different statistical techniques to conduct scientific research precisely ➢ To gather in depth knowledge on scientific interpretation techniques
ARD 206	Agribusiness Management and Entrepreneurship Development	➢ To gather the skills on market survey, price determination techniques and supply chain management etc. ➢ The students know how to develop Entrepreneurship and agri-business plan, how to deal Cash Management and Marketing Management for Agri Business
ARD-207	Indian Culture and Spiritual Heritage-II	➢ The students are acquainted with the rich cultural and spiritual heritage of India that exist and is traditionally maintained in the rural India. ➢ The students are familiar with value based education system which helps them to work under extreme

		pressure and deals with any problems empathically
ARD-208	Rural Living and Learning Experience-I	➢ The students develop coping strategy in village situation. They have a clear idea about the rural problems and prepare action plan based on available local resources
ARD 251	Forest and Tribal Livelihoods Development	➢ To generate better understating about forest based tribal people and their livelihood and know about the different and role of forest protection committee to conserve the forest eco system

SEMESTER-III		
Course Code	**Course Name**	**Course Outcomes**
ARD 301	Rural Development Management	➢ The students should have come across the basic steps/criteria which can be considered to formulate any projects. ➢ The students should know the various components of a Project including Logical Framework Analysis, Budgeting, Stake holder analysis etc. ➢ The students will came to know the different techniques to identify the most viable projects ➢ The students may be able to set the various indicators against each activity to track the ongoing progress of a Project and also know the monitoring mechanism for the same. ➢ The students should have develop the decision making tools which can be implemented/performed during a critical situation. ➢ The students will be able to coordinate with various officials to successfully organize any projects/activities ➢ The students will be able to prepare the Project Proposal based on the Rural Developments/Social development activities

ARD 302	Rural Development and Extension Programmes & Organizations	➢ The students should aware about the various extension activities running by Central & State Govt. ➢ They know the major flagship programmes introduced by Govt. of India to eradicate the poverty, sustain the livelihood, conserve the water etc. ➢ Will be able to know the various rural development programmes run by different units of Ramakrishna Mission ➢ They will gather hand hold experience on functioning of Extension Agency like ATMA, KVK etc. ➢ Will know the ongoing programmes under different ministries of Govt. of India ➢ The students will be developed an idea on how to link up the extension activities to any rural development programmes
ARD 303	Rural Health Management	➢ The students should know the various channels of health care services provided by Govt. ➢ They will develop a concept on different communicable and non-communicable diseases ➢ They should gather some basic concept on various first hand remedies against various diseases ➢ The students can aware the rural mass about different health related schemes and programmes adopted by state and central Govt. ➢ Through posters the students will be able to disseminate the different causes of Diarrhea, Dengue, HIV etc. ➢ They will be able to know the different components of Rural hospitals ➢ They will understand the waste management concepts ➢ The students will come across the different sanitation units of a village.
ARD 304	Rural Women and Child Development	➢ The students should know the different crimes occurred against the rural women and children especially human trafficking, sexual abuse, dowry, female infanticide etc. ➢ They will know the various reasons for gender discrimination which further accelerate the different social problems ➢ They will aware the different legal rights, policies and programmes to protect the victimized women and children ➢ They should have independently develop an intervention strategy to overcome various social problems existed in the society

		➢ They should aware the different shelter (Home) provided by the Govt. like SWADHAR, Short Stay home ➢ They will be able to facilitated the victims to get back into the main stream of the society
ARD 305	Technologies in Agriculture and Allied Sectors	➢ The students should know the different identical features and benefits of the livestock rear by the rural communities. ➢ They should know how to prepare the Vermi-compost ➢ They will know the different steps involve in Apiculture and equipments for the same ➢ They will be able to identify the different agri-implemets and will be able to operate the tractor in agricultural field ➢ Will understand the different sources and methods of irrigation and techniques for reduce the wastage of water ➢ They will be able to cultivate the Mushroom ➢ They should know the different stakeholders involve in agri-marketing and aware the various channels for the same ➢ They should know how to measure the specific gravity of the milk, how to take reading of the body temperature of Cow etc. ➢ They should know the different grassroots innovations functioning in the agricultural field ➢ They should know the role of fishery science in rural development.
ARD 306	Rural Living and Learning Experience-II	➢ The students should know about the rural life and rural community ➢ Know the livelihood patterns of the villagers ➢ Will be able to identify the different problems (Agricultural, Health, Social) faced by the rural people as well as able to facilitated them to minimize the problems ➢ Will be able to identify the location specific needs ➢ Might have developed grassroots planning and monitoring of a livelihood based project by participatory planning ➢ Will be able to capture the cultural graphs/changes between early twentieth century and current scenario ➢ Will be able to prepare the community action plan to improve the live and livelihood of the rural folks

Special Modules		
ARD 355	Extension Education-II	➢ The students should know the role of the information communication technologies in agriculture and allied sector ➢ Should be able to familiar with different extensions tools ➢ Should know the ICT based technologies to successfully run any extension based projects ➢ Should develop the entrepreneurship activities in agriculture ➢ Should know the role of international organizations involved in extension services ➢ Will be able to prepare the training event for the farmers including budgeting ➢ Should know the different activities performed by Agricultural Technology Management Agency (ATMA) ➢ Should able to facilitate the farmers to adopt any suitable technologies
ARD-356	Social Problem Intervention	➢ The students should know about the different evil practices that are strongly existed in the society. ➢ The students should know the different aspects of crime, nature of crime and causes of crime, different types of criminal etc. ➢ They should get an idea about the motives of criminals, their characteristics features and psychology etc. ➢ They should be acquainted with the diverse theory of criminology including Retributive theory, Psycho-analytical' theory, Tannenbaum's theory, Merton's Theory etc. ➢ They should know the importance of criminal research and will be able to constructed the hypotheses in criminal research ➢ They should gain the concept of historical changes from the concept of punishment to correction and reformation ➢ They should know the different Acts which could be effectively implemented against the criminals ➢ They will aware about the different types of punishment like Cognizable and Non-cognizable offences, Bailable and non – bailable ➢ They should know the distinguish between General Diary (GD) and FIR and will be aware

		that which one would be followed in different situation

SEMESTER - IV		
Course Code	**Course Name**	**Course Outcomes**
ARD 401	Rural Development Administration	The students should learn the following ➢ The formation and developmental process of Panchayati Raj Institution (PRI) in India ➢ The role of State Election Commission, State Finance Commission, District Planning Commission in Panchayati Raj Institution (PRI) ➢ The role of Panchayati Raj Institution's (PRI) to effectively implementation of the various schemes under Grampanchayat ➢ The democratic decentralization process, three tier structure and their contribution ➢ The basic features of 73rd Amendment Act ➢ Social Legislations, Rights of rural people to social justice, security and welfare ➢ The students should know the different activities of Gram Panchayat (GP) and will be aware that how does it functioning ➢ Traditional administrative set up in Tribal area ➢ Total Sub Plan (TSP) and organization change in tribal development ➢ Land reforms, Right to Information Act (RTI) and performance of Community Based Organization (CBO) in Rural Development
ARD 403	Seminar-I	➢ The students should know the viability of their research topic as ratified by a group of external examiners
ARD 404	Seminar-II	➢ The students will know to find out their results against each objectives as approved by the group of external examiners

ARD 405	Dissertation + Research Paper Submission	➢ The students will learn to conduct an independent research work and will be able to prepared a Dissertation copy ➢ The students will be able to write a research article to be communicated to a peer reviewed journal
ARD 406	Learning through Organisational Attachment	The students should learn and gain the following ➢ Study on the Organization especially in the specific thrust area in Rural Development ➢ How does the organization functioning ➢ The structure of the Organization (Organogram) and the various activities carried out by the organization ➢ Should aware the culture and decorum of the office ➢ The students will get a handhold exposure to working with the Organization in a small thematic area/projects ➢ Should know and differentiate the priority area of the project work ➢ Should know about the spirit of Team Work by a part of the team to complete any projects within stipulated time period. ➢ Will be able to prepared the report based on their field visit ➢ Will be able to learnt the technique how can claim their actual expenses (reimbursement) for travelling, food & logging ➢ Should know how to build the rapport with various functionaries at different levels to successfully execute the project
ARD 451	Natural Resource and Watershed Management	The student should gain the following ➢ Should know the different source of Natural resources ➢ Concept of Watershed and different types of watershed based on their area ➢ Participatory engagement and community mobilization to construct a watershed programme ➢ Ground water management and common property sources ➢ Formation of SHG's to facilitate the women for their empowerment ➢ Will be able to prepared the watershed development plan on the basis of land capability classification

		➢ Should aware about the roles of different committees to manage the watershed ➢ Should know the monitoring and evaluation aspects of watershed ➢ Should know the concept of agro-forestry and grassland management policy for watershed areas

Programme Name: MSc in Agricultural Biotechnology

Programme Outcome:

1. To provide an apprehensive knowledge on application biotechnology in modern agriculture
2. To provide basic knowledge on crop production and crop protection
3. To impart in-depth practical knowledge in production of vermicompost, biopesticides, biofertilizers etc.
4. To provide knowledge on the basic rules of laboratory safety and use of instruments to conduct basic experiments
5. Use of basic microbial techniques to isolate and characterize the isolated microorganisms from soil and water samples
6. Use of statistical design, statistical software to interpret the data collected for research
7. Use of modern techniques to conduct research work in plant biotechnology
8. To build the manpower to serving agricultural sector
9. To make students competitive in pursuing higher studies

Programme Specific Outcome:

1. To provide knowledge of application of biotechnology in plant biology
2. Use of modern tools and techniques to conduct research on plant scienes
3. Use of statistical tools for interpretation of data
4. Use of molecular marker for screening of efficient germplasm
5. Use of plant tissue culture techniques for production of disease free plants

Course Outcome

SEMESTER – I		
Course Code	**Course name**	**Course outcomes**
ABT-101	Fundamentals of Crop Production	• Basic idea about Agro-climatic zones of west Bengal • Basic concept on soil sampling, soil quality testing (pH, EC, C, N, P estimation), organic farming and vegetative plant propagation methods(theoretical knowledge). • Basic idea about seasonal cropping patterns • Basic idea on use of fertilizers, common agricultural practices
ABT-102	Fundamentals of Crop Improvement	• Basic idea on breeding techniques for crop improvement • Basic concept on mendelian genetics, gene interaction, Linkage and crossing over • To learn the process of fertilization
ABT-103	Plant Physiology	• Basic idea about general plant physiology: Transpiration, photosynthesis and stress • Hand on experience on estimation of osmotic potential as well chrolophyll of plant sample
ABT-104	Biostatistics-I	• To learn different statistical measures(Central tendency; measures of dispersion, correlation and regression etc) • Collection of data and its analysis and its interpretation • Tabulation and graphical representation of data • Sampling and its type • Hypothetical testing (T test, Z test, F test etc)
ABT-105	Molecular Biology	• Basic idea about macromolecule such as protein and DNA, RNA • Central dogma of molecular biology • Basic idea about gene expression with special reference to post transcriptional modifications
ABT-106	Plant Tissue culture	• General idea to establish *in vitro* culture of plant. • Media preparation, sterilization and culture of different explants for induction of fresh culture, shoot tip, callus culture, embryo culture, anther culture etc
ABT-107	Spiritual and Cultural Heritage of India-I	• The students are acquainted with the rich cultural and spiritual heritage of India that exist and is traditionally maintained in the rural India. • The students are familiar with value based education system which helps them to work under

		extreme pressure and deals with any problems empathically
		SEMESTER - II
ABT-201	Fundamentals of Crop Protection	• One will be able to know about all types of diseases associated with crops • One can understand about all the causative organisms behind the damages caused to crops • One will have a vivid knowledge about the pesticides: dosage, types and mechanism of action of the same • Furthermore, a clear understanding of Integrated Pest Management can be achieved • One can know about weeds: biology, ecology, classification and diversification • One will be able to know about herbicides: chemical nature. classification, dosage and mode of action • Practical implications of many of the above gained knowledge will be possible
ABT-202	Plant Biochemistry	• One can have a basic understanding of the structure and function of biomolecules like carbohydrates, protein and lipids • An idea of enzyme mechanisms can be understood • One can comprehend the metabolic pathways • One will be equipped with practical hand on experience to estimate different biochemical parameters like sugar, protein, free fatty acids etc
ABT-203	Biostatistics-II	• A knowledge of different statistical design to study different cropping systems • A clear understanding of several statistical tools used in plant biological studies
ABT-204	Microbiology	• One can get the idea of several microscopic techniques used in studying microbes • To learn how to isolate the microorganisms from soil and water followed by their culture on medium under controlled condition • One will get to know about the life stages of the microorganisms. • One will understand about how the microbes affect the soil environment. One will understand about mushroom culture which may help in further business prospect.
ABT-205	Genetic Engineering	• One will understand about genetic modification through gene cloning, gene transfer • One will get some idea about host restriction and modification system. • One will get some theoretical idea about the techniques used in DNA estimation, Electrophoresis, blotting, PCR, DNA sequencing etc • Basic knowledge on Agrobacterium mediated gene transfter
ABT-206	Molecular Tools and	• One will get some idea of handling the laboratory instruments.

	Techniques	One will be able to learn about the molecular techniques used in DNA extraction.
ABT-207	Cell Biology	• One will be able to understand about prokaryotes and eukaryotic cell structure. • One will understand about cell cycle. • One will be able to get some idea about cellular organelles and their function. • Basic knowledge on cellular signal transduction.
ABT-208	Spiritual and Cultural Heritage of India-II	• The students are acquainted with the rich cultural and spiritual heritage of India that exist and is traditionally maintained in the rural India. • The students are familiar with value based education system which helps them to work under extreme pressure and deals with any problems empathically
ABT-209	Seminar-I	• An effective way to learn, understand, create and deliver power point presentation in front of delegates.
	SEMESTER - III	
ABT-301	Immunology	• Basic idea about immune system and its components • One will be able to learn theoretical knowledge on the principle and technique of tools like ELISA , Immunoelectrophoresis, Immunoblot, hybridization based detection method to detect the pathogen
ABT-302	Bioinformatics	• Basic idea about Database like NCBI, Public Biological Databases, and File format (gene bank file format, FASTA format, PDB format). • One will able to use tools to generate 3 dimensional structure of protein. • Comparative genomics and phylogeny study.
ABT-303	Molecular breeding	• One will get basic idea about molecular marker and its type. • Use of PCR based marker system (RAPD, ISSR etc) to analyze the plant DNA sample. • Use of software to study the genetic divergence and similarity. • Gel electrophoresis and subsequent study of agarose gel using gel doc system.
ABT-304	Genomics and Proteomics	• Classical ways of genome analysis, gene annotation. • 16S rRNA typing/ sequencing, EST's and SNP's.
ABT-305	Transgenic in Crop improvement	• Concepts, principles and scope of transgenic technique vis-à-vis Biotechnology. • Application of transgenics for improvement in agriculture and human benefit.
ABT-306	Environmental Biotechnology	• Detailed knowledge of wastewater management. • Application of Biotechnology in solid waste management: Composting; Vermiculture; Effective micro-organism technology, Biogas, sanitary landfill technology

		• Preparation of biofertilizer.
ABT-307	Organisational /Industrial Placement	• Study on the organization: its structure, foundation, activities. • To have an hand on experience in understanding the decorum of office work • To work as a part of team and value the team work • To understand the importance of prioritization of particular thematic project work • To have a chance to work with delegates followed by probable placements
ABT-308	Seminar-II: Proposed plan of dissertation work	• An effective way to learn, understand, create and deliver power point presentation related to research problem in front of delegates.
SEMESTER - IV		
ABT-401	Seminar-III	• Sharing of findings of research which is done in last six month with delegates
ABT402	Dissertation Work	• Hand on experience on how to conduct research work

The evaluation pattern for both theory and practical aspects of a course are envisaging four Unit Test (40% wattage) each followed by semester ending examinations (60% weighted). In general, a Unit Test corresponds to one or more course outcomes, thus ensuring their direct assessment. In the semester ending examinations theory and practical assessment are conducted separately to access both theoretical knowledge and practical skills of the students.

Two RLLLE programmes are conducted for M.sc ARD student to provide them with an opportunity to learn why applying classroom knowledge in real life situation. In LOA Programs both M.sc ARD and AGBT Students works in the real life projects of reputed agricultural organizations. Both these courses are evaluated separately based on the field performance, seminar presentation and quality of documentation. All the students of the centre mandatorily take up dissertation work where both theoretical and practical aspects of conducting independent research are tried and scientifically documented. This is evaluated in the form of seminar and research report by a group of external experts.

Ramakrishna Mission Vivekananda Educational and Research Institute

School of Agriculture and Rural Development

Department of IRTDM

Ranchi Campus

Programme Outcomes, Programme Specific Outcomes and Course Outcomes of all Academic Programmes offered at RKMVERI – IRTDM

The programme outcomes of the Dept. of IRTDM is framed following the Bloom's Taxonomy (1956) of educational objectives that categorize educational objectives into following six hierarchic levels,

1. Knowledge
2. Comprehension
3. Application
4. Analysis
5. Synthesis
6. Evaluation

In 2001, another team of scholars—led by Lorin Anderson, a former student of Bloom's, and David Krathwohl, a Bloom colleague who served on the academic team that developed the original taxonomy—released a revised version of Bloom's taxonomy. In the revised version, three categories were renamed and all the categories were expressed as verbs rather than nouns. *Knowledge* was changed to *Remembering*, *Comprehension* became *Understanding*, and *Synthesis* was renamed *Creating*. In addition, *Creating* became the highest level in the classification system, switching places with *Evaluating*. The revised version is now *Remembering*, *Understanding*, *Applying*, *Analysing*, *Evaluating*, and *Creating*, in that order. The educational objectives of the programmes offered under IRTDM actually follows the revised Bloom's taxonomy to address the cognitive nuances of the learners

Programme: M.Sc. in Agriculture, Rural and Tribal Development

Programme Outcome (PO)

PO-1: The programme has been framed to provide an understanding and experience of different aspects of Agriculture, Rural and Tribal Development.

PO-2: Providing detailed knowledge of agriculture in India and Indian farmers income generating enterprises in general and Jharkhand in particular

PO-3: Knowledge dissemination regarding various technique of farming and farming system in India including alternative approaches of farming practices like organic farming

PO-4: It is innovative, skill and employment oriented to attract bright students to the discipline of agriculture, rural and tribal development.

PO-5: To make students competitive in pursuing higher studies and to become agri-preneurs

PO-6: Facilitating detailed study of various agriculture and allied branches required to raise the income of farmers

PO-7: It is to provide a holistic perspective of rural and tribal developmental schemes/programmes of central Government in general and state Government in particular.

Programme Specific Outcome (PSO)

PSO-1: To provide knowledge on ancient agriculture, modern crop production techniques and alternative farm production approaches like organic, bio-dynamics and homa farming

PSO-2: To impart knowledge about tribal society and their cultural heritage

PSO-3: To acquire knowledge and understanding about different socio-economics aspects of rural farming community of Jharkhand

PSO-4: To serve the rural and tribal community through different livelihood promoting interventions

PSO-5: To expose pupils for hands-on-training on agriculture and rural development schemes and functioning of organizations through Rural Development Work Experience and Learning through Organizational Attachment Programmes

PSO-6: To impart skills required for creation of sustainable livelihood opportunities with particular reference to small and marginal farmers and rural women

Course Outcome (CO)

SEMESTER-I		
Course Code	**Course Name**	**Course Outcomes**
IRTD-101	Genesis of Rural and Tribal Development	The course helps the students to develop: **CO-1:** Concept of rural development and tribal development **CO-2:** Swami Vivekananda, Gandhiji and Rabindranath Tagore's philosophy of rural development **CO-3:** The issues and challenges of rural development with special reference to Jharkhand **CO-4:** Insights of different rural and tribal development programmes in India
IRTD-102	Extension Education -I	The course helps the students to develop deep into the: **CO-1:** Concept, philosophy and principles of extension education. **CO-2:** System of extension education in India. **CO-3:** Different TOT models and delivery system. **CO-4:** Selected extension system of other countries.
IRTD-103	Basic Agriculture	The course familiarize the students on: **CO-1:** Basics of Agricultural Sciences. **CO-2:** Identification & classification of crops. **CO-3:** Concepts of nutrient management, weed management and water management. **CO-4:** Overview of seed technology and farm implements.

IRTD-104	Rural and Tribal Society	The course offers: **CO-1:** An introduction to the rural and tribal social structure in India. **CO-2:** The students about the ways in which rural people cope with life. **CO-3:** The process and outcome related to rural change. **CO-4:** Understanding of customs and institutional linkage with development.
IRTD-105	Integrated Aquaculture	T**o** familiarize the students with: **CO-1:** The basics & fundamentals of aquaculture. **CO-2:** Integrated aquaculture, pond and feed management. **CO-3:** Wastewater aquaculture and cultivation of aquatic macrophytes. **CO-4:** Constraints of aquaculture.
IRTD-106	Panchayati Raj Institution	The students would get insights into: **CO-1:** The PRIs and its functioning. **CO-2:** The broader constitutional and legal framework of PRIs. **CO-3:** Relation of PRI with bodies of civil society, NGOs and community based organization. **CO-4:** The different developmental programmes implemented through PRIs.
SEMESTER-II		
IRTD-201	Rural and Tribal Economy	The student will equipped with:

		CO-1: The different aspects of rural and tribal economy and its relation with the development. **CO-2:** The theoretical concepts of small scale economy and its functioning. **CO-3:** Relation between poverty and development. **CO-4:** The concept of agricultural production systems, unemployment, agricultural labor, SHG, Agricultural finance and indebtedness, rural industries *etc*. **CO-5:** The functioning and problems of each aspect in the micro-level through practical exercises.
IRTD-202	Commercial Agriculture	To familiarize the students with the basics of: **CO-1:** Both traditional and modern beekeeping including rearing techniques care and management. **CO-2:** Identification, cultivation and marketing of Lac. **CO-3:** Identification, cultivation and marketing of Tasar and silk worm. **CO-4:** Mushroom cultivation including processing and marketing.
IRTD-203	Horticulture	To familiarize the students with the basics of: **CO-1:** The different branches of horticulture like olericultue, pomology, floriculture etc. **CO-2:** Preservation techniques and value addition of fruits and vegetables. **CO-3:** Orchard management, planting and propagation techniques.

		CO-4: Cultivation techniques for medicinal and aromatic plants etc.
IRTD-204	Extension Education -II	The course creates the awareness about: **CO-1:** The concept and meaning of group and leadership. **CO-2:** The attitudinal and motivational theories. **CO-3:** Adoption and diffusion of innovation
IRTD-205	Health and Nutrition	The course creates the awareness about: **CO-1:** The basic concepts of health and health related issues. **CO-2:** The role of health and nutrition professional in rural and tribal development. **CO-3:** The cultural and clinical dimensions of health. **CO-4:** The national programmes related to the eradication of water and sanitation problems. **CO-5:** The first-aid techniques for initial prevention.
IRTD-206	Personality Development -I	The course helps the students to develop: **CO-1:** Internal personality **CO-2:** Moral and ethical values **CO-3:** Leadership quality
SEMESTER-III		
IRTD-301	Rural and Tribal Women and Children	The students would be acquainted with: **CO-1:** the concept and approaches of gender and related issues **CO-2:** the situational overview of the rural and tribal women of India.

		CO-3: the programmes and other activities related to women development. **CO-4:** the concept of child labour and the rights related to women and child.
IRTD-302	Adult and Non-Formal Education	The course helps the students to understand the: **CO-1:** Concept and principles of adult education. **CO-2:** Objectives of NLM and the meaning of functional literacy. **CO-3:** Programmes related to adult education and its method of evaluation. **CO-4:** Teaching and learning methods of adult education.
IRTD-303	Basic Environmental Science	The course helps the students to understand the: **CO-1:** meaning, nature and scope of different types of natural resources. **CO-2:** techniques for sustainable utilization of different resources. **CO-3:** policies related to conservation and its related impacts. **CO-4:** process of nurturing human resources and different aspects of disaster mitigation.
IRTD-304	Farming System Approaches	The students would be acquainted with: **CO-1:** the meaning, nature and scope of farming systems approach. **CO-2:** the principles, issues and management practices in sustainable agriculture.

		CO-3: the techniques of data collection using PRA tools . **CO-4:** the application of PRA tools in the rural context.
IRTD-305	Crop Production Technology	The course helps the students to familiarize with: **CO-1:** the basics of plant physiology. **CO-2:** the production technology of important cereals of Jharkhand like paddy, wheat, maize and finger millet. **CO-3:** the production technology of important pulse and oilseed crops in Jharkhand. **CO-4:** the production technology of jute, tea and sugarcane in Jharkhand
IRTD-306	Personality Development -II	The course helps the students to develop: **CO-1:** Internal personality **CO-2:** Moral and ethical values **CO-3:** Leadership quality
SEMESTER-IV		
IRTD-401	Development Communication	The course the students to familiarize with: **CO-1:** the basics aspects of communication for development. **CO-2:** the tools, techniques and methods of information dissemination for rural development. **CO-3:** the changing milieu of development communication paradigm. **CO-4:** the application and role of ICT and its subsequent effects on rural people.

IRTD-402	Rural Development Administration	The students would be acquainted with: **CO-1:** the meaning, nature and scope of development administration and its perspectives. **CO-2:** the strategy, structure and implementation of developmental activities . **CO-3:** the role of bureaucrats and other coordinating agencies in rural transformation. **CO-4:** the dimensions of tribal administration in India.
IRTD-403	Basic Animal Husbandry	The course helps the students to familiarize with: **CO-1:** the basics of livestock farming and associated activities. **CO-2:** the different types of livestock breeds, their disease, treatment and management. **CO-3:** the technology of production, requirements and importance of livestock industry in Jharkhand. **CO-4:** the marketing and financial viability of livestock and poultry farming.
IRTD-404	Organic Agriculture	The students would be acquainted with: **CO-1:** the principles, advantages and limitation of organic farming and natural farming. **CO-2:** the agricultural heritage of India viz. Vedic, biodynamic *etc.* **CO-3:** the role and production of different types of compost and vermitechnology. **CO-4:** the importance of Integrated Nutrient Management.

IRTD-405	Rural Banking	The students would be acquainted with: **CO-1:** the institutional structure of rural financing in India. **CO-2:** the functioning of financial institutions in rural development. **CO-3:** the role, constraints and future challenges of banks in rural development. **CO-4:** the recent financial schemes of Govt. for rural and agricultural development.
IRTD-406	Personality Development- III	The course helps the students to develop: **CO-1:** Internal personality **CO-2:** Moral and ethical values **CO-3:** Leadership quality
SEMESTER-V		
IRTD-501	Rural and Tribal Demography	The course helps the students to familiarize with: **CO-1:** the basics of population perspectives of rural and tribal India. **CO-2:** the different concepts and elements related to population analysis. **CO-3:** the theoretical perspectives of demography and composition of Indian population. **CO-4:** the relevance of demographic study and its application on current social concerns.
IRTD-502	Agricultural Bio-technology	The course helps the students to familiarize with: **CO-1:** the basics of biotechnology and its application to agriculture.

		CO-2: the handling and use of different laboratory equipments. **CO-3:** the technology of production of biofertilizers and biofungicides. **CO-4:** the essentials of soil biotechnology.
IRTD-503	Rural & Agricultural Marketing	The course helps the students to familiarize with: **CO-1:** the concepts and aspects related to traditional and rural marketing systems. **CO-2:** the evolving concepts in the modern marketing systems. **CO-3:** the marketing services, channels and agencies involved in rural marketing. **CO-4:** the different Act and policies to improve the rural marketing systems.
IRTD-504	Entrepreneurship Development	The course helps the students to familiarize with: **CO-1:** the concepts, theories, problems and prospects of entrepreneurship. **CO-2:** the entrepreneurial qualities and the factors motivating for entrepreneurship. **CO-3:** the need, content phases and constraint of entrepreneurship development programme. **CO-4:** the process of technical, financial and market analysis for establishing an enterprise.
IRTD-505	Research Methodology	The course helps the students to familiarize with: **CO-1:** the different techniques of data collection.

		CO-2: the different technique of classification and tabulation of data.. **CO-3:** the different aspects of social research and sampling. **CO-4:** the different statistical method for the analysis of research data.
IRTD-506	Personality Development - IV	The course helps the students to develop: **CO-1:** Internal personality **CO-2:** Moral and ethical values **CO-3:** Leadership quality
SEMESTER-VI		
IRTD-601	Integrated Crop Management	The course helps the students to familiarize with: **CO-1:** the different methods of crop disease management. **CO-2:** the different IPM techniques for pest management **CO-3:** the management of water resources for better crop cultivation. **CO-4:** the different water conservation techniques.
IRTD-602	Rural Development: Planning and Management	The course helps the students to familiarize with: **CO-1:** the concepts and aspects of the rural development management. **CO-2:** the functions of planning commission and features of different five year plans. **CO-3:** the concept of organizational development and its relevance in rural development. **CO-4:** the principles and aspects of farm management.

IRTD-603	Personality Development - V	The course helps the students to impart knowledge on: **CO-1:** The Indian cultural & spiritual heritages **CO-2:** Some great personalities/spiritual characters of different religions
IRTD-604	Development of Non-Farm Sectors	The course helps the students to familiarize with: **CO-1:** the problems and possibilities of different traditional village crafts. **CO-2:** the role of different rural non-farm sector promoting agencies. **CO-3:** the role of cooperative sectors in the development of village industries **CO-4:** the theoretical underpinnings related to non-farm sectors.
IRTD-605	Project work	The course helps the students to develop: **CO-1:** Hands-on experience on agriculture and rural development activities **CO-2:** Knowledge on project formulations, project write up *etc.*
IRTD 606	Rural Living and Learning Experience (RLLE)- I	The course helps the students to develop: **CO-1:** Practical knowledge on agriculture and allied activities of rural people **CO-2:** Idea on rural life especially agricultural activities by learning by doing principle **CO-3:** Understanding about the rural tribal lives and their socio-cultural perspectives

SEMESTER-VII		
IRTD 701	Integrated Rural and Tribal Development – Concept and Approaches	The course helps the students to: **CO-1:** understand different developmental philosophy and its implication to rural change. **CO-2:** develop conceptual clarity on different approaches of rural development. **CO-3:** know historical background of welfare and voluntary action in India. **CO-4:** be familiar with different emerging rural development models in India and abroad.
IRTD-702	Extension Education-III	The course helps the students to familiarize with: **CO-1:** the different aspects of extension education and transfer of technology. **CO-2:** the activities of different agencies engaged in rural development. **CO-3:** the rural development activities of different branch centers of Ramakrishna Mission. **CO-4:** the rural development strategies and policies of selected countries.
IRTD-703	Advanced Horticulture	The course helps the students to familiarize with: **CO-1:** the principles, issues and management practices in farming system and sustainable agriculture. **CO-2:** the importance and production packages for different spices, medicinal and aromatic plants.

		CO-3: marketing and preservation techniques of fruits, vegetables and flowers and value addition of fruits and vegetables. **CO-4:** the protective cultivation of different horticultural crops and seed production techniques including hybrid seed production.
IRTD-704	Research Methodology	The course helps the students to get acquainted with: **CO-1:** the basics of research methodology. **CO-2:** the different qualitative methods and approaches of research. **CO-3:** the quantitative techniques of data analysis. **CO-4:** the simple software packages for the research.
IRTD-705	Rural Living and Learning Experience	The course helps the students to develop: **CO-1:** Practical knowledge on agriculture and allied activities of rural people **CO-2:** Idea on rural life especially agricultural activities by learning by doing principle **CO-3:** Understanding about the rural tribal lives and their socio-cultural perspectives
IRTD-706	Human Resource Development and Management	The course helps the students to familiarize with: **CO-1:** the basics of human resource development and management **CO-2:** the importance and application of organizational behavior in HRD. **CO-3:** the management and acquisition of manpower

		CO-4: the process of developing rural human resources.
SEMESTER-VIII		
IRTD-801	Indian Cultural and Spiritual Heritage	The course helps the students to develop: **CO-1:** Internal personality **CO-2:** Moral and ethical values **CO-3:** Leadership quality **CO-4:** Knowledge on Indian spiritual and cultural heritage
IRTD-802	Integrated Faming System Technologies	The course helps the students to to get acquainted with: **CO-1:** the basics of integrated farming systems. **CO-2:** the different integrated management technologies of plant nutrient, pest, disease, weed, water etc. **CO-3:** the certification of organic products. **CO-4:** the economics of integrated farming system.
IRTD-803	Planning, Policy and Panchayati Raj Institution	The course helps the students to familiarize with: **CO-1:** the background and techniques of different types of planning. **CO-2:** the different policies and programmes related to rural development. **CO-3:** the aspects of local organisation and its functions. **CO-4:** the role of different grass root level agencies in rural development.
IRTD-804	Information and Communication Technology (ICT)	The course helps the students to get acquainted with: **CO-1:** the basics of ICT and its role in rural development.

	in Rural Development	**CO-2:** the knowledge of different ICT enabled rural services. **CO-3:** the idea of geographical information system. **CO-4:** the aspects of agricultural information system
IRTD-805	Learning through Organisational Attachment	The course helps the students to familiarized with: **CO-1:** Organizational behaviour and its activities **CO-2:** Placement opportunities **CO-3:** Acclimatization with adverse working environment *etc.*
IRTD-806	Agribusiness Management	The course helps the students to get acquainted with: **CO-1:** the introduction to agri-business management. **CO-2:** the different financial aspects of agri-business management. **CO-3:** the issues like intellectual property rights, business ethics, marketing in relation to agri-business. **CO-4:** the management procedures of different agro-based industry.
IRTD-811	Protected Cultivation of High Value Crops	The course helps the students to develop: **CO-1:** Knowledge on production technology of high value crops under protection **CO-2:** Idea about functioning mechanisms of different protective structures **CO-3:** Knowledge on media and soil preparation for protective cultivation
SEMESTER-IX		

IRTD-901	Indian Cultural and Spiritual Heritage	The course helps the students to get acquainted with: **CO-1:** the concept of service and its explanation from different viewpoints. **CO-2:** the eternal glory of India and her future. **CO-3:** the Swamiji's view on social reforms.
IRTD-902	Rural Entrepreneurship Development	The course helps the students to get acquainted with: **CO-1:** the concept of entrepreneurship and its relevance in rural development. **CO-2:** the different programmes of entrepreneurship development. **CO-3:** the different institutions supporting entrepreneurs. **CO-4:** the policies of government and selected success stories.
IRTD-903	Production Economics and Farm Management	The course helps the students to get acquainted with: **CO-1:** the concept of production economics and its related aspects. **CO-2:** the issues of farm management in the Indian context. **CO-3:** the tools of farm management. **CO-4:** the different aspects of farm resource management.
IRTD-904	Rural and Tribal Development and Management	The course helps the students to get acquainted with: **CO-1:** the introduction to the management and organizational development. **CO-2:** the different aspects of project formulation and management.

		CO-3: the different criteria of project evaluation. **CO-4:** the process of draft project preparation and its social valuation assessment.
IRTD-905	Rural Living and Learning Experience	The course helps the students to develop: **CO-1:** Practical knowledge on agriculture and allied activities of rural people **CO-2:** Idea on rural life especially agricultural activities by learning by doing principle **CO-3:** Understanding about the rural tribal lives and their socio-cultural perspectives
IRTD-906	Bio-pesticides, Bio-agents & Bio-fertilizers	The course helps the students to develop: **CO-1:** Knowledge on production of bio-agents (predators & parasitoids of insect pests **CO-2:** Knowledge on production of microbial pesticides **CO-3:** Knowledge on production of bio-fertilizers
IRTD-907	Financial and Accounting Management	The course helps the students to get acquainted with: **CO-1:** the basic concept of accounting. **CO-2:** the process of financial management. **CO-3:** the aspects of importance of financial planning. **CO-4:** the essentials of profit planning.
IRTD-911	Project Management in Agricultural Development	The course helps the students for: **CO-1:** Preparation of DPR **CO-2:** Capital Budgeting Techniques **CO-3:** Techniques of Resource Mobilization

SEMESTER-X		
IRTD-952	Extension Education- IV	The course helps the students for: **CO-1:** Technology dissemination **CO-2:** Conducting Participatory Adaptive Research **CO-3:** Understanding about the livelihood options of rural farming community
IRTD-953	Rural Development Work Experience	The course helps the students to: **CO-1:** expose in real life situations and gives them opportunities to apply in actual situations **CO-2:** know the concepts on integrated rural and tribal development **CO-3:** understand about different technologies based on agriculture and related fields **CO-4:** utilize management concepts learnt in class room situations
IRTD-999	Dissertation	The course helps the students to: **CO-1:** develop writing skill of thesis in a scientific manner **CO-2:** conduct research activities **CO-3:** to impart knowledge on need based research intervention especially in the areas of agriculture, rural and tribal development

Programme: M.Sc. in Rural Development and Management

Programme Outcomes (PO)

PO 1: Understand the macro-micro emphasis and compare and contrast theoretical experience at one level with those at another.

PO 2: Show how social issues can be better understood by emphasizing the micro/macro connections.

PO 3: Describe and apply some basic theories or theoretical orientations in at least one area of rural context.

PO 4: Design a research study in an area of choice.

PO 5: Summarize basic questions and issues in the area of rural and tribal development.

PO 6: Compare and contrast basic questions and issues in the area of management of rural and tribal institutions of the country.

PO 7: Show how multidisciplinary knowledge helps understand the field of rural development in a holistic way.

PO 8: Summarize current research in the area.

PO 9: Develop specific policy implications of research and theories in the area.

PO 10: Synthesize information by pulling together disparate pieces of the rural development programme.

Programme Specific Outcomes (PSO):

PSO 1: The learners will be able to describe the basic concepts, theory and methods of rural development such as rural society, cultural relativism, participatory approach, decentralization, rural livelihood, poverty, entrepreneurship.

PSO 2: The learners will demonstrate an understanding of history, fundamental concepts, and theory in rural development, and be able to apply the methods used in development studies to explain the situation of rural and tribal India.

PSO 3: The learners will describe how the scientific method is used in development planning and major evolutionary changes in rural development efforts from the earliest efforts to the contemporary experiments.

PSO 4: The learners will gain hands-on experience in either the application of research methods during dissertation or in the application of key development concepts to a work setting through participation in the internship program.

PSO 5: The programme will develop confidence among the learners to feel themselves as change agents for social change and transformation.

Course Outcomes (CO)

Course No.	Course Name	Course Outcomes
SEMESTER 1		
RDM 101	Rural Development – Concept, Policies and Approaches	• To understand the concept and dimensions of development • To have an outlook of different phases, approaches, government polices of rural development in India • To get idea on rural development experiences in Asian, Latin American and African perspectives. • To get understanding of social service, Social Welfare, Social Security, Social Assistance, Social Policy, Social Planning, Social Development, Social Change and Social Action. • To have an outlook of several successful rural development experiments in India
RDM 102	Rural Development: Thoughts and Theories	• To get an overview of Indian thinkers (Rabindranath Tagore, Swami Vivekananda and Gandhiji) in the field of Rural Development. • To develop insights into different economic theories, theories of societies and culture and several development theories for rural development.
RDM 103	Rural Economics and Cooperation	• To understand the concept of rural poverty and have an outlook of several employment generation schemes. • To get an in-depth knowledge of importance, scope, limitations of agricultural

		development in the field of economic development of the country. • To understand the need, basics and history of cooperative movement in India.
RDM 104	Rural Society and Social Problems	• To understand the concept of Society, Social Structure, Community, Institution, Association, Culture, Norms and Values. • To get an understanding of caste system, Social Stratification and Social Change especially in rural India • To understand the meaning, nature and different factors responsible for Social Disorganization and also to have an outlook of different Social Problems
RDM 105	Rural Development Administration and Panchayati Raj	• To have an outlook on rural administration in India. • To get an in-depth knowledge on history of PRIs and local self-government and its role and functions in the field of Rural Development. • To get an understanding of administration in tribal areas and its safe guard in the constitution of India.
RDM 106	Rural Planning and Management: Principles and Practices	• To understand the concept, role and importance of planning for development and understanding the scope of rural development planning in the era of globalization.

		• To understand the concept and importance of participation in planning process. • To understand the concept, meaning, issues of rural development and management.
RDM 107	Fieldwork I	To provide • contextual exposure and opportunity to compare the theoretical knowledge with actual situation • an opportunity to learn the lifestyle of an underprivileged community through engagement
RDM 108	Integrated Personality Development	• To get a knowledge of life & teachings of great moral human personalities • To understand and make a practice of personality development technique in day to day life • To get an idea regarding the spiritual heritage of India. • To develop leadership quality.
SEMESTER 2		
RDM 201	Basic Agriculture for Farmer's Welfare	• To have an understanding the agrarian society and the livelihood of the dependents. • To have an idea regarding the major field crops grown in India and their sustainable cultivation practices.
RDM 202	Social Policy and Social Legislation	• To get an understanding of concept, definitions, need, importance of social policies and its evolution. • To get an in-depth knowledge of social policies in India. • To understand the concept and definitions of social legislation,

		its relation with social justice, its role as an instrument of Social Change.
RDM 203	Rural Demography	• To have an understanding of concepts, aspects of demography, objectives, scope of social demography. • To gain knowledge of need of population study and different approaches of population control. • To understand the rural population composition
RDM 204	Social Innovations and Entrepreneurship	• To have an understanding of concept, theories and practice of social innovation. • To have an understanding of concept, definitions, role of social enterprizes in rural development. • To have an outlook of different rural enterprizes.
RDM 205	Rural Health and Well Being	• To understand the definition and concept and evolution of public health, public health acts, health problems in developed and developing countries, health problems in India with especial reference to Jharkhand. • To understand Concept, types and uses of epidemiology and understanding the epidemiology of diseases common in rural areas. • To have a knowledge of nutrition and its importance in promotion of good health in rural areas. • To understand the different environmental health problems in India

RDM 206	Rural Labour Welfare and Human Resource Management	• To have an understanding of meaning, definition, scope, theories, principles and approaches of labour welfare. • To get an in-depth knowledge on concept, origin and the need for Human Resource Development and Human Resource Management and also have an understanding of different approaches to Human Resource Development and Human Resource Management. • To get a knowledge of Organizational behaviour and its importance and its historical back ground.
SEMESTER 3		
RDM 301	ICT and Development Communication	To get acquainted with: • the basics of ICT and its role in rural development. • the knowledge of different ICT enabled rural services. • the idea of geographical information system. • the aspects of agricultural information system.
RDM 302	Rural Ecology, Sustainable Livelihood and Natural Resource Management	To understand the • meaning, nature and scope of different types of natural resources. • techniques for sustainable utilization of different resources. • policies related to conservation and its related impacts.

		• process of nurturing human resources and different aspects of disaster mitigation.
RDM 303	Rural Tourism	To understand the • concept, meaning and scope of rural tourism. • process of sustainable tourism planning • new development in the domain of tourism industry. • role of tourism in changing rural areas through successful rural tourism model.
RDM 304	Research Methodology	To familiarize with: • the different techniques of data collection. • the different technique of classification and tabulation of data. • the different aspects of social research and sampling. • the different statistical method for the analysis of research data.
RDM 305	Rural Women and Children	To remember and analyse: • the concept and approaches of gender and related issues • the situational overview of the rural and tribal women of India. • the programmes and other activities related to women development.

		• the concept of child labour and the rights related to women and child.
RDM 306	Computer Application and Management Information System	To develop: • Skills of using computer and its application in managing information • the skill of e-documentation using standard software
RDM 307	Fieldwork II	To provide • contextual exposure and opportunity to compare the theoretical knowledge with actual situation • participatory learning techniques
SEMESTER 4		
RDM 401		• To understand the rural finance and rural credit system in India and also to understand the evolution and growth of rural credit system in the country. • To have an in-depth knowledge of micro-credit and micro-finance. • To have a knowledge of rural financing through commercial banks
RDM 402	Accounting and Financial Management	• To get a knowledge of basics of accounting and financial management. • To get a skill to prepare balance sheet. Preparation of a trading account, P& L account. Financial analysis and planning of a business. Journalisation of data & ledger maintenance, trial

		balance, profit and loss statement etc.
RDM 403	Watershed Development and Management	• To have a knowledge of watershed management, • To develop a skill for preparation of action plan for watershed development through the application of GIS and other related tools and techniques. • To develop a skill to prepare DPR for watershed development
RDM 405		• To develop a skill of critical thinking and scientific report writing.

RKMVERI

Programme Outcome, Programme Specific Outcome and Course Outcome of Academic Programmes Offered by the Department of Sanskrit and Philosophy.

Programme Outcome, Programme Specific Outcome and Course Outcome of *MA (Integrated) in Sanskrit*.

Programme Name: MA (Integrated) in Sanskrit.

Programme Outcome:

1. Realization of Swami Vivekananda's “life-building, man-making, character-making” education.
2. Producing scholars well versed in traditional śastric knowledge blended with modern outlook with a proper comprehension of modern developments.
3. Producing an educated class of citizens who would be inculcated with the right blend of the rich cultural and spiritual heritage of ancient India and the enlightenment values such as scientific temper, technological skill, pragmatic outlook and team-work.

Programme Specific Outcome:

1. Revivalism of Sanskrit language by producing a group of scholars who are well equipped in the four basic language skills i.e. reading, writing, speaking and listening.
2. Revivalism of Sanskrit knowldege traditions like Vyakarana, Vedanta etc.
3. Creating a Sanskrit scholastic community well versed in both traditional as well as modern outlook and temperament.

Course Outcome:

1	SK-101	कठोपनिषत् शांकरभाष्यसमेता	Student will be able to – 1) understand the ideas expressed through the Upanishadic language of Katha branch of Krishna Yajurveda. 2) to analyze the structure of scriptural interpretation followed in the Uttara-Mimamsa system of Shankaracharya. 3) get a thorough acquaintance with the ancient Indian spiritual wisdom.
2	SK-102	ईशमुण्डकोपनिषदौ शाङ्करभाष्यसहिते	Student will be equipped with – 1) the knowledge of the Vedantic concepts expressed in the Ishavasya and Mundaka, two Upanishads of great importance belonging to the Shukla Yajurveda and Atharvaveda respectively. 2) the ability to analyze the structure of scriptural interpretation followed in the Uttara-Mimamsa system of Shankaracharya. 3) the acquaintance with the ancient Indian spiritual wisdom.
3	SK-103	छान्दोग्योपनिषदि 6-8 आध्यायाः	The learner will be endowed with – 1) a close acquaintance with the hermeneutical methodology employed by Shankara Bhagavatpada in interpreting the most celebrated and exegetically challenging portions of Chandogyopanishad, the most famous Upanishad of Samaveda. 2) an ability to discern and employ this methodology by oneself, for which a model was already presented to the student in SK-161. 3) the capacity to discern the methodology of teaching Advaita, followed in different scriptures of the Vedantic tradition.
4	SK-104	बृहदारण्यकोपनिषदि तृतीयचतुर्थाध्यायौ सशांकरभाष्यौ	Student will be able to – 1) develop an in-depth comprehension of the main portions of the logest and most celebrated Upanishadic commentary of Shankara Bhagavatpada. 2) grasp the source of many of the doctrines of Advaita Vedanta. 3) discern different shades of the methodology of Advaita Vedanta, as they occur in the Brihadaranyaka Upanishad.

5	SK-105	तैत्तिरीयोपनिषत् शाङ्करभाष्योपेता	Student will be able to gain – 1) a good grasp of the intricacies of the Advaitic methodology found in the Taittiriyopanishad. 2) an in-depth idea of the hermeneutical method that Shankara Bhagavatpada employed while producing his first Upanishadic commentary in the form of Taittiriyabhashyam. 3) a first-hand knowledge of the original text of this Upanishad and how they are connected to different contexts of Vedic ritualism and worship.
6	SK-106	माण्डूक्योपनिषद् माण्डूक्यकारिका च शाङ्करभाष्यसहिता	Student gets to – 1) understand the greatest exponent of Advaita Vedanta in the pre-Shankara era, Shri Gaudapadacharya. 2) develop the skill to analyse the states of consciousness, which forms a most efficient methodology of the Advaita philosophy. 3) know in detail the purport of Omkara-related statements found in other Upanishads.
7	SK-107	केनोपनिषद् ऐतरेयोपनिषच्च शांकरभाष्योपेते	Student will – 1) comprehend the methodology employed to teach the Advaitic truth in Kena and Aitareya – two concise Upanishads – one of Samaveda and the other of Rgveda. 2) be able to analyse the structure of scriptural interpretation followed in the Uttara-mimamsa system of Shankaracharya.
8	SK-108	प्रश्नोपनिषद् शांकरभाष्योपेता	Student develops – 1) an understanding of the methodology employed to teach Advaita in Prasnopanishad belonging to the recension of Atharvaveda. 2) a thorough perception of the nature of moral code that forms an integral part of the spiritual practices prescribed in this Upanishad, for an Advaitin.
9	SK-125	भगवद्गीतायाः 2,3,4 अध्यायाः सशांकरभाष्याः	Learner develops – 1) an acumen to discern the theme and the import of the often confusing terminology of Bhagavad Gita. 2) mastery over the opening chapters of the most popular scripture of the Vedantins. 3) understanding of the Vedantic way of dealing with the moral dilemmas.

10	SK-126	भगवद्गीतायाः 13, 15, 18 अध्यायाः सशांकरभाष्याः	Student learns – 1) further application of the axioms and terminology of the Smriti Prasthana already learned. 2) to solve the intricacies presented by the text and it's commentary. 3) to interpret in Advaitic terms what is considered as philosophically most important chapters of the Bhagavad Gita.
11	SK-131	ब्रह्मसूत्रे प्रथमाध्याये प्रथमद्वितीयपादौ शाङ्करभाष्योपेतौ	Learner will be endowed with a thorough understanding of – 1) the basic features of the Nyaya-prasthana of Vedanta. 2) concept of Adhyasa, axiom of Samanvaya and how this basic axiom of Vedanta-Mimamsa is implemented in the first two sections of the first chapter of the Brahmasutrabhashyam. 3) the exegetical methodology followed by Shankara Bhagavatpada in his masterpiece.
12	SK-132	ब्रह्मसूत्रे प्रथमाध्याये तृतीयचतुर्थपादौ शाङ्करभाष्योपेतौ	Learner will develop mastery over– 1) the contents of the second half of the first chapter of Brahmasutrabhashyam. 2) resolving the apparent disharmony of the Sruti passages by following up the discussions in those sections.
13	SK-133	ब्रह्मसूत्रे द्वितीयाध्याये प्रथमद्वितीयतृतीयपादाः शाङ्करभाष्योपेताः	Learner will be skilled in – 1) interpreting the subject-matter of the first half of the second chapter of Brahmasutrabhashyam. 2) presenting the Vedantic doctrines in a fashion that they do not contradict with Smriti, Yukti and Sruti.
14	SK-134	ब्रह्मसूत्रे द्वितीयाध्याये चतुर्थपादः तृतीयाध्यायस्य प्रथमपादश्च शाङ्करभाष्योपेतः	Learner enhances – 1) his/her capacity to present the Vedantic doctrines in a fashion that they are not in contradiction with the Sruti, further. 2) his/her knowledge regarding the transmigration of the soul according to Advaita Vedanta. 3) his/her understanding regarding the sadhana part of Vedanta such as developing detachment towards all erratic perceptions of the Upanishadic Truth.

15	SK-135	ब्रह्मसूत्रे तृतीयाध्याये द्वितीयतृतीयपादौ शाङ्करभाष्योपेतौ	Learner will be in possession of in-depth knowledge regarding – 1) different states of consciousness that the transmigratory soul undergoes. 2) the purpose and method of analyzing those states. 3) the nature and results of different upasanas in the Upanishads.
16	SK-136	ब्रह्मसूत्रे तृतीयाध्याये चतुर्थपादः चतुर्थाध्यायश्च शाङ्करभाष्योपेतः	Learner understands sine dubio – 1) the nature and result of Brahmavidya. 2) the role of accelerating components for its emergence. 3) the basic concepts of soteriology of Shankara Vedanta.
17	SK-141	चतुःसूत्री भामतीसहिता	Student will be able to grasp – 1) the salient features of one of the most celebrated schools of Advaita Vedanta – Bhamati. 2) the exegetical approach taken by the Bhamati school. 3) critical analysis of the terminology employed by the Bhamati school.
18	SK-151	पञ्चदश्याम् 1-5 अध्यायाः	Student gains a good ground in – 1) a sub-school of Advaita Vedanta which is spearheaded by Bharatitirtha-Vidyaranya. 2) a a work considered as a lucid introduction to the Vivarana school of Shankara Bhagavatpada's philosophy. 3) the style of expounding the Advaita concepts using commonsense and analogy.
19	SK-161	वेदान्तसारः	Student gets introduced into – 1) the basics of Advaita Vedanta. 2) a popular form of Vedantic methodology which in turn will enable the learner to have further pursuits into the higher realms of Indian Philosophy.
20	SK-163	वेदान्तपरिभाषा उपमानान्ता	Student gains mastery over – 1) the Vedantic way of analyzing the first three among the six means of knowledge i.e. perception, inference and comparison. 2) the epistemological theories developed by the post-Shankara Advaita Vedantins. 3) a comparative scrutiny of the Vedantic and Nyaya theories of epistemology with special reference to perception etc.

21	SK-164	वेदान्तपरिभाषा अनुपलब्धितः आन्तम्	Student acquires mastery over – 1) the Vedantic way of analysing the last three among the six means of knowledge i.e. presumption, verbal testimony and non-apprehension. 2) the epistemological theories of the pos-Shankara Advaita Vedanta. 3) a comparative scrutiny of the Vedantic and Nyaya theories of epistemology with special reference to presumption etc.
22	SK-165	वेदान्तशास्त्रेतिहासः	Student acquires – 1) knowledge about all the major philosophical developments in the pre-Shankara and post-Shankara era of Vedanta. 2) critical understanding of the life and works of important literary figures in the field. 3) a historical and chronological sense while dealing with concepts, works and personalities in the Vedanta philosophy.
23	SK-167	सिद्धान्तलेशसङ्ग्रहे प्रथमपरिच्छेदः	Student gains – 1) an in-depth understanding of different views held by the famous Vedantins on a number of topics related to samanvaya, within the purview of Shankara Advaita. 2) an acumen to compare the subtle doctrinal differences held by the teachers of Advaita Vedanta. 3) awareness regarding how the Vedantic concepts underwent subtle, and often cryptic, changes, over time.
24	SK-171	अद्वैतसिद्धिः आदितो दृश्यत्वहेतुविचारान्ता	Student will be able to – 1) understand the opening discussions in the Advaitasiddhi. 2) gain insights into the most celebrated dialectical school of Advaita Vedanta after the advent of Navya-nyaya.

25	SK-173	अद्वैतसिद्धौ निर्दिष्टांशाः - जडत्वहेतुविचारः। परिच्छिन्नत्वहेतुविचारः। सन् घट इति प्रत्यक्षे अधिष्ठानानुवेधः। प्रत्यक्षस्य न्यायैः प्राबल्यविचारः। प्रत्यक्षस्योपजीव्यत्वेन प्राबल्यविचारः। प्रत्यक्षस्य लिङ्गबाध्यत्वविचारः। प्रत्यक्षस्य शब्दबाध्यत्वविचारः। अपच्छेदन्यायवैषम्य-विचारः। प्रतिकर्मव्यवस्थाविचारः। ज्ञाननिवर्त्यत्वान्यथोपपत्तिविचारः । अविद्यालक्षणविचारः।	Student develops insights into – 1) the line of arguments in the selected portions of the Advaitasiddhi 2) Intricacies of the Navya-nyaya methodology employed by Madhusudana Saraswati while defending the tenets of Advaita Vedanta against the Dvaitins.
26	SK-176	तत्त्वप्रदीपिकायां मिथ्यात्वानुमाने हेतुदोषनिरासपर्यन्तम्	Student develops – 1) conversance in defining and scrutinizing the exactitude of the Advaita terminoloy with special reference to the Pratyaktattvapradipika of Shri Chitsukhacharya 2) a close acquaintance with the old school Advaitic dialectics.

27	SK-182	पञ्चपादिका (प्रथमद्वितीयवर्णकम्)	Student develops conversance with – 1) the basic work of the earliest exegetical sub-school within Advaita Vedanta 2) the philosophical and historic context behind the emergence of sub-schools of Advaita Vedanta 3) one of the most celebrated methodology to interpret the commentaries of Shankara Bhagavatpada.
28	SK-201	सिद्धान्तकौमुदी पञ्चसन्ध्यन्ता (सूसं.178)	Students get – 1) acquaintanceship with the structure of Sanskrit Sandhis. 2) training in the theories of Sandhi. 3) the ability to understand the joining and splitting of Sanskrit words. 4) the ability to apply grammatical rules in examples.
29	SK-205	सिद्धान्तकौमुद्यामजन्तपुंलिङ्गप्रकरणाद् अव्ययप्रकरणं यावत् (सूसं.276)	Students get – 1) acquaintanceship with the basic structure of Word formation in Sanskrit. 2) an insight to the derivative style adopted in the formation of words. 3) the ability to apply grammatical rules in examples. 4) the ability to derive nominal word forms with the application of grammatical rules.
30	SK-209	सिद्धान्तकौमुद्यां कारकप्रकरणम् (सूसं.115)	Students get – 1) acquaintanceship with the basic structure of Sanskrit Sentences. 2) training in the theories of karaka. 3) the ability to understand the syntax and semantics of Sanskrit. 4) the ability to apply grammatical rules in examples.
31	SK-213	सिद्धान्तकौमुद्यां समासप्रकरणम् (सूसं.284)	Students get – 1) acquaintanceship with the basic structure of Sanskrit Compounds. 2) training in the theories of Compound formation. 3) the ability to understand the syntax and semantics of Sanskrit compounds. 4) the ability to apply grammatical rules in examples.

32	SK-215	सिद्धान्तकौमुद्याम् एकशेषात् समासाश्रयं यावत् स्त्रीप्रत्ययश्च (सूसं.220)	Students get – 1) acquaintanceship with the basic structure of Sanskrit Compounds. 2) training in the theories of Compound formation. 3) the ability to understand the syntax and semantics of Sanskrit compounds. 4) the ability to apply grammatical rules in examples.
33	SK-216	सिद्धान्तकौमुद्यां तद्धितप्रकरणे अपत्याधिकारात् प्राग्वहतीयं यावत् (1072-1625) सूसं. 554	Students get – 1) acquaintanceship with the basic structure of Word formation in Sanskrit. 2) an insight to the derivative style adopted in the formation of nominal words from nouns. 3) the ability to apply grammatical rules in examples. 4) the ability to derive nominal word forms from nouns with the application of grammatical rules.
34	SK-218	सिद्धान्तकौमुद्यां तद्धितप्रकरणे प्राग्घितीयात् द्विरुक्तं यावत् (1626-2150) सूसं.525	Students get – 1) acquaintanceship with the basic structure of Word formation in Sanskrit. 2) an insight to the derivative style adopted in the formation of nominal words from nouns. 3) the ability to apply grammatical rules in examples. 4) the ability to derive nominal word forms from nouns with the application of grammatical rules.
35	SK-221	सिद्धान्तकौमुद्यां तिङन्ते भ्वादिप्रकरणम् (सूसं.273)	Students get – 1) acquaintanceship with the basic structure of Word formation in Sanskrit. 2) an insight to the derivative style adopted in the formation of words. 3) the ability to apply grammatical rules in examples. 4) the ability to derive verbal word forms with the application of grammatical rules.

36	SK-223	सिद्धान्तकौमुद्याम् अदादितः णिजन्तपर्यन्तम् (सूसं.180)	Students get – 1) acquaintanceship with the basic structure of word formation in Sanskrit. 2) an insight to the derivative style adopted in the formation of words. 3) the ability to apply grammatical rules in examples. 4) the ability to derive verbal word forms with the application of grammatical rules.
37	SK-225	सिद्धान्तकौमुद्यां सन्नन्तात् लकारार्थं यावत् (सूसं.222)	Students get – 1) acquaintanceship with the basic structure of word formation in Sanskrit. 2) an insight to the derivative style adopted in the formation of verbal words from verbs and nouns. 3) the ability to apply grammatical rules in examples. 4) the ability to derive nominal word forms from verbs with the application of grammatical rules.
38	SK-227	सिद्धान्तकौमुद्यां कृत्यप्रकरणात् पूर्वकृदन्तप्रकरणं यावत् (सूसं.219)	Students get – 1) acquaintanceship with the basic structure of Word formation in Sanskrit. 2) an insight to the derivative style adopted in the formation of nominal words from verbs. 3) the ability to apply grammatical rules in examples. 4) the ability to derive nominal word forms from verbs with the application of grammatical rules.

39	SK-228	सिद्धान्तकौमुद्याम् उत्तरकृदन्तप्रकरणम् (सूसं.339)	Students get – 1) acquaintanceship with the basic structure of Word formation in Sanskrit. 2) an insight to the derivative style adopted in the formation of nominal words from verbs. 3) the ability to apply grammatical rules in examples. 4) the ability to derive nominal word forms from verbs with the application of grammatical rules.
40	SK-236	लघुसिद्धान्तकौमुदी अजन्तपुंलिङ्गान्ता (सूत्रसंख्या - 216)	Students get – 1) acquaintanceship with the basic structure of Paninian Grammar. 2) an insight to the simple derivative style adopted in the Laghusiddhantakaumudi. 3) the ability to apply grammatical rules in examples. 4) the ability to derive nominal word forms with the application of grammatical rules.
41	SK-237	लघुसिद्धान्तकौमुद्याम् अजन्तस्त्रीलिङ्गादारभ्य अव्ययप्रकरणं यावत् स्त्रीप्रत्ययश्च (सूस.186)	Students get – 1) acquaintanceship with the basic structure of Paninian Grammar. 2) an insight to the simple derivative style adopted in the Laghusiddhantakaumudi. 3) the ability to apply grammatical rules in examples. 4) the ability to derive nominal word forms with the application of grammatical rules.
42	SK-238	लघुसिद्धान्तकौमुद्यां तिङन्तप्रकरणम् (सूसं.325)	Students get – 1) acquaintanceship with the basic structure of Paninian Grammar. 2) an insight to the simple derivative style adopted in the Laghusiddhantakaumudi. 3) the ability to apply grammatical rules in examples. 4) the ability to derive verbal word forms with the application of grammatical rules.
43	SK-239	लघुसिद्धान्तकौमुद्याम् कृत्तद्धितौ	Students get – 1) acquaintanceship with the basic structure of Paninian Grammar. 2) an insight to the simple derivative style adopted in the Laghusiddhantakaumudi. 3) the ability to apply grammatical rules in examples. 4) the ability to derive word forms with the application of grammatical rules.

44	SK-241	महाभाष्ये 2,3,4 आह्निकानि	Students get – 1) acquainted with the higher level of grammatical knowledge. 2) an insight to complexities of understanding meaning of sūtras 3) the ability to understand the methods of establishing theories in a-systematic way. 4) the ability to apply the methods to establish theories.
45	SK-242	महाभाष्ये 5,6,7 आह्निकानि	Students get – 1) acquainted with the higher level of grammatical knowledge. 2) an insight to complexities of understanding meaning of sūtras. 3) the ability to understand the methods of establishing theories in a-systematic way. 4) the ability to apply the methods to establish theories.
46	SK-243	महाभाष्ये 8, 9 आह्निकानि	Students get – 1) acquainted with the higher level of grammatical knowledge. 2) an insight to complexities of understanding meaning of sūtras. 3) the ability to understand the methods of establishing theories in a-systematic way. 4) the ability to apply the methods to establish theories.
47	SK-251	परमलघुमञ्जूषा वाक्यवादः च	Students get – 1) acquaintanceship with the Advanced theories of śābdabodha. 2) training in the advanced theories of karaka. 3) the ability to understand the complexities of syntax and semantics of Sanskrit. 4) the ability to analyze sentences based on theories in examples.
48	SK-255	परिभाषेन्दुशेखरे 1-50 परिभाषाः	Students get – 1) acquaintanceship with the advanced knowledge about the meta-rules of Sanskrit grammar. 2) training in the application of meta-rules. 3) the ability to understand the complex nature of meta-rules. 4) the ability to apply meta-rules in examples.

49	SK-257	परिभाषेन्दुशेखरे 51-133 परिभाषाः	Students get – 1) acquaintanceship with the advanced knowledge about the meta-rules of Sanskrit grammar. 2) training in the Application of meta-rules. 3) the ability to understand the complex nature of meta-rules. 4) the ability to apply meta-rules in examples.
50	SK-265	लघुशब्देन्दुशेखरे आदितः न पदान्तद्विरिति सूत्रं यावत्	Students get – 1) acquaintanceship with the advanced knowledge about the structure of Sanskrit Sandhis. 2) training in the Advanced theories of Sandhi. 3) the ability to understand the complex nature of joining and splitting of Sanskrit words. 4) the ability to apply grammatical rules in examples.
51	SK-266	लघुशब्देन्दुशेखरे अजन्तप्रकरणम्	Students get – 1) acquaintanceship with the advanced knowledge about the structure of word formation in Sanskrit. 2) training in the advanced theories of meaning and examples of sūtras. 3) the ability to understand the complex nature of Word formation of Sanskrit words. 4) the ability to apply grammatical rules in examples.
52	SK-267	लघुशब्देन्दुशेखरे कारकम्	Students get – 1) acquaintanceship with the Advanced structure of Sanskrit sentences. 2) training in the advanced theories of karaka. 3) the ability to understand the complexities of syntax and semantics of Sanskrit. 4) the ability to apply grammatical rules in examples.

53	SK-268	लघुशब्देन्दुशेखरे स्त्रीप्रत्ययाव्ययीभावप्रकरणे	Students get – 1) acquaintanceship with the advanced knowledge about the structure of compound formation in Sanskrit. 2) training in the advanced theories of meaning and examples of sūtras. 3) the ability to understand the complex nature of compound formation of Sanskrit. Students are able to apply grammatical rules in examples.
54	SK-271	वैयाकरणभूषणसारे (1-4) आदितो नामार्थप्रकरणं यावत्	Students get – 1) acquaintanceship with the advanced theories of śābdabodha. 2) training in the advanced theories of karaka. 3) the ability to understand the complexities of syntax and semantics of Sanskrit. 4) the ability to analyze sentences based on theories and examples.
55	SK-273	वैयाकरणभूषणसारे (5-14) समासशक्तिनिर्णयतः अन्तं यावत्	Students get – 1) acquaintanceship with the Advanced theories of śābdabodha. 2) training in the advanced theories of compound words. 3) the ability to understand the complexities of syntax and semantics of Sanskrit. 4) the ability to analyze sentences based on theories in examples.
56	SK-281	वाक्यपदीये ब्रह्मकाण्डम्	Students get – 1) acquainted with the philosophical aspects of grammar. 2) an insight to complexities of philosophy of grammar and language in general. 3) the ability to understand the methods of establishing philosophical theories in a systematic way. 4) the ability to apply the methods to establish theories.

57	SK-301	ऋग्वेदीयम् अग्निसूक्तम् (1.1.1), इन्द्रसूक्तम् (1.32), पुरुषसूक्तं(10.7.90), देवीसूक्तम् (10.10.125), नासदीयसूक्तं(10.11.129) च सायणभाष्योपेतम्, (35 SCH), निरुक्ते प्रथमद्वितीयाध्यायौ (20 SCH)	Learner will be endowed with – 1) mastery over some of the exemplary portions of the Vedic literature. 2) a thorough acquaintance of the methodology employed by Sayanacharya in interpreting the Vedas. 3) the comprehension of the selected portions of Yaska's Nirukta. 4) the understanding of the basics of Vedic etymology.
58	SK-311	अर्थसङ्ग्रहः	Learner gets to – 1) comprehend the basic terminology and concepts of Purva Mimamsa system of Vedic exegesis. 2) know the basics of lexical and logical semantics employed in the Purva Mimamsa. 3) gain a good foundation to explore the Purva and Uttara Mimamsa systems further.
59	SK-315	भाषातत्त्वम् (भाषोत्पत्तिसिद्धान्ताः, भाषाणां वर्गीकरणं, ध्वनिनियमाः, अर्थपरिवर्तननियमाः) + SWAYAM	Learner will be able to grasp – 1) the basics of Linguistics. 2) the possibilities of extending and applying the Sanskrit grammatical rules to other arenas. 3) how to utilize online resources to develop knowledge in a field of one's own choice.

60	SK-331	सांख्यकारिका (1-30 कारिकाः) (30), योगसूत्रे समाधिपादः व्यासभाष्यसहितः (20)	Learner gains – 1) a good comprehension of the Sankhya system of philosophy, in the form it is available today. 2) basic analytical skills to look beyond the text and infer the precedents of a particular philosophical concept. 3) comprehension of the selected portion of Yoga Sutras of Patanjali. 4) understanding of the inter-relation existing between the Sankhya and Yoga systems of philosophy. 5) conception regarding the inter-relation existing between Sankhya-Yoga on the one hand and other philosophical schools like Vedanta on the other hand.
61	SK-341	तर्कसंग्रहो न्यायबोधिनीसहितः	Learner gains a good ground in – 1) the basic concepts and terminology of Indian logic with special reference to Tarkasangraha. 2) Nyayabodhini's line of interpreting the Tarkasangraha. 3) a particular sub-school of Indian logic where Nyaya and Vaisheshika systems are synthesized. 4) defining and scrutinizing the exactitude of philosophical terms. 5) the kind of philosophical language used in Sanskrit texts composed in the period of post-Buddhist revivalism and medieval era.
62	SK-342	तर्कसंग्रहो दीपिकासहितः	Learner further gains a good ground in – 1) the basic concepts and terminology of Indian logic with special reference to Tarkasangraha. 2) Dipika's line of interpreting the Tarkasangraha. 2) a particular sub-school of Indian logic where Nyaya and Vaisheshika systems are synthesized. 3) defining and scrutinizing the exactitude of philosophical terms. 4) the kind of philosophical language used in Sanskrit texts composed in the period of post-Buddhist revivalism and midieval era.

63	SK-344	न्यायसिद्धान्तमुक्तावल्याम् प्रत्यक्षखण्डः पस्पशाह्निकम् च	Learner gains mastery over – 1) the selected portions of the Nyaya-siddhanta-muktavali. 2) a particular sub-school of Indian logic where Nyaya and Vaisheshika systems are synthesized. 3) defining and scrutinizing the exactitude of philosophical terms. 4) the kind of philosophical language used in Sanskrit texts composed in the period of post-Buddhist revivalism and medieval era. 5) the Paspasahnika portion of the Mahabhashyam of Patanjali. 6) the basic methodology employed by Patanjali to interpret Panini's Ashtadhyayi. 7) the basics of Paninian linguistics.
64	SK-345	न्यायसिद्धान्तमुक्तावल्याम् अनुमानखण्डः शब्दखण्डश्च	Learner develops command over – 1) the selected portions of the Nyaya-siddhanta-muktavali. 2) a particular sub-school of Indian logic where Nyaya and Vaisheshika systems are synthesized. 3) defining and scrutinizing the exactitude of philosophical terms. 4) the kind of philosophical language used in Sanskrit texts composed in the period of post-Buddhist revivalism and medieval era.
65	SK-370	व्युत्पत्तिवादे प्रथमाकारके अभेदान्वयवादपर्यन्तम्	Students get – 1) acquaintanceship with the Advanced theories of śābdabodha of naiyyāyikas. 2) training in the advanced theories of naiyyāyikas about karaka. 3) the ability to understand the complexities of syntax and semantics of Sanskrit. 4) the ability to analyze sentences based on theories in examples.
66	SK-371	व्युत्पत्तिवादे प्रथमाकारकस्य राजपुरुषवादादिभागः	Students get – 1) acquaintanceship with the Advanced theories of śābdabodha of naiyyāyikas. 2) training in the advanced theories of naiyyāyikas about karaka. 3) the ability to understand the complexities of syntax and semantics of Sanskrit. 4) the ability to analyze sentences based on theories in examples.

67	SK-401	अलंकारशास्त्रोपकण्ठम् (35) विवेकानन्दप्रणीतसंस्कृतस्तोत्राणि च (15)	Learner gets to know – 1) the fundamental ideas of Sanskrit Aesthetics and Literary Criticism. 2) different schools of aesthetics and literary criticism, developed based on the Natyashastra of Bharatamuni. 3) some of the Sanskrit works of Swami Vivekananda. 4) a model of late 19th century Sanskrit literature.
68	SK-411	रघुवंशे प्रथमसर्गः	Learner will be given to – 1) understand the selected portion of the masterpiece of Kalidasa. 2) have an acquaintance with the Classical Sanskrit poetry. 3) comprehend the universal ethical values embodied in the Sanskrit literature.
69	SK-412	वेतालपञ्चविंशत्यादिभ्यः चिताः अंशाः	Learner gains a good ground in – 1) the language and moral ideas of the selected works. 2) have an thorough acquaintance with the Classical Sanskrit prose. 3) applying the rules of Sanskrit grammar already learnt, in extracting the meaning of Classical works.
70	SK-413	अभिज्ञानशाकुन्तले आदितः चत्वारः अङ्काः	Learner will be able to – 1) comprehend the selected portions of the Abhijnana-shakuntala. 2) gain a good acquaintance with the Classical Sanskrit drama. 3) comprehend the universal ethical values embodied in the Sanskrit literature.
71	SK-431	संस्कृतसाहित्येतिहासः + SWAYAM (2+2 Cr)	Learner will be able to know – 1) different branches of Sanskrit literature. 2) the authors and their works in those branches. 3) the chronological order of different authors and their works. 4) how to utilize online resources to develop knowledge in a field of one's own choice.

72	SK-441	साहित्यदर्पण आदितः तृतीये रसप्रकरणान्तम् (35), वृत्तरत्नाकरे चितानि 20 छन्दांसि (15)	Learner gets to know – 1) the theories of Sanskrit Aesthetics and Literary Criticism as embodied in the selected portions of Sahityadarpana. 2) the basic doctrines of different schools of aesthetics and literary criticism in Sanskrit. 3) the basics of Sanskrit prosody along with some of the most employed metres in Sanskrit, along with examples.
73	SK-444	साहित्यदर्पणे 4,5,8,9 परिच्छेदाः, कुवलयानन्दे चिता अलंकाराः च	Learner gets to know – 1) the theories of Sanskrit Aesthetics and Literary Criticism as embodied in the selected portions of Sahityadarpana. 2) the basic doctrines of different schools of aesthetics and literary criticism in Sanskrit. 3) the basics of Sanskrit prosody. 4) some of the most employed metres in Sanskrit, along with examples.
74	SK-451	ध्वन्यालोके प्रथमोद्योतः सलोचनः	Learner will be equipped with – 1) a detailed comprehension of the selected portion of the work. 2) the understanding of the subtleties of the Dhvani School of Sanskrit aesthetics and literary criticism. 3) a close acquaintance with contributions of Anandavardhana and Abhinavagupta to the field.
75	SK-501	वेदपाठः	Student gets to – 1) learn by heart the selected portions of the four Vedas, through the traditional method. 2) learn thereby the proper way of chanting the Vedas. 3) inculcate in oneself thereby the cultural, ethical, spiritual and philosophical value of those scriptures. 4) learn to employ them during special occasions of cultural activities.

76	SK-502	वेदपाठः	Student gets to – 1) learn by heart the selected portions of the four Vedas, through the traditional method. 2) learn thereby the proper way of chanting the Vedas. 3) inculcate in oneself thereby the cultural, ethical, spiritual and philosophical value of those scriptures. 4) learn to employ them during special occasions of cultural activities.
77	SK-503	वेदपाठः	Student gets to – 1) learn by heart the selected portions of the four Vedas, through the traditional method. 2) learn thereby the proper way of chanting the Vedas. 3) inculcate in oneself thereby the cultural, ethical, spiritual and philosophical value of those scriptures. 4) learn to employ them during special occasions of cultural activities.
78	SK-511	गीतोपनिषत्पाठः (गीता 1-2, ईश-केनोपनिषदौ) (118+18+35=171)	Learner gets to – 1) learn by heart the proper way to chant the popular scriptures in Sanskrit, part by part. 2) inculcate in oneself thereby the cultural, ethical, spiritual and philosophical value of those scriptures. 2) learn the simple meaning of the portions memorized. 3) learn to employ them during special occasions of cultural activities.
79	SK-512	गीतोपनिषत्पाठः (गीता 3-4, कठोपनिषद्) (85+119=204)	Student gets to – 1) learn by heart the proper way to chant the popular scriptures in Sanskrit, part by part. 2) inculcate in oneself thereby the cultural, ethical, spiritual and philosophical value of those scriptures. 2) learn the simple meaning of the portions memorized. 3) learn to employ them during special occasions of cultural activities.

80	SK-513	गीतोपनिषत्पाठः (गीता 5-8, मुण्डकोपनिषद्) (134+64=198)	Student gets to – 1) learn by heart the proper way to chant the popular scriptures in Sanskrit, part by part. 2) inculcate in oneself thereby the cultural, ethical, spiritual and philosophical value of those scriptures. 2) learn the simple meaning of the portions memorized. 3) learn to employ them during special occasions of cultural activities.
81	SK-514	गीतोपनिषत्पाठः (गीता 9-13, माण्डूक्योपनिषद्) (186+12=198)	Student gets to – 1) learn by heart the proper way to chant the popular scriptures in Sanskrit, part by part. 2) inculcate in oneself thereby the cultural, ethical, spiritual and philosophical value of those scriptures. 2) learn the simple meaning of the portions memorized. 3) learn to employ them during special occasions of cultural activities.
82	SK-515	गीतोपनिषत्पाठः (गीता 14-18, प्रश्नोपनिषद् 1+2) (177+16+13=206)	Student gets to – 1) learn by heart the proper way to chant the popular scriptures in Sanskrit, part by part. 2) inculcate in oneself thereby the cultural, ethical, spiritual and philosophical value of those scriptures. 2) learn the simple meaning of the portions memorized. 3) learn to employ them during special occasions of cultural activities.
83	SK-521	संस्कृतभाषाप्रवेशः (प्रौढरचनानुवादकौमुदी, पाणिनीयम्, संस्कृतसंभाषणसोपनम्)	Student gets a thorough training in – 1) the declined forms of different parts of speech. 2) composing grammatically and conventionally correct Sanskrit sentences. 3) translating sentences from Bengali and English into Sanskrit, and vice versa. 4) different fields of Sanskrit grammar through basically a descriptive method, unlike the Paninian system.

84	SH-601	Spiritual Heritage of India	Student acquires – 1) acquaintance with the the ancient spiritual wisdom of India embodied in the Sanskrit literature and expressed variously in contemporary India's cultural and national life. 2) such ideas that lead to national integration and enlightenment. 2) universal ethical values that help in character building of an individual.
85	SH-602	Spiritual Heritage of India	Student acquires – 1) acquaintance with the the ancient spiritual wisdom of India embodied in the Sanskrit literature and expressed variously in contemporary India's cultural and national life. 2) such ideas that lead to national integration and enlightenment. 2) universal ethical values that help in character building of an individual.
86	SH-603	Spiritual Heritage of India	Student acquires – 1) acquaintance with the the ancient spiritual wisdom of India embodied in the Sanskrit literature and expressed variously in contemporary India's cultural and national life. 2) such ideas that lead to national integration and enlightenment. 2) universal ethical values that help in character building of an individual.
87	SH-604	Spiritual Heritage of India	Student acquires – 1) acquaintance with the the ancient spiritual wisdom of India embodied in the Sanskrit literature and expressed variously in contemporary India's cultural and national life. 2) such ideas that lead to national integration and enlightenment. 3) universal ethical values that help in character building of an individual.

88	SH-605	Spiritual Heritage of India	Student acquires – 1) acquaintance with the the ancient spiritual wisdom of India embodied in the Sanskrit literature and expressed variously in contemporary India's cultural and national life. 2) such ideas that lead to national integration and enlightenment. 2) universal ethical values that help in character building of an individual.
89	EN-611	English (General)	Student will be able to – 1) make a comparative analysis of the English literature with that of Sanskrit. 2) read, write and speak correct English. 3) gain exposure to the global academic atmosphere. 4) develop employability for oneself.
90	EN-612	English (General)	Student will be able to – 1) make a comparative analysis of the English literature with that of Sanskrit. 2) read, write and speak correct English. 3) gain exposure to the global academic atmosphere. 4) develop employability for oneself.
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92	EN-614	English (General)	Student will be able to – 1) make a comparative analysis of the English literature with that of Sanskrit. 2) read, write and speak correct English. 3) gain exposure to the global academic atmosphere. 4) develop employability for oneself.

93	EN-615	English (General)	Student will be able to – 1) make a comparative analysis of the English literature with that of Sanskrit. 2) read, write and speak correct English. 3) gain exposure to the global academic atmosphere. 4) develop employability for oneself.
94	EN-616	English (General)	Student will be able to – 1) make a comparative analysis of the English literature with that of Sanskrit. 2) read, write and speak correct English. 3) gain exposure to the global academic atmosphere. 4) develop employability for oneself.
95	CA-621	Computer Applications (General) (Th-32, Pr-64 Hrs)	Student will be able to – 1) use basic computer applications. 2) utilize ICT enabled learning and teaching facilities. 3) develop employability for oneself.
96	CA-622	Computer Applications (General) (Th-32, Pr-64 Hrs)	Student will be able to – 1) use basic computer applications. 2) utilize ICT enabled learning and teaching facilities. 3) develop employability for oneself.
97	CA-623	Computer Applications (General) (Th-32, Pr-32 Hrs)	Student will be able to – 1) use basic computer applications. 2) utilize ICT enabled learning and teaching facilities. 3) develop employability for oneself.
98	CA-624	Computer Applications (General) (Th-32, Pr-32 Hrs)	Student will be able to – 1) use basic computer applications. 2) utilize ICT enabled learning and teaching facilities. 3) develop employability for oneself.

99	CA-625	Computer Applications NLP (General)	Student will be able to – 1) know the basics of NLP and the application of Sanskrit in it. 2) understand interdisciplinary research possibilities in the field. 3) use basic computer applications. 4) utilize ICT enabled learning and teaching facilities. 5) develop employability for oneself.
100	CA-626	Computer Applications NLP (General)	Student will be able to – 1) know the basics of NLP and the application of Sanskrit in it. 2) understand interdisciplinary research possibilities in the field. 3) use basic computer applications. 4) utilize ICT enabled learning and teaching facilities. 5) develop employability for oneself.
101	ES-631	Environmental Studies (Compulsory)	Student will be able to – 1) develop a rational understanding regarding the importance of the environmental well-being. 2) preserve, safeguard and feel for the environment in all its levels.
102	ES-632	Environmental Studies (Compulsory)	Student will be able to – 1) develop a rational understanding regarding the importance of the environmental well-being. 2) preserve, safeguard and feel for the environment in all its levels.

103	HN-641	Hindi (Compulsory Language)	Student will be able to – 1) make a comparative analysis of the Hindi literature with that of Sanskrit. 2) read, write and speak correct Hindi. 3) gain exposure to the larger arena of academics in the nation, where Hindi is slowly acquiring an important position. 4) make oneself an enlightened citizen contributing towards national integration language-wise. 4) develop employability for oneself.
104	HN-642	Hindi (Compulsory Language)	Student will be able to – 1) make a comparative analysis of the Hindi literature with that of Sanskrit. 2) read, write and speak correct Hindi. 3) gain exposure to the larger arena of academics in the nation, where Hindi is slowly acquiring an important position. 4) make oneself an enlightened citizen contributing towards national integration language-wise. 5) develop employability for oneself.
105	PR-651	Comparative Philosophy and Religion	Student get a thorough understanding of – 1) Basic Feature of Indian Philosophy. 2) The history of Western Philosophy. 3) Basics of Charvaka Philosophy. 4) Different philosophers in the pre-Socratic Age.
106	PR-652	Comparative Philosophy and Religion	Student get a thorough understanding of – 1) the basics of the Buddhist philosophy. 2) the basics of Comparative Religion with special reference to Zoroastrianism. 3) the philosophical developments in the Socratic and Medieval Ages.
107	PR-653	Comparative Philosophy and	Student get a thorough understanding of – 1) the philosophy of St. Thomas Acquinas. 2) the modern age of Western philosophy with special reference to Rene Descartes.

		Religion	3) the basics of Abrahamic faith with special reference to Judaism. 4) the basics of Nyaya-Vaisheshika systems.
108	PR-654	Comparative Philosophy and Religion	Student get a thorough understanding of – 1) the basics of Sankhya and Yoga. 2) the basic features of Christianity. 3) the basics of the philosophy of Spinoza and George Berkeley.
109	PR-655	Comparative Philosophy and Religion	Student get a thorough understanding of – 1) the basic features of the philosophy of David Hume. 2) the basics of Islam. 3) the basics of Purva and Uttara Mimamsas. 4) the similarity of thought in the religions of Abrahamic origin.
110	PR-656	Comparative Philosophy and Religion	Student get a thorough understanding of – 1) the basics of Jainism and Buddhism. 2) the basics of Sikhism and Hinduism. 3) the overview of different world religions and Western and Indian philosophical traditions. 4) the synthesis and harmony of thought in Ramakrishna and Vivekananda philosophy.

Programme Outcome, Programme Specific Outcome and Course Outcome of *PhD in Sanskrit*.

Programme Name: PhD in Sanskrit.

Programme Outcome:

1. Producing an educated class of citizens who would be inculcated with the right blend of the rich cultural and spiritual heritage of ancient India and the enlightenment values such as scientific temper, technological skill, pragmatic outlook and team-work.
2. Providing a appropriate research orientation and a fair opportunity for extensive as well as intensive study in various research areas in Sanskrit.
3. Realization of Swami Vivekananda's “life-building, man-making, character-making” education.

Programme Specific Outcome:

1. Revivalism of Sanskrit research in the medium of Sanskrit.
2. Resuscitation of Sanskrit knowledge traditions like Vyakarana, Vedanta etc, by updating, improving and investigating into new arenas of knowledge.

   Creating a Sanskrit research community well versed in both traditional as well as modern outlook and temperament.
3. Enhancing the Sanskrit knowledge traditions by producing good research works on different research concerns arising out of traditional as well as modern outlook in the field of Sanskrit studies.

Course Outcome:

1.	SK-900	Research Methodology	Student acquires – 1) a thorough understanding in the ancient and modern research techniques and methods. 2) skill to employ those techniques and methods in research related to Sanskrit knowledge traditions.
2.	SK-901	Manuscriptology	Student acquires – 1) knowledge about different writing systems and medium of writing, with special reference to Sanskrit and Indian traditions. 2) a detailed understanding about editing and preservation techniques of manuscripts.
3.	SK-902	Tools and Techniques of Knowledge Representation in Sanskrit	Student acquires – 1) an overview about the ancient techniques and terminologies by which research works have been done so far. 2) skill to coin, define, re-define, modify and employ research-oriented terminology and concepts.
4.	SK-910	Sarvadarsanasamgraha	Student gets to know – 1) the particular research methodology Madhavacharya employed in Sarvadarsanasamgraha. 2) of how various systems of thought are represented in ancient texts, through an example.
5.	SK-911	Foundation of Research in Sanskrit Philosophy	Student gets acquainted with – 1) the research techniques applicable to the specific field chosen by him/her, in this case Sanskrit Philosophy. 2) possible arenas demanding research, in that specific field.
6.	SK-920	Foundation of Research in Sanskrit Vyakarana	Student gets acquainted with – 1) the research techniques applicable to the specific field chosen by him/her, in this case Vyakarana. 2) possible arenas demanding research, in that specific field.

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Programme Outcomes, Programme Specific Outcomes and Course Outcomes of MSc and PhD programmes in Mathematics

Department of Mathematics
Ramakrishna Mission Vivekananda Educational and Research Institute
Belur Math, Howrah, INDIA

Programme Name: MSc Mathematics

Programme Outcomes

- Inculcate critical thinking to carry out scientific investigation objectively without being biased with preconceived notions.
- Equip the student with skills to analyze problems, formulate an hypothesis, evaluate and validate results, and draw reasonable conclusions thereof.
- Prepare students for pursuing research or careers in industry in mathematical sciences and allied fields
- Imbibe effective scientific and/or technical communication in both oral and writing.
- Continue to acquire relevant knowledge and skills appropriate to professional activities and demonstrate highest standards of ethical issues in mathematical sciences.
- Create awareness to become an enlightened citizen with commitment to deliver one's responsibilities within the scope of bestowed rights and privileges.

Programme Specific Outcomes

- Understanding of the fundamental axioms in mathematics and capability of developing ideas based on them.
- Inculcate mathematical reasoning.
- Prepare and motivate students for research studies in mathematics and related fields.
- Provide knowledge of a wide range of mathematical techniques and application of mathematical methods/tools in other scientific and engineering domains.
- Provide advanced knowledge on topics in pure mathematics, empowering the students to pursue higher degrees at reputed academic institutions.
- Strong foundation on algebraic topology and representation theory which have strong links and application in theoretical physics, in particular string theory.
- Good understanding of number theory which can be used in modern online cryptographic technologies.
- Nurture problem solving skills, thinking, creativity through assignments, project work.
- Assist students in preparing (personal guidance, books) for competitive exams e.g. NET, GATE, etc.

Programme Name: PhD Mathematics

Programme Outcomes

Students have/capable of

- Undergone relevant (taught) courses required for undertaking specialized research.
- Identifying unsolved yet relevant problem in a specific field.
- Articulating ideas and strategies for addressing a research problem.
- Undertaken original research on a particular topic.
- Effectively communicating research, through journal publications and conference presentations, to the mathematics community.
- Disseminating research to a broader audience.

Program Specific Outcomes

- Generate publications in reputed mathematical journals.
- Provide scope for interaction with international researchers and developing collaborations.
- Demonstrate the highest standard of ethics in research.
- Provide opportunities to research students for communication (and discussion) of advanced mathematical topics to undergraduate and graduate students.
- Produce next generation researchers in mathematics.

Course Outcomes

SEMESTER—I		
Course Code	Course Name	Course Outcomes
M201	**Algebra 1**	Knowledge gained: • Concept of group action and theorems about group actions. • Structure of permutation groups. • Polynomial rings, EDs, PIDs, & UFDs, and relations among them. • Universality of Polynomial rings Skills gained: • Solving problems using the powerful concept of group action. • Facility in understanding the structure of a problem where the problem involves a permutation group - e.g. nature of the roots of a polynomial equation. • Ability to understand a large class of commutative rings by regarding them as quotients of polynomial rings by suitable ideals. Competency developed: • Applying the concept of a group action to real life problems such as Counting • Facility in handling problems involving polynomial equations • Facility in working with situations involving commutative rings, in particular monogenic algebras of matrices. Implies facility in working with matrices, a concept that finds a large number of applications in real life including the graphs and networks. • Facility in solving real life problems by thinking logically and outside of box.
M202	**Topology**	Knowledge gained: • Topological spaces • Connectedness, compactness, separation axioms • Continuity • Metric spaces review • Fundamental groups • Covering spaces • Computations Skills gained: • Generalization of concepts like continuity • Generalizations of theorems • Distinguishing spaces up to homeomorphisms Competency gained: • Understanding of topological spaces and having a grasp on basic results
M203	**Complex Analysis**	Knowledge gained: • Metric spaces (in particular, the complex plane). • Analytic functions, Cauchy-Riemann differential equations, harmonic functions.

		• Power series, zeros, singularities. • Cauchy's theorem, Cauchy's integral formula, and applications. • Cauchy's residue theorem, and applications. • Mobius transformations. • Riemann mapping theorem. Skills gained: • Differentiation of functions on C, deciding if a function on C is analytic. • Development of functions into power series, classifying singularities. • Integration of functions on C, applications to counting zeros and poles. • Evaluation of indefinite real integrals using complex analysis. • Constructing Mobius transformations mapping given circles to given circles. Competency developed: • Understanding of topological and geometric properties of the complex plane. • Differentiation and integration of functions on C, with applications to problems from real analysis. • Viewing analytic functions as conformal mappings.
M204	**Linear Algebra 1**	Knowledge gained: • Matrix theory, determinants and their application to systems of linear equations. • Eigenvalues, diagonalization of matrices and reduction of systems of linear equations into simpler systems of easily tractable nature. • Vector theory: subspace, basis, linear independence, inner product spaces etc. • Applications of matrix algebra. Skills gained: • Matrix manipulations. • Handing of systems of linear equations. • Use mathematical software to solve problems on linear systems. • Ability to go abstract from concrete: from concrete notion of solution spaces to vector spaces. • Linear modelling problems Competency developed: • Solving Systems of linear equations. • Qualitative analysis of systems of linear equations. • Vector Spaces, linear independence and foundations of abstract algebraic thinking.
M205a	**Real Analysis I**	Knowledge gained: • Basic definition of metric space, norm linear space and inner product space. • Series and sequence of continuous functions. • Equicontinuous families, Arzela-Ascoli Theorem and Stone-Weierstrass Theorem. • Function of several variables and differentiation in Rn. • Inverse and Implicit function Theorem. • Submanifolds of Rn and Rank Theorem.

		Skills gained: • Viewing C[0,1], i.e., the space of continuous functions on [0,1] as a metric space. • The notion of convergence in c[0,1] and related theorems. • Differentiability of functions in several variables and their relation to partial derivatives. • Realising the differentials in terms of geometric properties. Competency developed: • Ability to handle convergence of series and sequence of functions. • Ability to differentiate functions in Rn. • Apply Implicit and inverse function theorem, moving towards calculus on manifolds.
SEMESTER—II		
M205b	**Real Analysis II**	Knowledge gained: • Ordinary differential equations and linear system of o.d.e's. • Cauchy-Peano existence and uniqueness Theorem. • Picard-Lindelof Theorem, Continuation of solutions. • Examples of second-order partial differential equations, i.e., Heat, Wave and Laplace equation. • Properties of Harmonic and subharmonic functions. • Solution to the Dirichlet problem. Skills gained: • Solve ordinary differential equations. • Solve linear system of homogeneous and non-homogeneous o.d.e.s. • Idea about Partial differential equation and link to partial derivatives. • Idea about the solution of the Dirichlet problem for certain subdomains of Rn. Competency developed: • Ability to handle ordinary differential equations and solve them under appropriate assumptions. • Ability to solve a linear system of o.d.e.'s • Apply important properties of harmonic and subharmonic functions. • Apply the solvability of the Dirichlet problem in appropriate conditions.
M206	**Algebra 2 - Fields and Galois Theory**	Knowledge gained: • Solving polynomial equations using formulas for roots • How to test if a polynomial is irreducible Finite Field (Galois Fields) • Understanding which equations can be solved using radials using the conce Skills gained: • Ability to understand/obtain the roots of a polynomial equation if the same has (or can be reduced to) degree less than five. • Facility in working with finite fields • Applying the concept of a field extension to various mathematical problems including geometric constructions and perfect division of a circle into n parts

		Competency developed: • Facility in working with mathematical problems that involve polynomial equations. • Facility in handling problems involving polynomial equations • Applying mathematical methods to the real-life problems including cryptography. • Highly developed reasoning ability.
M207-2	**Theory of Modules**	Knowledge gained: • Module theory as linear algebra over general rings.. • Special classes of modules: free modules, projective modules, flat modules etc. • Theory of modules over PID and its application to Jordan and Rational canonical forms. • Basic concepts in homology: Hom, Tensor etc. Skills gained: • Ability to handle complicated matrices and systems of equations via decomposing into nice forms. • Ability to deal with module theory which is indispensable in wide ranges of mathematical disciplines such as algebra, topology, number theory, operator theory etc. • Ability to handle modern algebraic notions like quotients, generators and relations, universal mapping property etc. • Ability to apply intuitions gained from linear algebra to other seemingly unrelated areas of mathematics. Competency developed: • Deeper insight into and further comfort with linear algebra • Ability to think about classical problems in algebra that involves systems of equations in terms of language of modern algebra. • Basic preparation various research areas in pure mathematics like algebraic geometry, Algebraic Number Theory, Topology etc. • An abstract perspective to many real life problems that can be modelled using linear algebra.
M208	**Measure Theory**	Knowledge gained: • Definition and properties of the exterior measure on R^d. • Measurable sets and Lebesgue measure, construction of non-measurable sets. • Measurable functions. • Lebesgue integration, convergence theorems for Lebesgue integrals and Fubini's theorem. • L^p spaces and Fourier inversion formula. • Connection between differentiation and integration in the context of Lebesgue theory. Skills gained: • Computation of Lebesgue measures. • Establishing measurability or non-measurability of sets and functions. • Approximating measurable functions by simple and step functions. • Computation of Lebesgue integrals, applications to volume calculations and Fourier analysis. • Deciding under which conditions the fundamental theorem of calculus is applicable in the context of Lebesgue integration.

		Competency developed: • Extension of the concepts of measures and integration. • Understanding that Lebesgue integration can solve certain problems for which Riemann integration does not provide adequate answers (in particular, in Fourier analysis). • Viewing differentiation and integration as inverse operations in the more general context of Lebesgue theory, understanding the limitations of this view.
M209	**Elementary Number Theory**	Knowledge gained: • Definitions of divisibility and related algorithms • Basic congruence results • Quadratic reciprocity • Distribution of primes • Basic additive results • Diophantine approximation and transcendental numbers Skills gained: • Solutions of diophantine equations • Arithmetical functions • Distribution of primes Competency developed: • Useful tools in cryptography and related applied subjects
SEMESTER—III		
M211	**Functional Analysis**	Knowledge gained: • Concept of normed linear spaces and inner product spaces. • Concept of bounded linear operators between these spaces. • Concept of the dual space of a normed linear space. • Concept of compact, self-adjoint and normal operators. • Concept of the spectrum of a bounded linear operator. Skills gained: • Using topology to work with infinite dimensional vector spaces. • Using careful analysis to show that certain spaces of functions are complete. • Comparing the differences between finite and infinite dimensional spaces. • Comparing the differences between Banach and Hilbert spaces. • Analysing the structure of the spectrum of certain operators. Competency developed: • Working with a complete orthogonal set a.k.a. Schauder basis in a Hilbert space. • Investigating the best approximation of a given vector by vectors in a given subspace. • Computing the dual spaces of certain Banach spaces. • Working with weak and weak* topologies on normed linear spaces.
M212	**Algebraic Topology**	Knowledge gained: • Concept of homotopy of maps and topological spaces • Concept of chain complexes of abelian groups

		• Concept of homology and cohomology groups of spaces • Exposure to the language of categories and functors Skills gained: • Ability to compute homology groups using long exact sequences • Ability to exercise geometric intuition and visualisation • Ability to translate geometric intuition into rigorous proofs • Working with geometric objects which exist only in higher dimensions Competency developed: • Ability to differentiate between some more topological spaces • Working with homological methods in algebra • Using algebraic methods to solve topological problems • Using topological methods to solve algebraic problems
M213	**Discrete Mathematics**	Knowledge gained: • Basic set theory, cardinal numbers, different concepts of infinity. • Basic combinatorics, induction, inclusion exclusion, pigeon hole principle. • More advance topics in combinatorics: recurrence relations, generating functions, Polya's theorem, graphs, trees, topics in matching such as Marriage theorem. • Ramsey theory, planar graph. • Partially ordered set: Dilworth's theorem and extremal set theory. • Application to real life problems such as network theory, data structure, optimization etc. Skills gained: • Efficiency in handling with discrete structures. • Efficiency in Set theory and handling formal of notions of size. • Efficiency in notions of matching, ordering, planarity. • Efficiency in solving concrete combinatorial problems whose presence is ubiquitous in science and engineering. Competency developed: • Ability to deal with notions of mapping and via that notion ability to tackle various notions of infinity like countable, uncountable etc. • Ability to use graphs as unifying theme for various combinatorial problems. • Ability to apply combinatorial intuitions in network theory, data structure and various other fields of science.
ELECTIVES (SEMESTER—III & IV)		
CS221	**Design and Analysis of Algorithms**	Refer to MSc in Computer Science curriculum CS241
CS244	**Introduction to Optimization Techniques**	Refer to MSc in Computer Science curriculum CS222
AM200	**Nonlinear Dynamics**	Knowledge gained: • Capable of determining fixed points and their stability.

	and Asymptotic Analysis	• Analyze the type of bifurcation. • Ability to draw phase portraits. • Learn the art of asymptotic approximation to challenging mathematical problems. Skills gained: • Knowledge of nonlinear differential equations and their analysis. • Simplify and solve mathematical problems involving small parameters. Competency gained: • Ability to solve complex nonlinear problems. • Asymptotic solutions to complex differential equations.
AM201	**Numerical Algorithms**	Knowledge gained: • Wide variety of numerical techniques to solve mathematical problems arising in diverse scientific contexts. Implementation of stable algorithms for finding roots of nonlinear equations, solving linear system of equations, and solution for ODEs, etc. • Influence of data representation on computers on numerical algorithms. Skill gained: • Implementing numerical algorithms through computer programs. • Analysis of errors of numerical algorithms. Competency gained: • Obtain approximate stable solution to mathematical problems making use of numerical algorithms.
CS312	**Approximation and Online Algorithms**	Refer to MSc in Computer Science curriculum CS312
CS312	**Computing for Data Science**	Refer to MSc in Big Data Analytics curriculum DA100
M308	**Differential Geometry**	• Knowledge of Riemannian manifolds and submanifolds. • Knowledge of operators on forms and integrations, Lie derivative, Stokes theorem, Gauss-Bonnet formula and Index theorem. • Tackle problems on General Relativity, control of non-linear systems, shape analysis.
M313	**Algebraic Geometry**	• Learn topology on projective spaces. • Learn local properties on plane curves. • Solve complex problems on ordinary differential equations. • Tackle problems on CAD/CAM, computer vision.
M322	**Geometric Topology**	• Understanding of Knots and Links, surgery on links. • Knowledge of Hyperbolic geometry groups. • Solve complex problems in topological quantum field theory.
M323	**Lie groups and Lie Algebras**	• Knowledge of Killing form, Lies and Engel's theorem, Universal enveloping algebra and Poincare-Birkhoff-Witt theorem, root space decomposition. • Understanding of Linear Lie group, Lie algebra, Lie transformation groups. • Solving of complex differential equations.
M324	**Advanced Differential Geometry**	• Knowledge of Jacobi Fields, conjugate points, Isometric immersions, Second fundamental form.

		• Knowledge of Bonne-Myers and Synge-Weinstein Theorems, Rauch comparison theorem, Morse Index theorem, Preissman's Theorem, Sphere theorem. • Solve complex problems to diverse problems (in physics, engineering) with differential geometry.
M325	**Complex Manifolds and Riemann Surfaces**	• Learn Cauchy's theorem in several complex variables, Definition and calculus on complex manifolds. • Learn Sheaves and cohomology, Divisors and Line bundles, Normalization theorem. • Applications in string theory.
M 327	**Advanced Algebraic Topology**	• Learn Homotopy groups, Serre spectral sequence. • Learn vector bundles, generalized cohomology theory. • Applications in physics, algebraic geometry.
M332	**Programming and Data Structures**	Refer to MSc in Big Data Analytics curriculum DA101.
M334	**Automata theory, Languages and Computability**	Refer to MSc in Computer Science curriculum CS200.
M341	**Classical Mechanics 1**	Refer to the syllabus of the Physics Department.
M342	**Classical Mechanics 2**	Refer to the syllabus of the Physics Department.
M343	**Quantum Mechanics**	Refer to the syllabus of the Physics Department.
M400	**Project**	• Inculcate a taste for research in Mathematics. • Develop oral and written presentation skills.
M450	**Research Methodology**	• Use of online resources (e.g. MathSciNet) for literature survey. • Preparation of documents using latex software.

Department of Physics

Ramarkrishna Mission

Vivekananda Educational and Research Institute

Programme Outcomes, Programme Specific Outcomes and Course Outcomes

Master of Science (MSc) in Physics

MSc (Physics)

Program Outcomes

PO1. Critical Thinking: Take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at ideas and decisions (intellectual, organisational, and personal) from different perspectives.

P02. Analytical Skill: To analyse from various branches of knowledge and arrive at independent conclusions.

PO3. Effective Communication: Communicate and comprehend clearly in person and through electronic media in English and to make meaning of the world by connecting people, ideas, books, media and technology.

PO4. Social Responsibility: To be conscious of the society and it’s requirement, and contribute towards it.

PO5. Effective Citizenship: Demonstrate empathetic social concern and equity centred national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.

PO6. Ethics & Morals: Recognize different value systems, understand the moral dimensions of decisions, and accept responsibility for them.

PO7. Environment and Sustainability: Understand the issues of environmental contexts and sustainable development.

PO8. Self-directed and Life-long Learning: Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

MSc (Physics)

Program Specific Outcomes

PSO1. Understanding the Scientific paradigm and its foundational philosophical principles.

PSO2. Understanding the foundational empirical principles of Physics.

PSO3. Understanding the epistemological source of knowledge in Physics and its connection with regards to theoretical analysis in Physics.

PSO4. Acquiring a rigorous knowledge in fundamental areas of Physics.

PSO5. Application of knowledge to real-life problems.

MSc (Physics)

Course Outcomes

Design and Fabrication Laboratory (PHY519)	CO1 Learn to apply creative skills and knowledge
	CO2 Learn to make technology accessible
	CO3 Learn to develop an open-ecology through sharing of ideas and knowledge
	CO4 Create an interdisciplinary/multidisciplinary platform for implementation of various ideas
	CO5 Train and empower the students in designing, assembling, fabricating and programming digital/microprocessor controlled systems, using a hands-on approach
	CO6 Learn to design cost-effective real-life devices/gadgets to benefit human beings and society as a whole
	CO7 Learn how to program the microprocessor hardware and analyse data
	CO8 Learn how to interface the microprocessor with a computer
	CO9 Learn how to interface the microprocessor hardware with sensors
	CO10 Learn how to interface control devices using the microprocessor hardware
	CO11 Design, fabricate and implement complete projects out of these microprocessor controlled hardware, preferably with some real-life application.
Computer Fundamentals and Computational Physics (PHY415)	CO1 Develop numerical, computational and analytical skills relevant to theoretical and experimental physics problem solving
	CO2 Acquire a hands-on approach towards computer hardware, software, clustering and networking
	CO3 Learn about Open Source philosophy and working in an Open Source environment
	CO4 Synchronise computational skills acquired with requirements of theoretical physics courses
	CO5 Work using Open Source operating systems (Linux/Unix) and software
	CO6 Learn programming skills in Shell scripting, C++, FORTRAN, Python, etc.
	CO7 Learn various Data Visualising skills, eg. GNUPlot, etc.
	CO8 Learn (scientific) Typesetting and presentation skills, primarily using LaTeX
	CO9 Application to various real-life problems
	CO10 Assemble & set up of fully functional PCs from scratch
	CO11 Construct cost-effective computer clusters for high-performance computing
Classical Mechanics (PHY411)	CO1 Understand Lagrangian Formulation
	CO2 Understand Hamiltonian Formulation
	CO3 Understand Canonical Transformations
	CO4 Understand Dynamics of a rigid body
	CO5 Learn Hamilton – Jacobi Theory

	CO6 Understand Mechanics of Continuous media
	CO6 Learn Theory of small oscillations
	CO7 Learn Classical Perturbation Theory
	CO8 Learn Non-linear dynamics and chaos
Quantum Mechanics I and II (PHY412 and PHY422)	CO1 Learn the principle of superposition
	CO2 Understand the postulates of quantum mechanics
	CO3 Learn about symmetries
	CO4 Study single particle formulation of non-relativistic quantum mechanics
	CO5 Learn the applications to physical systems
	CO6 Understand quantisation scheme and classical correspondence
	CO7 Learn Path integral formulation of quantum mechanics: free particle and particle in a well (perturbative approach)
	CO8 Learn Quantum theory of scattering, Approximation method in quantum mechanics
	CO9 Learn about quantum computation and quantum information theory
	CO10 Learn about Bell's inequalities
	CO11 Understand density matrix, reduced density matrix
	CO12 Entanglement, entanglement entropy (von Neumann and Renyi)
Mathematical Tools in Theoretical Physics I and II (PHY414 and PHY424)	CO1 Learn the Theory of complex variables
	CO2 Learn the Theory of linear ordinary differential equations
	CO3 Understand integral transforms
	CO4 Gain exposure to Special functions
	CO5 Gain knowledge of boundary value problems and Green's function
	CO6 Understand integral equations.
Classical Theory of Fields I: Electrodynamics (PHY413)	CO1 Learn about action principle formulation of relativistic particle
	CO2 Learn about relativistic formulation of Electromagnetic (EM) fields
	CO3 Learn about Action formulation of EM fields: Maxwell equations
	CO4 Learn about the vector potential: relativistic formulation
	CO5 Learn about Interaction of EM fields with currents: Noether's theorem
	CO6 Learn about interaction of charged particle with EM fields: Lorentz force equations, examples
	CO7 Learn about the Energy-Momentum tensor: Conservation and Poynting's theorem, ambiguities
	CO8 Learn about Vacuum EM waves: geometrical optics limit; polarisation, Stokes parameters and Poincare sphere,
	CO9 Learn about EM waves in media: Faraday rotation,
	CO10 Learn about EM potentials due to an arbitrarily moving charged particle, EM fields from the moving charges: radiation and Coulomb fields,
	CO11 Learn about Dipole radiator: Lamor's formula, radiated power spectrum,

	CO12 Learn principles of Synchrotron radiation: radiated power spectrum;
	CO13 Understand Polarisation,
	CO14 Learn about classical scattering by EM waves by charges: Rayleigh and Thomson scattering,
	CO15 Learn about Elements of multipole radiation: E1, E2 and M1 modes,
	CO16 Learn about radiation reaction and inconsistencies of the Maxwell theory.
Classical Theory of Fields II: General Relativity (PHY423)	CO1 Understand curvilinear coordinate systems in R3: Euclidean metric
	CO2 Understand invariance principles: Special Relativity and Gravity, Principle of Equivalence.
	CO3 Understand Pseudo-Newtonian derivation of redshift.
	CO4 Learn about curved spacetime: geodesics, Newtonian approximation.
	CO5 Learn about invariants in curved spacetime – scalar, vector and tensor fields, p-form fields, metric tensor.
	CO6 Understand parallel transport and affine connection, covariant derivative, geodesics, Lie derivative and isometries, Invariant measure, Invariant matter field, Belinfante energy-momentum tensor.
	CO7 Learn about external field problems – Stationarity and timelike Killing vector fields.
	CO8 Learn about gravitational redshift in stationary spectrum.
	CO9 Learn about spherically symmetric vacuum sptm: Schwarzchild Geodesics in Schwarzchild sptm : ISCOs and bounded orbits.
	CO10 Learn about light bending by a spherical star, Perihelion shift of Mercury.
	CO11 Learn about coordinate time and proper time, proper distance.
	CO12 Learn about curved spacetime geometry – Geodesic deviation, Riemann curvature tensor: components, invariants (Ricci and Kretchmann), Weyl tensor, Bianchi Identity.
	CO13 Learn about Einstein-Hilbert-Lorentz action and Einstein equation.
	CO14 Understand Newtonian approximation, Schwarzchild solution and properties of Gravitational waves, Introduction to relativistic cosmology.
Statistical Mechanics I (PHY426)	CO1 Get an overiew of thermodynamics;
	CO2 Objectives of statistical mechanics;
	CO3 Understand Microstates and macrostates;
	CO4 Understand Phase space and concept of an ensemble;
	CO5 Understand Liouville’s theorem and the concept of equilibrium;
	CO6 Understand Ergodic hypothesis and postulate of equal a priori probability;
	CO7 Understand Microcanonical ensemble: Boltzmann’s definition of entropy and derivation of thermodynamics;
	CO8 Understand the equipartition theorem;
	CO9 Understand Microcanonical ensemble calculations for a classical ideal gas;
	CO10 Understand the Gibbs paradox;

	CO11 Understand Canonical ensemble; Energy fluctuations in the canonical ensemble;
	CO12 Understand Grand canonical ensemble; Density fluctuations in the grand canonical ensemble;
	CO13 Understand Quantum statistical mechanics: Postulate of equal a priori probability and postulate of random phases; Density matrix; Ensembles in quantum statistical mechanics;
	CO14 Understand the ideal quantum gas: Microcanonical and grand canonical ensembles;
	CO15 Understand Fermi-Dirac and Bose-Einstein statistics; Bose-Einstein condensation.
Statistical Mechanics II (PHY516)	CO1 Understand basic introduction to phase transitions: first order and continuous;
	CO2 Understand critical phenomena: critical exponents and scaling hypothesis;
	CO3 Understand Ising model: exact solution in one dimension, mean-field approximation and calculation of critical exponents, Landau theory;
	CO4 Get an overview of probability theory: Law of large numbers and the central limit theorem; Random walk;
	CO5 Understand Brownian motion: Langevin and Fokker-Planck descriptions; Fluctuation-Dissipation theorem;
	CO6 Understand Markovian process;
	CO7 Understand Master equation;
	CO8 Understand the concept of steady states, detailed balance and equilibrium vs non-equilibrium;
	CO10 Get familiarized with a simple illustration using interacting random walks (simple symmetric and asymmetric exclusion processes).
Particle Physics I and II: Nuclear Physics (PHY522/523)	CO1 Understand charge, mass, constituents, binding energy and separation energy, level scheme, excited states, spin, parity and isospin, nuclear size and form factors, static electromagnetic moments.
	CO2 Understand Two-nucleon system: a) Deuteron: ground and excited states; electric quadrupole and magnetic dipole moments; non-central force and tensor interaction. b) Scattering states: n-p and p-p scattering at low energies; effective range and scattering length; singlet and triplet states; ortho- and para-hydrogen, charge independence of nuclear forces. c) Nucleon-nucleon scattering at higher energies d) Polarization in nucleon-nucleon scattering – l.s forces e) Exchange forces and saturation f) General properties of nucleon-nucleon forces;
	CO3 Learn about the Yukawa potential.
	CO4 Understand Complex– nuclear structure: a) need for nuclear models b) Fermi Gas model c) Static Liquid Drop model d) Shell Model e) Collective Model f) Unified Model.
	CO5 Understand about Nuclear Reactions: a) types of reactions and conservation principles b) Compound Nuclear Reactions – Resonances and the Breit Wigner formula c) Direct Reactions, Optical Model, Nuclear Fission – Bohr – Wheeler theory, Electromagnetic Transitions – Multipole transitions and selection rules.

Particle Physics I and II: Particle Physics (PHY522/523)	CO1 Learn about Relativistic kinematics: Mandelstamm variables; collision and decay kinematics; reaction thresholds; phase space, cross-section and decay formulae;
	CO2 Learn about types of interactions and their relative strengths;
	CO3 Learn about the discovery of positron, muon, pion, neutrino and other particles;
	CO4 Learn about Symmetry, conservation laws and Quantum numbers;
	CO5 Learn about classification of elementary particles;
	CO6 Learn about determination of quantum numbers of different particles;
	CO7 Learn about Hadrons – classification by isospin and hypercharge;
	CO8 Learn about Quarks, colour, Leptons and gauge bosons;
	CO10 Learn about Weak Interactions: a) phenomenology, conservation laws and selection rules b) Fermi theory of beta decay, V-A interaction c) non-conservation of parity d) Neutral Kaon decay – CP violation and regeneration e) Z and W+ and W- bosons,
	CO11 Learn about E-M interactions – the QED Lagrangian from gauge invariance principles.
	CO12 Understand Group Theory: Lie Group – SU(2), SU(3), SU(n) – Discrete Symmetry – C, P, T,
	CO12 Learn about QED – Feynman rules – Cross section and Decay rate calculations,
	CO13 Learn about Hadron Structure and Quark Model, Parton model, Deep Ineasltic Scattering – QCD , Weak Interaction phenomenology – Electroweak unification, Non-Abelean Gauge Theory – Standard Model
Condensed Matter, Atomic and Molecular Physics (PHY520)	CO1 Learn about Crystal structure — Lattice and basis, Examples of crystal structures, Direct and reciprocal lattice, Xray diffraction and crystal structure determination;
	CO2 Learn about theories on Specific heat of solids — Boltzmann, Einstein and Debye theories;
	CO3 Learn about theories of Elecrons in metals — Drude and Sommerfeld theories;
	CO4 Understand Lattice dynamics: Normal modes, phonons, anharmonic effects, lattice thermal conductivity;
	CO5 Learn about theories of Electrons in solids — Electrons in a periodic potential: Nearly free electron model, Bloch’s theorem, Insulators, semiconductors, and metals: Band structures and optical properties;
	CO6 Learn aspects of Magnetism — Magnetic properties of atoms: Para and diamagnetism, Spontaneous magnetic order: Ferro-, antiferro-, and ferri-magnetism, Domains and hysteresis
	CO7 Be exposed to Spectroscopy: General definition and terminology, Multiplet structure and designation of spectral terms, coupling of two or more electrons in equivalent shells, spin orbit interaction and alkali spectra, Relativistic mass correction, Darwin term and hydroden fine structure. Zeeman and Stark effect.
	CO8 Learn about two electron systems, their wavefunctions, spectral terms.

	CO9 Study Many body theory, Hatree and Hatree Fock approximation, Configuration Interaction, Lamb shift.
	CO10 Learn about General structure of molecular energy levels, Born Oppenheeimer approximation. Rotational, vibrational, Rotational-vibrational and electronic spectra of diatomic molecules and their detailed structures.
	CO11 Understand Franck Condon principle and its implications, Raman spectra.
Quantum Field Theory I (PHY513)	CO1 Learn about Relativistic quantum mechanics and the Dirac equation and its solutions,
	CO2 Learn about Canonical quantisation: Free scalar field, electromagntic field, Dirac field,
	CO3 Understand Wick's Theorem, Correlation functions, Propagators for the scalar, Dirac and electromagnetic field.
	CO4 Learn the basis of interacting theories and Feynman diagrams.
Quantum Field Theory II (PHY523)	CO1 Learn about Interacting Quantum Field theories, Quantum electrodynamics (QED), Calculation techniques for Feynman diagrams of all major processes in QED,
	CO2 Learn about divergences in Quantum Field Theory, Removal of divergences, radiative corrections, explicit calculation of Lamb shift,
	CO3 Learn about Renormalisation theory, Wilson renormalisation group.
	CO4 Get exposure to Statistical field theory and applications to condensed matter physics, Two dimensional Ising model and gauge theories.
Advanced General Relativity and Astrophysics (PHY525)	CO1 Learn about Gravitational waves – Linearized General Relativity – Graviational waves in linearised GR – Energy radiated by gravitational waves – Detection of gravitational waves.
	CO2 Learn about White dwarfs – Astronomy basics – theormodynamics preliminaries – Degenerate electron gas – Equations of state – Chandrasekhar limit – Thomas-Fermi approximation approach to white dwarf – white dwarf cooling. Neutron stars – Histroy and formation – Structure and stability – Interior – Equations of state – Maximum mass – rotating neutron stars, pulsars.
	CO3 Learn about Black Holes – Penrose-Carter diagram of Minkowski and Schwarzschild spacetime – Reissner – Nordstrom blackhole – Majumdar-Papapetrou solutions – Kerr black hole – Kerr-Newman black holes – Geodesic congruences and the Raychaudhuri equation – Hamiltonian formulation of GR – Laws of black hole mechanics.
Cosmology (PHY524)	CO1 Learn about Comological observations, The expansion of the universe,
	CO2 Learn about Spacetime geometry, Comoving coordinates, Friedmann-Roberson-Walker (FRW) metric, Proper distances, Dynamics of a photon moving in FRW background, particle and event horizons.
	CO3 Learn about cosmological redshift. Hubble's law, Luminosity distances.
	CO4 Learn about the dynamics of expansion: Einstein field equations, Friedmann equation, Critical density, Matter dominated and radiation dominated expansion.
	CO5 Learn about galaxy Rrotation curves, Indirect evidence for dark-matter, discovery of accelerated expansion. Dynamics of dark energy, consmological constant.

	CO6 Learn about the Cosmic Mircrowave Background Radiation (CMBR), The equilibrium era, recombination and last scattering, the dipole aniotropy, The Synyaev Zel'dovich effect, Primary fluctuations in CMBR, Scahs-Wolfe effect, Harrison – Zel'dovich spectrum, Doppler fluctuations, Intrinsic temperature fluctuations, Integrated Scahs – Wolfe effect.
	CO7 Learn about the thermal History of early universe, Cosmological nucleosynthesis, Baryosysthesis and Leptosynthesis, cold dark matter.
	CO8 Learn about Comic inflation: flatness, horizon, monopole problem, Slow-roll inflation, Reheating. Comological perturbation theory, Origin of large scale structure.
Two-Dimensional Conformal Field Theory (PHY528)	CO1 Learn about the Conformal Group in D> 2 dimensions, Quasi primary fields, Conformal group in D=2 dimensions, Quasi primary and primary fields, secondary fields, 2-pt, 3-pt, f-pt correlation functions.
	CO2 Learn about Conformal ward identities, Stress energy tensor and conformal invariance, Mode expansion of Stress energy tensor, Virasoro Algebra, Conformal anomalies and Central charge, Operator product expansions.
	CO3 Learn about Kac determinants and Virasoro modules, briefly mentioned the minimal models, Crossing symmetry and conformal bootstrap method.
Advanced Condensed Matter Physics (PHY527)	CO1 Learn about Electron transport — Semi-classical equations, Bloch electrons in magnetic and electric fields, Hall effect and magneto-resistance, de Haas-van Alphen effect and Fermi surface determination;
	CO2 Learn about Semiconductors — Homogeneous semiconductors: carrier density, inhomogeneous semiconductors, carrier densities in a p-n junction, rectification;
	CO3 Learn about Dielectric properties — Screening, Thomas-Fermi and Lindhard expressions for dielectric constants, local field, optical properties, ferroelectrics;
	CO4 Learn about Mean field theory of ferromagnetic and antiferromagnetic transitions — Heisenberg model, spin waves;
	CO5 Learn about Superconductivity — Persistent current, Meissner effect and critical fields – type I and II superconductors, specific heat, Electron-Phonon interaction and BCS theory, Ginzburg-Landau theory, Superconducting tunneling-Josephson effect, high temperature superconductivity – brief discussion.

Doctor of Philsophy (PhD) in Physics

PhD (Physics)

Program Outcomes

PO1. To gain a thorough a knowledge of the literature relevant to chosen field of research

PO2. To gain a comprehensive understanding of scientific methods and techniques applicable to the chosen field of research.

PO3. To be able to demonstrate originality in the application of knowledge in tackling and solving problems

PO4. To develop the ability to critically evaluate current research and research techniques and methodologies

PO5. To develop the skill to present one’s own research and also scientific writing skills.

PhD (Physics)

Program Specific Outcomes

PSO1. To develop skills in developing new theories, and in planning and conducting experiments; developing practical research skills and learning new state of the art techniques used in research.

PSO2. Understanding the foundational empirical principles of Physics, specially in respective fields of research.

PSO3. Developing capability for independent exploration of research areas by identifying appropriate problems to work on.

PhD (Physics)

Course Outcomes

Research Methodology (PHY701)	CO1 Learn basic Computer Programming in FORTRAN/C++
	CO2 Learn Plotting using GNUplot
	CO3 Learn how to use LaTeX
	CO4 Learn basic Python programming
	CO5 Learn to use Mathematica
Advanced Quantum Field Theory (PHY712)	CO1 Understand interactions in the context of quantum field theory
	CO2 Understand Bosonic and fermionic systems in QFT.
Advanced Quantum Information Theory (PHY713)	CO1 Understand quantum correlations
	CO2 Learn the basics of Cryptography
	CO3 Learn the basics of quantum algorithms
Topical Course on Atomic, Molecular and Optical Physics (PHY705)	CO1 Gain understanding of one electron atoms, Dirac's theory of one electron atom
	CO2 Gain understanding of two electron atoms: Calculation of energy levels by perturbation and variational methods Doubly excited states
	CO3 Gain understanding of many electron atoms: Hartree Fock method
	CO4 Gain understanding of angular momentum coupling: LS, JJ and Intermediate coupling schemes, Spectral terms and Hund's rule, Multiplet structure.
	CO5 Learn about Laser Beams and Resonators:
	CO6 Learn about Nonlinear Optics and Atomic Laser Spectroscopy
Advanced Topics in Atomic and Molecular Physics (PHY706)	CO1 Understand the interaction of atoms with radiation:
	CO2 Understand the basics of molecular spectroscopy:
	CO3 Understand the basics of Microwave spectroscopy:
	CO4 Understand the basics of Infrared spectroscopy:
	CO5 Understand the basics of Electronic spectra
	CO6 Understand the basics of Raman Spectroscopy:
	CO7 Study about Intensities of molecular lines
	CO8 Classification of molecular terms and phosphorescence.
	CO9 Understand the Elements of ESR, NMR, NQR and molecular spectroscopy, chemical shifts.

Advanced Methodologies and Computational Aspects for Atomic Structure Calculations (PHY707)	CO1 Learn how to use employ numerical calculations and simulations in the context of atomic structure calculation
Advanced Cosmology (PHY702)	CO1 Learn about the elements of Standard (Friedman Robertson Walker) cosmology
	CO2 Learn about Cosmological observations
	CO3 Learn about cosmic microwave background radiation and its anisotropies
	CO4 Learn about Dark Matter
	CO5 Learn about Dark Energy
	CO6 Learn the principles of Cosmological Perturbation Theory
Advanced Particle Physics (PHY703)	CO1 Understand Spontaneous Symmetry Breaking
	CO2 Understand the Higgs Mechanism
	CO3 Gain familiarity with the Standard Model of Particle Physics
Topical Course on General Relativity (PHY704)	CO1 Understand the Einstein Equation
	CO2 Gain familiarity with the metric used for isotropic and homogeneous spacetime
	CO3 Learn about Gravitational Redshift
	CO4 Learn about the Schwarzchild metric
	CO5 Learn about bending of light by a spherical star
	CO6 Learn about perihelion shift of Mercury
Renormalization in Quantum Field Theory (PHY709)	CO1 Understand standard perturbative Renormalization techniques in scalar field theory: phi-4
	CO2 Understand standard perturbative Renormalization techniques in gauge theories: QCD
Topical Course on Statistical Physics (PHY710)	CO1 Understand kinetic theory
	CO2 Understand different ensembles (micro canonical, canonical, grand-canonical)
	CO3 Understand elements of quantum statistics (Fermi, Dirac, Bose)
Topics in Conformal Field Theory (PHY711)	CO1 Understand Conformal Transformations
	CO2 Understand Operator Product Expansion
	CO3 Understand the Conformal ward identities
	CO4 Learn about 3- and 4- point correlation functions
	CO5 Understand the computation of entanglement entropy in CFT..

MSc in Computer Science

Department of Computer Science

RKMVERI, Belur Campus

Program Outcomes

Program Specific Outcomes

Course Outcomes

Program outcomes

- Inculcate critical thinking to carry out scientific investigation objectively without being biased with preconceived notions.
- Equip the student with skills to analyze problems, formulate an hypothesis, evaluate and validate results, and draw reasonable conclusions thereof.
- Prepare students for pursuing research or careers in industry in mathematical sciences and allied fields
- Imbibe effective scientific and/or technical communication in both oral and writing.
- Continue to acquire relevant knowledge and skills appropriate to professional activities and demonstrate highest standards of ethical issues in mathematical sciences.
- Create awareness to become an enlightened citizen with commitment to deliver ones responsibilities within the scope of bestowed rights and privileges.

Program Specific Outcomes

- Understanding the theoretical underpinnings in computing and computing systems.
- Knowledge of the synergy between s/w and h/w through the study of computer architecture, compilers, and systems programming.
- Knowledge about storage, organization, and manipulation of structured data.
- Knowledge and application of various algorithms, algorithmic methods, and data structures in solving computational problems drawn from various fields such computer graphics, computational geometry, distributed systems, data mining, mobile computing.
- Understanding the linkages that optimization has with machine learning, deep learning, data mining, computer vision etc.
- Knowledge of complexity classes and its appearance in algorithm design.
- Develop workable solutions for problems drawn either from social context or from research corpus.
- Develop s/w applications for handheld devices in Android.
- Use software development tools, software systems in modern computing platforms.
- Communicate computer science concepts, designs, and solutions effectively and professionally.

CS241
Design and Analysis of Algorithms

Joydeep Mukherjee joydeep.m1981@gmail.com

Course Description: This course deals with topics in design and analysis of algorithms. In particular, the course will cover different techniques of algorithm design illustrating them with several examples and also highlight some of the lower bounding techniques in algorithm design such as NP-Completeness.

Prerequisite(s): (1) High School Mathematics.
Note(s): Syllabus changes yearly and may be modified during the term itself, depending on the circumstances. However, students will be evaluated only on the basis of topics covered in the course.
Course url:
Credit Hours: 4

Text(s):

Introduction to Automata Theory, Languages, and Computation, third edition
John E. Hopcroft, Rajeev Motwani & Jeffery D. Ullman
ISBN-13: 978-8131720479

Introduction to Algorithms, third edition
Thomas H. Cormen, Charles E. Leiserson, Ronald Rivest, Clifford Stein
ISBN: 9788120340077

Algorithm Design, first edition
Eva Tardos, Jon Kleinberg
ISBN: 9789332518643

Course Objectives:

Knowledge acquired: (1) Asymptotic analysis of running time of algorithms,
(2) different techniques of algorithm design, and,
(3) polynomial time reducibility.
Skills gained: The students will be able to
(1) compare different algorithms in terms of their running time ,
(2) design algorithms for some practical problems, and,
(3) do polynomial time reductions based on knowledge gained in the class.

Course Outline (tentative) and Syllabus:

The weekly coverage might change as it depends on the progress of the class. However, you must keep up with the reading assignments. Each week assumes 4 hour lectures. Quizzes will be unannounced.

Week	Content
Week 1	• Different order notations like $O, \Theta, \Omega, o, \theta, \omega$ and compare two different functions using order notation. • Methods to calculate and state running time of algorithms using order notations.
Week 2	• Introduction of the Divide and Conquer paradigm of algorithm design. • Devising algorithms using divide and conquer for merge sort, counting inversions, finding closest pair of points in a plane, fast integer multiplication etc. • Home assignment 1
Week 3	• Fast Fourier Transform and its application. • Quiz 1
Week 4	• Introducing the concept of Dynamic Programming and use of memoization. • Devising algorithms using dynamic programming for the problems like longest increasing subsequence, edit distance, knapsack, matrix chain multiplication, independent sets in trees etc.
Week 5	• Greedy methods of algorithm design. • Studying few techniques for proving the correctness of greedy algorithm.
Week 6	• Devising greedy algorithm for various problems like minimum spanning tress, Huffman codes, Horn clauses etc. • Home assignment 2 • Quiz 2
Week 7	• Breadth First Search (BFS)in graphs. • Depth First Search (DFS) in graphs.
Week 8	• Topological sorting of a directed acyclic graph. • Finding all strongly connected components of a directed graph. • Finding articulation points,bridges and biconnected component of a graph. • Finding Eulerian tour in a Eulerian graph. • Home assignment 3
Week 9	• Union Find data structure. • Kruskal and Prim's algorithm for minimum spanning trees. • Home assignment 4
Week 10	• Algorithms for single source shortest paths in a directed graph like Bellman-Ford algorithm, Dijkstra's algorithm. • Home assignment 5 • Quiz 4
Week 11	• Few applications of Single Source Shortest Paths algorithms • Home assignment 6
Week 12	• Algorithms for all pair shortest paths. • Matrix multiplication based procedure. • Floyd-Warshall algorithm. • Johnson's algorithm for sparse graphs. • Home assignment 7 • Quiz 5
Week 13	• String Matching algorithms • Home assignment 8
Week 14	• Introduction to the concept of P, NP, NP-Completeness, • Circuit satisfiability, Boolean satisfiability
Week 15	• NP-Completeness reduction for few problems. • Review for Final Exam

CS123

Concepts of Programming Languages

Time: TBA

Place: MB212

Instructor: Dhyanagamyananda

dhyangamyananda@gmail.ac.in, swathyprabhu@gmail.com
url: http://cs.rkmvu.ac.in/šwat/
Office: MB205, Medhabhavan, RKMVERI, Belur
Office Hours: 10 pm—12 noon, 3 pm—5 pm
(+91) 033-2654 9999

Course Description: CS123 deals with analysing the relevance, benefit, and limitations of various features that have been implemented in important and widely used programming languages. It introduces the student to various programming paradigms. With C programming language as a case study, the student is introduced to the different stages in compilation, namely Lexical analysis, Semantic Analysis, and intermediate code generation.

Prerequisite(s): (1) Good working knowledge of C, and C++/Java
Note(s): Syllabus changes yearly and may be modified during the term itself, depending on the circumstances. However, students will be evaluated only on the basis of topics covered in the course.
Moodle url: http://moodle.rkmvu.ac.in/course/view.php?id=58
Credit Hours: 4

Text(s):

Principles of programming languages, third edition
Kenneth Louden

Understanding Programming Languages -ebook
M. Ben-Ari

The anatomy of programming languages
Alice. E. Fisher, & Frances. S. Grodzinsky

Compilers: Principles, Techniques, & Tools
Aho, Lam, Seith, & Ullman

Course Objectives:

Knowledge acquired: (1) Different models of computation,
(2) their associated complexity classes, and,
(3) reducibility.

Skills gained: The students will be able to

1. classify different langauges based on the programming paradigms, like imperative, functional, logic, procedural, object oriented, declarative.
2. critically analyse the programming language design criterion like readability, writeability, orthogonality, generality etc.
3. differentiate between the syntactic and semantic notions of programming languages.
4. discern the relative merit and demerit in the choice of programming language to solve a given computing problem.
5. explain equivalence checking, conversion, polymorphism for PL Data types.
6. conceptualize the PL Procedure environments, activations and allocations.
7. understand how memory is dynamically managed, and exception handling is implemented.
8. understand the differences among operational semantics, denotational semantics, and axiomatic semantics.

Grade Distribution:

Assignments	20%
Quizzes	10%
Midterm Exam	20%
Final Exam	40%

Grading Policy: There will be relative grading such that the cutoff for A grade will not be less than 75% and cutoff for F grade will not be more than 34.9%. Grade distribution will follow normal bell curve (usually, A: $\geq \mu+3\sigma/2$, B: $\mu+\sigma/2 \ldots \mu+3\sigma/2$ C: $\mu-\sigma/2 \ldots \mu+\sigma/2$, D: $\mu-3\sigma/2 \ldots \mu-\sigma/2$, and F: $< \mu-3\sigma/2$)

Approximate grade assignments:

>= 90.0	A+
75.0 – 89.9	A
60.0 – 74.9	B
50.0 – 59.9	C
about 35.0 – 49.9	D
<= 34.9	F

Course Policies:

- **General course policies, Grades, Labs and assignments, Attendance and Absences** These clauses are common to all courses. And it can be found in the program schedule.

Course Outline (tentative) and Syllabus:

The weekly coverage might change as it depends on the progress of the class. However, you must keep up with the reading assignments. Each week assumes 4 hour lectures. Quizzes will be unannounced.

Week	Content
Week 1	• Definition of programming languages, their elements, environments, and design criteria, • Reading assignment: Chapter 1,2, KL
Week 2	• Lexical structure of PL, scope of lexical analysis, tools for implementing lexical analysis. • Reading assignment: Chapter 6, KL, Ref: Ch 5 ASUL • Programming assignment 1: Building a lexical analyser for C–. • Quiz 1
Week 3	• Context free grammars, Parse trees, Abstract Syntax trees, Ambiguity, Associativity and precedence of operators. Understanding the C grammar. • Reading assignment: Chapter 6: KL, Chapter 4.2,3 ASUL, C-Grammar from KR
Week 4	• Overview of various Parsing Techinques, Top-Down parsing • Reading assignment: Chapter 2.4, 4.4 ASUL, • Programming assignment: Building a top down parser for expression grammar.
Week 5	• Bottom-up parsing: Reductions, Handle pruning, Shift-reduce parsing, handling conflicts. • Reading assignment: Chapter 4.5 ASUL • Quiz 2
Week 6	• LR Parsing: Items, LR(0) Automaton, SLR parsing tables, Viable prefixes • Reading assignment: Chapter 4.6 ASUL
Week 7	• LR(1) items, construction of LR(1) automaton, LR(1) parsing tables, LALR parsing tables. • Reading assignment: Chapter 4.7, ASUL • Quiz 3
Week 8	• Parser generator tool: Yacc/Bison • Reading Assignment: Internet resources, Ref: Bison, Shroff Publishers. • Proramming assignment: Building AST for C– using yacc/bison • Review for Midterm Exam

Week	Content
Week 9	• Syntax directed translation: Inherited and Synthesized attributes, S-attributed and L-attributed definitions • Reading assignment: Chapter 5.1,2 ASUL • Home assignment 4
Week 10	• SDT-contd: structure of a Type, postfix translation schemes, Parser-stack implementation of postfix SDT's. • Reading assignment: Chapter 5.3,4 ASUL • Home assignment 5 • Quiz 4
Week 11	• Intermediate code generation: Tranlation of expressions, Type checking • Reading assignment: Chapter 6.4,5, ASUL • Home assignment 6
Week 12	• ICG-contd: Boolean expressions, short-circuit code, flow-of-control statements, avoiding redudant gotos, boolean values, and jumping code. • Reading assignment: Chapter 6.6, ASUL • Home assignment 7 • Quiz 5
Week 13	• ICG-contd: Backpatching, switch statements, procedures. • Reading assignment: Chapter 6.7,8, ASUL • Home assignment 8
Week 14	• Types revisited: Type Constructors, Type Equivalence, Type Checking, Type Conversion, Hindley-milner Polymorphic Type Checking. • Reading assignment: Chapter 8, KL
Week 15	• Dynamic memory management • Reading assignment: Chapter 7, AB • Review for Final Exam
Week 16,17	• Logic programming: Horns clauses, resolution and unification, Prolog: a case study. • Reading assignment: Chapter 7, AB • Programming assignment:
Week 18,19	• Functional programming: A study of Haskell • Reading assignment: Programming in Haskell. • Programming assignment:

CS211
Graph algorithms and Combinatorial optimization

Instructor: Dhyanagamyananda swathyprabhu@gmail.com

Course Description: CS211 is the first course to deal with the topic of this course. This course is a mixed bag of graph algorithms. Some of these algorithms are relevant in the context of optimization. The field of graph algorithms is vast and the kind of problem studied in CS211 are those that are in general difficult to solve but has easy solutions for a sub-class of them.

Prerequisite(s): Design and Analysis of Algorithms, Data and File Structures.
Credit Hours: 4

Text(s):

Algorithm Design, PHI
Kleinberg & Targos

Introduction to Graph Theory
Douglas West

Lecture Notes from University of Waterloo

Draft on Discharging techinque by Douglas West

Course Objectives:

Knowledge acquired: .

(1) Flow networks.
(2) Planar graph theory
(3) Algorithm design and analysis

Grade Distribution:

Assignments 20%, Quizzes 10%, Midterm Exam 20%, Final Exam 40%

Course Outline (tentative) and Syllabus:

The weekly coverage might change as it depends on the progress of the class. However, you must keep up with the reading assignments. Each week assumes 4 hour lectures. Quizzes will be unannounced.

Week	Content
Week 1	• Network Flow: Definition, Basic Idea, Algorithm, Maxflow mincut theorem, Ford Fulkerson Algorithm Analysis, LP formulation of maxflow and proof. • Reading assignment: Chapter 3, KT
Week 2	• Layered Network: Definition, Theorem, Computation of blocking flow (Edmonds, Dinics, MPM) • Reading assignment: XBitmap from Wiki. • Programming assignment 1: • Quiz 1
Week 3	• Student presentation of Tarzan's algorithm
Week 4	• Bipartite matching: Definition, Application, Using Ford Fulkerson Algorithm bipartite matching is obtained in O(—V——E—) time Edge connecting problem. The augmenting path algorithm for bipartite matching. • Reading Assignment:
Week 5	• Matching for Non-Bipartite Graph: Theorem and proof (Edmonds blossom shrinking) • Reading Assignment: • Quiz 2
Week 6, 7	• Max-Cut: NP-Hard problem and its proof, 2-Approximation algorithm, Randomized algorithm for max-cut, De-randomization LP based approximation algo for maxcut • Reading assignment:
Week 8,9	• Interval Graph: Intersection graph, Perfect elimination order (PEO), Chordal graph (Triangulated Graph), Simplicial vertex, Algorithm MIS, vertex cover, coloring, clique cover for interval graph, Finding a PEO Comparability graph • Reading assignment: Waterloo Lecture Notes • Home assignment: • Quiz 3

Week	Content
Week 10,11,12	• Trees and Friends, Trees, Treewidth, Tree decomposition, Closure properties, Partial k-trees, Partial k-trees to tree decomposition, Tree decomposition to partial k-trees, Dynamic programming MIS algo for partial k-tree • Home assignment 4 • Quiz at the end of three weeks.
Week 13,14	• Perfect Graph, Definition and properties, Perfect graph theorem, Triangulated graph is a perfect graph • Home assignment 7 • Quiz 5
Week 15	• Discharging method • Reading assignment: DW on discharging • Home assignment 8

CS312
Approximation and Online Algorithms

Instructor
Prof. Subir Kumar Ghosh

Prerequisite(s): CS241: DAA

Credit Hours: 4

Text(s):

1. M. R. Garey and D. S. Johnson, Computers and Intractibility: A guide to the theory of NP-completeness, W. H. Freeman, 1979.
2. R. Motwani, Lecture Notes on Approximation Algorithms, Volume 1, No. STAN-CS-92-1435, Stanford University, 1992.
3. D. P. Williamson and D. B. Shmoys, The Design of Approximation Algorithms, Cambridge University Press, 2011.
4. Vijay Vazirani, Approximation algorithms, Springer-Verlag, 2001.
5. S. Albers, Competitive Online Algorithms, Lecture notes, Max Plank Institute, Saarbrucken, 1996.
6. S. K. Ghosh and R. Klein, Online algorithms for searching and exploration in the plane, Computer Science Review, vol. 4, pp. 189-201, 2010.

Course Outline (tentative) and Syllabus:

The weekly coverage might change as it depends on the progress of the class. However, you must keep up with the reading assignments. Each week assumes 4 hour lectures.

Approximation Algorithm:
Performance Measure, Greedy Algorithm, Unweighted Vertex Cover Problem Minumum-Degree Spanning Tree, Minimum Weight Spanning Tree, The Traveling-Salesman Problem,The k-Center Problem, Multiway Cut and K-Cut Problems, Scheduling Jobs with Deadlines on a Single Machine, Scheduling Jobs on Identical Parallel Machines, The Set Cover Problem, An Application of Set Cover to Art Gallery problems, Shortest Superstring Problem Rounding Data and Dynamic Programming, The Knapsack Problem, The Bin-Packing Problem, The Primal-Dual Method, Weighted Vertex Cover Problem

Online Algorithms:
Competitive Analysis, The Paging Problem, Amortized Analysis, List Update Problem, Scheduling Jobs on Identical Parallel Machines, Graph Colouring, Machine Learning, K-Server Problem, Target Searching in an Unbounded Region and Target Searching in Streets

DA103
Linear Algebra

Course Description: CS301 deals with topics in linear algebra. In particular, the course will cover linear equations, vector spaces, linear transformations, eigenvalues and eigenvectors, bilinear forms, introduction to linear programming and related topics.

Prerequisite(s): (1) Highschool mathematics.
Note(s): Syllabus changes yearly and may be modified during the term itself, depending on the circumstances. However, students will be evaluated only on the basis of topics covered in the course.

Credit Hours: 4

Text(s):

Linear Algebra,
K. M. Hoffmann, R. Kunze
Prentice Hall.

Algebra,
M. Artin
Prentice Hall.

Introduction to Linear Algebra,
G. Strang
Wellesley-Cambridge Press.

Linear Programming,
L. I. Gass
Tata McGraw Hills.

Linear Programming,
G. Hadley
Narosa Publishing House.

Course Objectives:

Knowledge acquired: (1) systems of linear equations, their associated matrices and their properties,
(2) characteristic polynomial, eigenvalues and eigenvectors,
(3) bilinear forms, and,
(4) linear programming.
Skills gained: The students will be able to
(1) analyze system of linear equations,
(2) solving linear recurrences, and,
(3) formulating linear programming problems and finding their feasible and optimal solutions.

Grade Distribution:

Assignments	10%
Quizzes	10%
Midterm Exam	30%
Final Exam	50%

Course Outline (tentative) and Syllabus:

The weekly coverage might change as it depends on the progress of the class. However, you must keep up with the reading assignments. Each week assumes 4 hour lectures. Quizzes will be unannounced.

Week	Content
Week 1	• Systems of linear equations, Matrices and elementary row operations, Row reduced Echelon matrices,
Week 2	• Matrix multiplication, Invertible matrices, Transpose of a matrix,
Week 3	• Systems of homogeneous equations, Equivalence of row rank and column rank of a matrix, Determinant and volume of the fundamental parallelepiped,
Week 4	• Permutation matrices, Cramers rule, • Home assignment 1
Week 5	• Vector spaces and subspaces, Bases and dimensions, Coordinates and change of bases, Direct sums, • Home assignment 2
Week 6	• The Rank-Nullity theorem, Matrix of a linear transformation, Linear operators and isomorphism of vector spaces, Determinant of a linear operator,
Week 7	• Linear functionals, Annihilators, The double dual, • Home assignment 3
Week 8	• Eigenvalues and eigenvectors of matrices, The characteristic polynomial, Algebraic and geometric multiplicities of eigenvalues,
Week 9	• Diagonalizability, Cayley-Hamilton theorem, Solving linear recurrences, • Home assignment 4
Week 10	• Matrix of a bilinear form, Symmetric and positive definite bilinear forms, Normed spaces,
Week 11	• Cauchy-Schwarz inequality and triangle inequality, Angle between two vectors, Orthogonal complement, Projection,
Week 12	• Gram-Schmidt orthogonalization, Hermitian operators, The Spectral theorem, • Home assignment 5
Week 13	• Bounded and unbounded sets, Convex functions, Convex cone, Interior points and boundary points, Extreme points or vertices,
Week 14	• Convex hulls and convex polyhedra, Supporting and separating hyperplanes, Formulating linear programming problems,
Week 15	• Feasible solutions and optimal solutions, Graphical method, The basic principle of Simplex method, Big-M method, • Home assignment 6

CS250 Database Management Systems

Instructor:

Course Description: CS250 deals with a detailed study of principles of RDBMS.

Prerequisite(s): The student must know about a typical file system, data types like integer, float, and string, basic computer arithmetic, venn diagram regpresentation of union, intersection, and complement of sets.
Note(s): Syllabus changes yearly and may be modified during the term itself, depending on the circumstances. However, students will be evaluated only on the basis of topics covered in the course.
Course url:
Credit Hours: 4

Text(s):

- H. F. Korth and A. Silberschatz: Database System Concepts, McGraw Hill, New Delhi, 1997.
- R. A. Elmasri and S. B. Navathe: Fundamentals of Database Systems, 3rd ed., Addison-Wesley, 1998.
- R. Ramakrishnan: Database Management Systems, 2nd ed., McGraw Hill, New York, 1999.
- C. J. Date, A. Kannan and S. Swamynathan, An Introduction to Database Systems, Pearson Education, Eighth Edition, 2009
- J D Ullman : Principles of Database Systems, Computer Science Press; 2nd edition (December 1982)

Course Objectives:

Knowledge acquired: At the finish of this course, students will be quite empowered and will know
(1) basic concepts of the database approach, the underlying models and organizational issues
(2) the relational database model takes a logical view of data
(3) data modelling
(4) the theoretical underpinnings of the relational database, including concepts like functional dependence, entity integrity, and relational integrity.
(5) how a flawed data model can impact relational database implementation and manipulation
(6) relational database operators, the data dictionary, and the system catalog
(7) the various relational algebra operations that provide the basis for relational database manipulation
(8) concurrency control and locking protocols.

Skills gained: The students will be able to
(1) interpret the modeling symbols for the most popular ER modeling tools.
(2) model the RDBMS schema with the help of ER models given a problem statement in English.
(3) construct queries in SQL to manipulate live RDBMS
(4) analyze database requirements and determine the entities involved in the system and their relationship to one another sophisticated database applications

Competence Developed: The student will be able to
(1) tackle the design, development, and implementation of databases in an organization.
(2) assume any role in the database design and implementation process
(3) identify computational bottlenecks in the performance of an algorithm

Course Outline (tentative) and Syllabus: The weekly coverage might change as it depends on the progress of the class. However, you must keep up with the reading assignments. Each week assumes 4 hour lectures.

1. Introduction and Conceptual Modeling Database system concepts, three-schema Architecture, data independence, database administrator, database user, Client/Server Architecture, E-R diagram, mapping constraints, Keys, Generalization, Aggregation, Reducing E-R diagram to tables.

2. Relational Model: Concepts, constraints and Languages . Structure of Relational database, Entity Integrity, Referential Integrity, Foreign Keys, Query languages, Relational algebra and relational calculus, SQL, views.

3. Database Design Theory and Methodology Functional dependencies, Closure of a set of functional dependencies, Canonical cover, closure of attribute sets, Lossless decomposition, Dependency preservation, 1 NF, 2 NF, 3 NF, BCNF, Multivalued dependencies and 4 NF, Join dependencies and 5 NF.

4. Data Storage, Indexing and Query Processing File organization, Sequential file, B+ tree index files, B-tree index file, Static hash Functions, Dynamic hash functions, Query processing and Query optimization.

5. Transaction Processing Concepts Transaction, Properties of transaction, database recovery, shadow paging, recoverable schedule, serializable schedule; Concurrency control: Lock-Based protocol, Timestamp-Based protocol, Multiple granularity, Multiversion schemes; Deadlock Handling.

6. Database Security Discretionary access control, Mandatory access control and multi-level security, statistical database security, Introduction to flow control, Encription and public key infrastructures, privacy issues and preservation.

DA220 Machine Learning

Instructor: **Tanmay Basu**

Course Description: DA220 deals with topics in supervised and unsupervised learning methodologies. In particular, the course will cover different advanced models of data classification and clustering techniques, their merits and limitations, different use cases and applications of these methods. Moreover, different advanced unsupervised and supervised feature engineering schemes to improve the performance of the learning techniques will be discussed.

Prerequisite(s): (1) Linear Algebra and (2) Probability and Stochastic processes
Credit Hours: 4

Text(s):

Introduction to Machine Learning E. Alpaydin ISBN: 978-0262-32573-8
The Elements of Statistical Learning J. H. Friedman, R. Tibshirani, and T. Hastie ISBN: 978-0387-84884-6
Pattern Recognition S. Theodoridis and K. Koutroumbas ISBN: 0-12-685875-6
Pattern Classification R. O. Duda, P. E. Hart and D. G. Stork ISBN: 978-0-471-05669-0
Introduction to Information Retrieval C. D. Manning, P. Raghavan and H. Schutze ISBN: 978-0-521-86571-5

Course Objectives:

Knowledge Acquired:

1) The background and working principles of various supervised learning techniques viz., linear regression, logistic regression, bayes and naive bayes classifiers, support vector machine etc. and their applications.
2) The importance of cross validation to optimize the parameters of a classifier.
3) The idea of different kinds of clustering techniques e.g., k-means, k-medoid, single-linkage, DBSCAN algorithms and their merits and demerits.
4) The significance of feature engineering to improve the performance of the learning techniques and overview of various supervised and unsupervised feature engineering techniques.
5) The essence of different methods e.g., precision, recall etc. to evaluate the performance of the machine learning techniques.

Skills Gained: The students will be able to

1) pre-process and analyze the characteristics of different types of standard data,
2) work on scikit-learn, a standard machine learning library,
3) evaluate the performance of different machine learning techniques for a particular application and validate the significance of the results obtained.

Competence Developed:

1) Build skills to implement different classification and clustering techniques as per requirement to extract valuable information from any type of data set.
2) Can train a classifier on an unknown data set to optimize its performance
3) Develop novel solutions to identify significant features in data e.g., identify the feedback of potential buyers over online markets to increase the popularity of different products.

Evaluation:

Assignments 50% Midterm Exam 25% Endterm Exam 25%

Course Outline (tentative) and Syllabus:

The weekly coverage might change as it depends on the progress of the class. However, you must keep up with the reading assignments. Each week assumes 4 hour lectures.

Week	Contents
Week 1	• Overview of machine learning: idea of supervised and unsupervised learning, regression vs classification, concept of training and test set, classification vs clustering and significance of feature engineering • Linear regression: least square and least mean square methods
Week 2	• Bayes decision rule: bayes theorem, bayes classifier and error rate of bayes classifier • Minimum distance classifier and linear discriminant function as derived from Bayes decision rule
Week 3	• Naive bayes classifier: gaussian model, multinomial model, bernoulli model • k-Nearest Neighbor (kNN) decision rule: idea of kNN classifier, distance weighted kNN decision rule and other variations of kNN decision rule
Week 4	• Perceptron learning algorithm: incremental and batch version, proof of convergence • XOR problem, two layer perceptrons to resolve XOR problem, introduction to multilayer perceptrons
Week 5	• Discussion on different aspects of linear discriminant functions for data classification • Logistic regression and maximum margin classifier
Week 6	• Support vector machine (SVM): hard margin • Soft margin SVM classifier
Week 7	• Cross validation and parameter tuning • Different techniques to evaluate the classifiers e.g., precision, recall and f-measure
Week 8	• The basics to work with Scikit-learn: a machine learning repository in python • How to implement different classifiers in scikit-learn, tune the parameters and evaluate the performance
Week 9	• Text classification(case study for data classification): overview of text data, stemming and stopword removal, tf-idf weighting scheme and n-gram approach. • How to work with text data in scikit-learn
Week 10	• Assignment 2: Evaluate the performance of different classifiers to classify a newswire e.g., Reuters-21578. • Review for midterm exam • Data clustering: overview, cluster validity index
Week 11	• Partitional clustering methods: k-means, bisecting k-means • k-medoid, buckshot clustering techniques
Week 12	• Hierarchical clustering techniques: single linkage, average linkage and group average hierarchical clustering algorithms • Density based clustering technique e.g., DBSCAN
Week 13	• Feature engineering: overview of feature selection, supervised and unsupervised feature selection techniques • Overview of principal component analysis for feature extraction
Week 14	• How to work with Wordnet, an English lexical database • Sentiment analysis (case study for data clustering): overview, description of a data set of interest for sentiment identification, sentiment analysis using Wordnet
Week 15	• Assignment 2: Sentiment analysis from short message texts • Practice class for the second assignment • Review for endterm exam

Syllabus for the Computer Architecture Course

Class.no	Course Materials to be taught
1	Fundamental Concepts and ISA The von Neumann Model Von Neumann vs Dataflow ISA vs. Microarchitecture
2	ISA Tradeoffs -I
3	ISA Tradeoffs -II
4	Intro to Microarchitecture: Single-Cycle
5	Multi-Cycle and Microprogrammed Microarchitectures
6	Pipelining
7	Introduction to Verilog
8	LAB
9	Branch Prediction I
10	Introduction to TEJAS simulatorr
11	LAB
12	Branch Prediction II
13	Out-of-Order Execution
14	Memory Hierarchy and Caches
15	High Performance Caches
16	Virtual Memory

- Few Homework and Lab assignment are also included.
- Few topics after *pipelining* are very intense , so it may be that if students are not very comfortable ,due to limited class and time , we may trim down the syllabus.

CS301

Theory of Computation

Time: Wed & Fri (12 noon—2 pm)
Place: MB215

Sarvottamananda

sarvottamananda@rkmvu.ac.in, sarvottamananda@gmail.com
url: http://cs.rkmvu.ac.in/šarvottamananda/
Office: MB115, Medhabhavan, RKMVERI, Belur
Office Hours: 11 pm—12 noon, 4 pm—5 pm
(+91) 98740 94516

Course Description: CS301 deals with topics in computability theory and computational complexity. In particular, the course will cover different models of computation, their associated complexity classes, undecidability, intractability, space and time complexity classes, oracle turing machines, circuit complexity, and related topics.

Prerequisite(s): (1) Discrete Mathematics and (2) Automata Theory.
Note(s): Syllabus changes yearly and may be modified during the term itself, depending on the circumstances. However, students will be evaluated only on the basis of topics covered in the course.
Course url: http://cs.rkmvu.ac.in/courses/cs301/
Credit Hours: 4

Text(s):

Introduction to Automata Theory, Languages, and Computation, third edition
John E. Hopcroft, Rajeev Motwani & Jeffery D. Ullman
ISBN-13: 978-8131720479

Introduction to the Theory of Computation, second edition
Michael Sipser
ISBN-10: 81-315-0162-0

Computational Complexity: A Modern Approach, first edition
Sanjeev Arora & Boaz Barak
ISBN-13: 978-0-521-42426-4

Course Objectives:

Knowledge acquired: (1) Different models of computation,
(2) their associated complexity classes, and,
(3) reducibility.
Skills gained: The students will be able to
(1) analyze the complexity classes of problems closely related to those discussed in the class,
(2) analyze intractability and undecidability of some practical problems, and,
(3) do reductions based on knowledge gained in the class.

Grade Distribution:

Assignments	20%
Quizzes	20%
Midterm Exam	20%
Final Exam	40%

Grading Policy: There will be relative grading such that the cutoff for A grade will not be less than 75% and cutoff for F grade will not be more than 34.9%. Grade distribution will follow normal bell curve (usually, A: $\geq \mu + 3\sigma/2$, B: $\mu + \sigma/2 \ldots \mu + 3\sigma/2$ C: $\mu - \sigma/2 \ldots \mu + \sigma/2$, D: $\mu - 3\sigma/2 \ldots \mu - \sigma/2$, and F: $< \mu - 3\sigma/2$)

Approximate grade assignments:

>= 90.0	A+
75.0 – 89.9	A
60.0 – 74.9	B
50.0 – 59.9	C
about 35.0 – 49.9	D
<= 34.9	F

Course Policies:

- **General**

  1. Computing devices are not to be used during any exams unless instructed to do so.
  2. Quizzes and exams are closed books and closed notes.
  3. Quizzes are unannounced but they are frequently held after a topic has been covered.
  4. **No makeup quizzes or exams will be given.**

- **Grades**

  Grades in the **C** range represent performance that **meets expectations**; Grades in the **B** range represent performance that is **substantially better** than the expectations; Grades in the **A** range represent work that is **excellent**.

- **Labs and Assignments**

  1. Students are expected to work independently. **Offering** and **accepting** solutions from others is an act of dishonesty and students can be penalized according to the *Academic Honesty Policy*. Discussion amongst students is encouraged, but when in doubt, direct your questions to the professor, tutor, or lab assistant. Many students find it helpful to consult their peers while doing assignments. This practice is legitimate and to be expected. However, it is not acceptable practice to pool thoughts and produce common answers. To avoid this situation, it is suggested that students not write anything down during such talks, but keep mental notes for later development of their own.
  2. **No late assignments will be accepted under any circumstances**.

- **Attendance and Absences**

  1. Attendance is expected and will be taken each class. Students are not supposed to miss class without prior notice/permission. Any absences may result in point and/or grade deductions.
  2. Students are responsible for all missed work, regardless of the reason for absence. It is also the absentee's responsibility to get all missing notes or materials.

Course Outline (tentative) and Syllabus:

The weekly coverage might change as it depends on the progress of the class. However, you must keep up with the reading assignments. Each week assumes 4 hour lectures. Quizzes will be unannounced.

Week	Content
Week 1	• Finite Automata: Basic definitions, equivalence of finite automata, mille and muller automata, definition and acceptance criteria of timed and hybrid automata • Reading assignment: Chapter 2, HMU
Week 2	• Regular Expressions and Languages: definition of regular expressions and regular languages, relationship with finite automata, regulation expression algebra • Reading assignment: Chapter 3, HMU • Home assignment 1 • Quiz 1
Week 3	• Properties of Regular Languages: Pumping lemma for regular languages, Myhill-Nerode theorem and minimization of finite automata, closure properties of regular languages, decision problems and algorithms for regular languages • Reading assignment: Chapter 4: HMU
Week 4	• Context Free Grammar and Languages: Definition of context free grammars and context free languages, parse trees, ambiguity in grammars and inherent ambiguity in languages, context sensitive languages • Reading assignment: Chapter 5, HMU
Week 5	• Pushdown Automata: Definition of pushdown automata, languages of pushdown automata, equivalence of pushdown automata and context free grammars, deterministic pushdown automata and its language class • Reading assignment: Chapter 6, HMU • Home assignment 2 • Quiz 2
Week 6	• Properties of Context Free Languages: Normal forms, pumping lemma for context free languages, closure properties of context free languages, decision properties of context free languages • Reading assignment: Chapter 7, HMU
Week 7	• Turing Machines: Halting problem, definition of Turing machines, its extensions, restrictions and their equivalences, linear bounded automata and its relationship with context sensitive languages • Reading assignment: Chapter 8, HMU • Home assignment 3 • Quiz 3
Week 8	• Undecidability and Intractability: class of recursive languages and recursively enumerable languages, non recursively enumerable diagonalization language L_d, undecidable recursively enumerable language L_u, Rice's theorem, Post's correspondence problem, reductions, classes P and NP, NP-complete problem 3SAT • Reading Assignment: Chapter 9 & 10, HMU • Review for Midterm Exam

Week	Content
Week 9	• Computational Model for space and time complexity classes: Defining Turing Machine model, efficiency and running time, machine representation, universal turing machine, efficient simulation of universal turing machine, class P • Reading assignment: Chapter 1, AB • Home assignment 4
Week 10	• NP and NP-completeness: Definition of class NP, reducibility, NP-completeness, Cook-Levin theorem, web of reductions, definitions of coNP, EXP, and NEXP • Reading assignment: Chapter 2, AB • Home assignment 5 • Quiz 4
Week 11	• Diagonalization: Time hierarchy theorem, nondeterministic time hierarchy theorem, Ladner's theorem, oracle machines and limits of diagonalization, Baker-Gill-Solovay theorem • Reading assignment: Chapter 3, AB • Home assignment 6
Week 12	• Space complexity: Space hierarchy thorems, class PSPACE, PSPACE-completeness, class NL and coNL, NL-completeness, NL=coNL, Savitch'e theorem • Reading assignment: Chapter 4, AB • Home assignment 7 • Quiz 5
Week 13	• Polynomial Hierarchy and Alternations: Class Σ_2^p, polynomial hierarchy, class PH, alternating Turing machines • Reading assignment: Chapter 5, AB • Home assignment 8
Week 14	• Boolean Circuits: Boolean circuits, class $P_{/poly}$, uniformly generated circuits, Turing machines with advice, circuit lower bounds, nonuniform hierarchy theorem, circuits of exponential size • Reading assignment: Chapter 6, AB
Week 15	• Randomized Computation: Probabilistic Turing machines, classes RP, coRP, ZPP, BPP, relationships between BPP and other classes, randomized reductions, randomized space bound computations • Reading assignment: Chapter 7, AB • Review for Final Exam

CS220

Data and File Structures

Course Description: This course introduces the study of internal and external data structures and algorithms with an on-going emphasis on the application of software engineering principles. Trees, graphs and the basic algorithms for creating, manipulating and using them will be covered. Various types of hash and indexed random access file structures will be discussed and implemented. B-trees and external file sorting will be introduced. Internal and external data/file organizations and algorithms will be compared and analyzed.

Prerequisite(s): (1) Programming in C/C++/JAVA/Python.
Note(s): Syllabus changes yearly and may be modified during the term itself, depending on the circumstances. However, students will be evaluated only on the basis of topics covered in the course.
Credit Hours: 4

Text(s): *Data Structures and Algorithms in JAVA*
Michael T. Goodrich, Roberto Tamassia, and Michael H. Goldwasser

Fundamentals of Data structures
Horowitz, E., and Sahni.S:

File Structures in C++
Folk & Zoellick & Riccardi

Data structures and algorithm analysis in C
Mark Allen Weiss

Course Objectives: Having completed this course successfully, the student should:

1. Be familiar with the use of data structures as the foundational base for computer solutions to problems.
2. Become introduced to and investigate the differing logical relationships among various data items.
3. Understand the generic principles of computer programming as applied to sophisticated data structures.
4. Comprehend alternative implementations using the differing logical relationships and appreciate the significance of choosing a particular logical relationship for implementation within real-world setting.
5. Demonstrate the ability to plan, design, execute and document sophisticated technical programs to handle various sorts of data structures.
6. become introduced the most important high-level file structures tools which include indexing, co-sequential processing, B trees, Hashing.

7. know the techniques for organization and manipulation of data in secondary storage including the low level aspects of file manipulation which include basic file operations, secondary storage devices and system software.

Course Outline (tentative) and Syllabus:
The weekly coverage might change as it depends on the progress of the class. Each week assumes 4 hour lectures.

Week	Content
Week 1	• Introduction to algorithm analysis: pseudo code, algorithm efficiency, asymptotic and empirical analysis of algorithms.
Week 2	• Introduction to data structures. Linear data structures: arrays, stacks, queues, linked lists (operations, implementations, applications.)
Week 3	• Non-linear data structures: binary trees and general trees (operations, implementations and applications). Binary search trees.
Week 4	• Priority queues and heaps: using a heap to implement a priority queue. Heap sort.
Week 5	• Balanced search trees: AVL trees
Week 6	• (2,4) and red-black trees.
Week 7	• B-trees and B^+ trees
Week 8	• Amortized Analysis, Splay tree
Week 9	• Hashing, Hash fucntions and collision resolution techniques -linear probing
Week 10	• Hashing and collision resolution techniques - quadratic probing, Double hashing
Week 11	• Graphs and elementary Graph operations - Breadth First Search, Depth First Search
Week 12	• Spanning Trees, Shortest paths
Week 13	• File Structure: Concepts of fields, records and files, Sequential, Indexed and Relative/Random File Organization
Week 14	• Indexing structure for index files, hashing for direct files
Week 15	• Multi-Key file organization and access methods.

CS 244 : Introduction to Optimization Techniques

Course Overview: The process of making optimal judgement according to various criteria is known as the science of decision making. A mathematical programming problem, also known as an optimization problem, is a special class of problem where we are concerned with the optimal use of limited resources to meet some desired objective(s). Mathematical models (simulation based and/or analytical based) are used in providing guidelines for making effective decisions under constraints. This course covers three major analytical topics in mathematical programming [linear, nonlinear and integer programming]. On each topic, the theory and modeling aspects are discussed first, and subsequently solution techniques or algorithms are covered.

Prerequisite(s): Linear Algebra
Credit Hours: 4
Course Objectives: Optimization techniques are used in various fields like machine learning, graph theory, VLSI design and complex networks. In all these applications/fields, mathematical programming theory supplies the notion of optimal solution via the optimality conditions, and mathematical programming algorithms provide tools for training and/or solving large scale models. Students will have knowledge of theory and applications of several classes of math programs.

Text(s): The course material will be drawn from multiple book chapters, journal articles, reviewed tutorials etc. However, the following two books are recommended texts for this course.

- *Linear programming and Network Flows*, Wiley-Blackwell; 4th Edition, 2010
  M. S. Bazaraa, John J. Jarvis and Hanif D. Sheral, **ISBN-13:** 978-0470462720
- *Nonlinear Programming: Theory and Algorithms*, Wiley-Blackwell; 3rd Edition (2006)
  M. S. Bazaraa, Hanif D. Sherali, C. M. Shetty, **ISBN-13:** 978-0471486008

Course Policies:

- **Grades**

  Grades in the **C** range represent performance that **meets expectations**; Grades in the **B** range represent performance that is **substantially better** than the expectations; Grades in the **A** range represent work that is **excellent**.

- **Assignments**

  1. Students are expected to work independently. Discussion amongst students is encouraged but offering and accepting solutions from others is an act of dishonesty and students can be penalized according to the *Academic Honesty Policy*.
  2. **No late assignments will be accepted under any circumstances**.

- **Attendance and Absence**

  Students are not supposed to miss class without prior notice/permission. Students are responsible for all missed work, regardless of the reason for absence. It is also the absentee's responsibility to get all missing notes or materials.

Grade Distribution:

Assignments	40%
Midterm Exam	20%
Final Exam	40%

Grading Policy: *Approximate grade assignments:*

>= 90.0 %	A+
75.0 – 89.9 %	A
60.0 – 74.9 %	B
50.0 – 59.9 %	C
about 35.0 – 49.9 %	D
<= 34.9%	F

Table 1: **Topics Covered**

Mathematical Preliminaries

- Theory of Sets and Functions,
- Vctor spaces,
- Matrices and Determinants,
- Convex sets and convex cones,
- Convex and concave functions,
- Generalized concavity

Linear Programming

- The (Conventional) Linear Programming Model
- The Simplex Method: Tableau And Computation
- Special Simplex Method And Implementations
- Duality And Sensitivity Analysis

Integer Programming

- Formulating Integer Programing Problems
- Solving Integer Programs (Branch-and-Bound Enumeration, Implicit Enumeration, Cutting Plane Methods)

Nonlinear Programming: Theory

- Constrained Optimization Problem (equality and inequality constraints)
- Necessary and Suffiecent conditions
- Constraint Qualification
- Lanrangian Duality and Saddle Point Optimality Criteria

Nonlinear Programming: Algorithms

- The concept of Algorithm
- Algorithms for Uconstrained Optimization
- Constraint Qualification
- Algorithms for Constrained Optimization (Penalty Function, Barrier Function, Feasible Direction)

Special Topics (if time permits)

- Semi-definite and Semi-infinte Programs
- Quadratic Programming
- Linear Fractional programming
- Separable Programming

DA230
Enabling Technologies for Big Data Computing

Instructor

Sudeep Mallick, Ph.D.
Sudeep.mallick@gmail.com

Course Description:

DA230 deals with technologies and engineering solutions for enabling big data processing and analytics . More specifically, it deals with the tools for data processing, data management and programming in the distributed programming paradigm using techniques of MapReduce programming, NoSQL distributed databases, streaming data processing, data injestion, graph processing and distributed machine learning for big data use cases.

Prerequisite(s): (1) Basic knowledge of python and Java programming languages (2) Tabular data processing / SQL queries. (3) Basic knowledge of common machine learning algorithms.
Credit Hours: 4

Text(s):

Hadoop: The Definitive Guide, fourth edition
Tom White
ISBN: 978-1-491-90163-2

Hadoop in Action, edition: 2011
Chuck Lam
ISBN: 978-1-935-18219-1

Spark in Action, edition: 2017
Petar Zecevic & Marko Bonaci
ISBN: 978-93-5119-948-9

Data-Intensive Text Processing with MapReduce, edition: 2010
Jimmy Lin & Chris Dyer
ISBN: 978-1-608-45342-9

Course Outline (tentative) and Syllabus:

The weekly coverage might change as it depends on the progress of the class. Each week assumes 4 hour lectures.

Week	Content
Week 1	• Big data computing paradigm and Hadoop: big data, hadoop architecture • Reading assignment: Chapter 1, LD & Chapter 1, TW • Lab: setting up Hadoop platform in standalone mode
Week 2	• Hadoop MapReduce (MR): Lab session with simple MR algorithms in Hadoop standalone mode • Reading assignment: Chapter 2, LD & Chapter 2, TW
Week 3	• Hadoop Distributed File System (HDFS), YARN and MR architecture, daemons, serialization concept, command line parameters: Lab session • Reading assignment: Chapter 3-5 & 7, TW
Week 4	• Implementing algorithms in MR - joins, sort, text processing, etc.: Lab session • Reading assignment: Chapter 3, LD & Chapter 7, TW • Lab assignment 1
Week 5	• Hadoop operations in Cluster Mode, Hadoop on AWS Cloud: Lab session • Reading assignment: Instructor notes
Week 6	• Understanding NoSQL using Pig: Lab Session • Reading assignment: Chapter 16, TW • Lab assignment 2
Week 7	• Introduction to Apache Spark platform and architecture, RDD, • Reading assignment: Chapters 1-3, ZB
Week 8	• Mapping, joining, sorting, grouping data with Spark RDD: Lab session • Reading assignment: Chapter 4, ZB • Review for Mid term exam
Week 9	• Advanced usage of Spark API: Lab session • Reading assignment: Chapter 4, ZB • Lab assignment 3
Week 10	• NoSQL queries using Spark DataFrame and Spark SQL: Lab session • Reading assignment: Chapter 5, ZB
Week 11	• Using SQL Commands with Spark: Lab session • Reading assignment: Chapter 5, ZB
Week 12	• Machine Learning using Spark MLib: Lab session • Reading assignment: Chapter 7, ZB
Week 13	• Machine Learning using Spark ML: Lab session • Reading assignment: Chapter 8, ZB • Lab assignment 4
Week 14	• Spark operations in Cluster Mode, Spark on AWS Cloud: Lab session • Reading assignment: Chapter 11, ZB
Week 15	• Graph processing with Spark GraphX: Lab session • Reading assignment: Chapter 9, ZB

DA104 Probability and Stochastic Processes

Instructor

Dr. Arijit Chakraborty (ISI Kolkata)

Course Description:

DA104 deals with technologies and engineering solutions for enabling big data processing and analytics . More specifically, it deals with the tools for data processing, data management and programming in the distributed programming paradigm using techniques of MapReduce programming, NoSQL distributed databases, streaming data processing, data injestion, graph processing and distributed machine learning for big data use cases.

Prerequisite(s): (1) Basic knowledge of python and Java programming languages (2) Tabular data processing / SQL queries. (3) Basic knowledge of common machine learning algorithms.
Credit Hours: 4

Text(s):

1. Introduction to time series analysis; PJ Brockwell and RA Davis
2. Time Series Analysis and Its Applications; Robert H. Shumway and David S. Stoffer
3. Introduction to Statistical time series; WA Fuller
4. A first course in Probability, Sheldon Ross, Pearson Education, 2010
5. Time Series Analysis; Wilfredo Palma
6. P. G. Hoel, S. C. Port and C. J. Stone: Introduction to Probability Theory, University Book Stall/Houghton Mifflin, New Delhi/New York, 1998/1971.

Syllabus

1. Basic Probability

a. Introduction
b. Sample Spaces
c. Probability Measures
d. Computing Probabilities: Counting Methods
   i. The Multiplication Principle
   ii. Permutations and Combinations
e. Conditional Probability
f. Independence

2. Random Variables

a. Discrete Random Variables
   i. Bernoulli Random Variables
   ii. The Binomial Distribution
   iii. Geometric and Negative Binomial Distributions
   iv. The Hypergeometric Distribution
   v. The Poisson Distribution
b. Continuous Random Variables

i. The Exponential Density
ii. The Gamma Density
iii. The Normal Distribution
iv. The Beta Density

c. Functions of a Random Variable

3. Joint Distributions

a. Introduction
b. Discrete Random Variables
c. Continuous Random Variables
d. Independent Random Variables
e. Conditional Distributions
i. The Discrete Case
ii. The Continuous Case
f. Functions of Jointly Distributed Random Variables
i. Sums and Quotients
ii. The General Case

4. Expected Values

a. The Expected Value of a Random Variable
i. Expectations of Functions of Random Variables
ii. Expectation of Linear Combinations of Random Variables
b. Variance and Standard Deviation
c. Covariance and Correlation
d. Conditional Expectation
e. Definitions and Examples
f. The Moment-Generating Function

5. Limit Theorems

a. Introduction
b. The Law of Large Numbers
c. Convergence in Distribution and the Central Limit Theorem

6. Stochastic Process

a. Markov chain
i. State transition matrix
ii. Hitting time
iii. Different States
b. Poisson process

CS211
Combinatorial optimization and Graph Algorithms

Instructor: Dhyanagamyananda swathyprabhu@gmail.com

Course Description: CS211 is the first course to deal with the topic of this course. This course is a mixed bag of graph algorithms. Some of these algorithms are relevant in the context of optimization. The field of graph algorithms is vast and the kind of problem studied in CS211 are those that are in general difficult to solve but has easy solutions for a sub-class of them.

Prerequisite(s): Design and Analysis of Algorithms, Data and File Structures.
Credit Hours: 4

Text(s):

Algorithm Design, PHI
Kleinberg & Targos

Introduction to Graph Theory
Douglas West

Lecture Notes from University of Waterloo

Draft on Discharging techinque by Douglas West

Course Outcome:

Knowledge gained: At the end of the course the student will know about
(1) flow networks
(2) the theory of various graph classes like planar graphs, perfect graphs, comparability graphs, etc
(3) algorithm design and analysis related to coloring, matching, perfectness, shortest distance, spanning trees etc.
(4) linear optimization in graph problems
(5) structural properties of graphs

Skills acquired: The students will be able to
(1) perform graph modelling for computing parameters in real life problems
(2) encode graphs in the programming context
(3) apply techniques like discharging method in analysis of planar graphs
(4) graph programming using native python libraries, and specialized sagemath tool.
(5) apply dynamic pogramming in solving specific graph problems

Competence developed: The student will be able to.
(1) read and understand research contributions in the field of structural graph theory and ask pertinent questions
(2) work on research problems related to graph algorithms, and structural graph theory

Grade Distribution:

Assignments 20%, Quizzes 10%, Midterm Exam 20%, Final Exam 40%

Course Outline (tentative) and Syllabus:

The weekly coverage might change as it depends on the progress of the class. However, you must keep up with the reading assignments. Each week assumes 4 hour lectures. Quizzes will be unannounced.

Week	Content
Week 1	• Network Flow: Definition, Basic Idea, Algorithm, Maxflow mincut theorem, Ford Fulkerson Algorithm Analysis, LP formulation of maxflow and proof. • Reading assignment: Chapter 3, KT
Week 2	• Layered Network: Definition, Theorem, Computation of blocking flow (Edmonds, Dinics, MPM) • Reading assignment: XBitmap from Wiki. • Programming assignment 1: • Quiz 1
Week 3	• Student presentation of Tarzan's algorithm
Week 4	• Bipartite matching: Definition, Application, Using Ford Fulkerson Algorithm bipartite matching is obtained in O(—V——E—) time Edge connecting problem. The augmenting path algorithm for bipartite matching. • Reading Assignment:
Week 5	• Matching for Non-Bipartite Graph: Theorem and proof (Edmonds blossom shrinking) • Reading Assignment: • Quiz 2
Week 6, 7	• Max-Cut: NP-Hard problem and its proof, 2-Approximation algorithm, Randomized algorithm for max-cut, De-randomization LP based approximation algo for maxcut • Reading assignment:
Week 8,9	• Interval Graph: Intersection graph, Perfect elimination order (PEO), Chordal graph (Triangulated Graph), Simplicial vertex, Algorithm MIS, vertex cover, coloring, clique cover for interval graph, Finding a PEO Comparability graph • Reading assignment: Waterloo Lecture Notes • Home assignment: • Quiz 3

Week	Content
Week 10,11,12	• Trees and Friends, Trees, Treewidth, Tree decomposition, Closure properties, Partial k-trees, Partial k-trees to tree decomposition, Tree decomposition to partial k-trees, Dynamic programming MIS algo for partial k-tree • Home assignment 4 • Quiz at the end of three weeks.
Week 13,14	• Perfect Graph, Definition and properties, Perfect graph theorem, Triangulated graph is a perfect graph • Home assignment 7 • Quiz 5
Week 15	• Discharging method • Reading assignment: DW on discharging • Home assignment 8

CS214 Applied Computer Graphics

Session: 2017-2018, Semester-II

Instructor: **Sarvottamananda**

Course Description: The course CS214—*Applied Computer Graphics* aims to teach modern OpenGL programming fundamentals to students. We mainly stress on 3D programming including modeling, lighting, shadow, animationa techniques. This course also teaches how to make use of modern hardware to efficiently render 3D scenes.

Prerequisite(s): Introduction to Computer Graphics, Linear Algebra, C++/C Programming
Note(s): Syllabus changes yearly and may be modified during the term itself, depending on the circumstances. However, students will be evaluated only on the basis of topics covered in the course.
Course url: `http://cs.rkmvu.ac.in/cs214`
Credit: 4 (four), approximately 60 credit hours

Text(s):

Computer Graphics with OpenGL by Donald Hearn and M Pauline Baker, third edition

Computer Graphics: Principles and Practice by John F Hughes, Andries Van Dam, Morgan Mcguire, David F Sklar, James D Foley, Steven K Feiner, and Kurt Akeley, third edition

Learn OpenGL: An offline transcript of learnopengl.com Joey de Vries, web resource, Jan 2018

Learning Modern 3D Graphics Programming by Jason L. McKesson, web resource, Jan 2018

OpenGL Programming Guide — the red book by John Kessenich Graham Sellers and Dave Shreiner, ninth edition

The OpenGL Graphics System: A specification (v4.5) — the blue book by Mark Segal and Kurt Akeley

Course Objectives:

Knowledge acquired :

- OpenGL graphics pipeline for different versions
- Concepts of 3D programming
- Mathematical foundations of 3D computer graphics
- Lighting and shadow models
- Ray tracing method
- Theory of animation

Skills gained :

- 3D models with loading, saving and display in OpenGL
- 3D Lights, creation and manupulation
- 3D Shadows modeling
- Rendering of 3D environments
- Basic 3D animation
- Basic 3D effects

General Competence :

- Present the solution to a defined computer graphics problem orally, and answer question about the solution
- Read and integrate academic material from various online sources
- Improved software development skills
- Learning version control and static code analysis
- Improvement in asking quality questions

Other goals : Understanding basic GPU hardware

Course Grading Policy: There will be flexi-relative grading such that the cutoff for 'A' grade will not be less than 75% and cutoff for 'F' grade will not be more than 34.9%. Grade distribution will follow the normal bell curve.

Approximate grade assignments:

>= 90.0	A+	$\geq \mu + 2\sigma$
75.0 – 89.9	A	$\mu + \sigma \ldots \mu + 2\sigma$
60.0 – 74.9	B	$\mu \ldots \mu + \sigma$
50.0 – 59.9	C	$\mu - \sigma \ldots \mu$
about 35.0 – 49.9	D	$\mu - 2\sigma \ldots \mu - \sigma$
<= 34.9	F	$< \mu - 2\sigma$

Approximate weightage of different components in evaluation:

Assignments (8)	20%
Quizzes (6)	20%
Midterm Exam	20%
Final Exam	40%

Course Policies:

- **General**

  1. Computing devices are not to be used during any exams unless instructed to do so.
  2. Quizzes and exams are closed books and closed notes.
  3. Quizzes are unannounced but they are frequently held after a topic has been covered.
  4. **No makeup quizzes or exams will be given.**

- **Grades**

  Grades in the **C** range represent performance that **meets expectations**; Grades in the **B** range represent performance that is **substantially better** than the expectations; Grades in the **A** range represent work that is **excellent**.

- **Labs and Assignments**

  1. Students are expected to work independently. **Offering** and **accepting** solutions from others is an act of dishonesty and students can be penalized according to the *Academic Honesty Policy*. Discussion amongst students is encouraged, but when in doubt, direct your questions to the professor, tutor, or lab assistant. Many students find it helpful to consult their peers while doing assignments. This practice is legitimate and to be expected. However, it is not acceptable practice to pool thoughts and produce common answers. To avoid this situation, it is suggested that students not write anything down during such talks, but keep mental notes for later development of their own.
  2. **No late assignments will be accepted under any circumstances**.

Course Outline (tentative) and Syllabus:

The weekly coverage might change as it depends on the progress of the class. However, you must keep up with the reading assignments. Each week assumes 4 lecture hours. Quizzes will be unannounced, so students should maintain close to 100% attendance.

Week	Content
Week 1	• Introduction to OpenGL • Reading assignment: Introductions in all references
Week 2	• OpenGL pipeline 1.x, 2.x, 3.x and 4.x, specifications and differences • Reading assignment: Chapter 1, redbook • Home assignment 1 • Quiz 1
Week 3	• Vertex and Fragment Shaders, fundamentals and basic programming Analysis of a simple beginner OpenGL 4.x program • Reading assignment: Chapter 2 & Chapter 3 of LO
Week 4	• OpenGL data representation Data structures for graphics • Reading assignment: Chapter 2, blue book
Week 5	• Mathematics for 3D computer graphics Transformations • Reading assignment: Relevant chapters in CG w/OpenGL • Home assignment 2 • Quiz 2
Week 6	• Model, view and projection matrices local space, world space, view space and clip space • Reading assignment: Chapter 8,9 LO
Week 7	• Textures, storing and using • Reading assignment: Chapter 7, LO • Home assignment 3 • Quiz 3
Week 8	• Basic color theory, physical, physiological and psychological explanations of color perception • Reading Assignment: Relevant Chapters of CG w/OpenGL • Review for Midterm Exam

Week	Content
Week 9	• Basic lighting and materials point lights, spot lights, directional light • Reading assignment: Chapter 13,14 LO • Home assignment 4
Week 10	• Shadows mapping, techniques and approximations • Reading assignment: Chapter 35, LO • Home assignment 5 • Quiz 4
Week 11	• Cubemaps, usage and programming • Reading assignment: Chapter 27, LO • Home assignment 6
Week 12	• Basic animation, data structures and programming • Reading assignment: Chapter 4, AB • Home assignment 7 • Quiz 5
Week 13	• Geometry Shaders • Reading assignment: Chapter 30, LO • Home assignment 8
Week 14	• Tessalation Shaders • Reading assignment: Chapter 9, redbook
Week 15	• Compute Shaders • Reading assignment: Chapter 12, redbook • Review for Final Exam

CS229 Programming Handheld Devices

Instructor: **Sudeep Mallick**

Course Description: CS128 is the first course in design and programming of handheld devices using Android technology platform covering the essential components of the Android platform. The course enables students to develop and publish apps developed with Java/Kotlin based language using Android Studio IDE and Android programming API from Google following Android platform best practices. It enables appreciation of the architecture of the android platform and various enabling components for web access, data persistence, multi-threading, UI management among others

Prerequisite(s): (1) Basic knowledge of Java programming language or any other programming language (2) Software analysis and design concepts.
Credit Hours: 4

Text(s):

1. Head First: Android Development, first edition (2015) Dawn Griffiths & David Griffiths
2. Android Programming: The Big Nerd Ranch Guide, edition: 2013 Bill Phillips & Brian Hanrdy ISBN: 10-0321804333
3. Android Developer `https://developer.android.com/`
4. Android Studio `https://developer.android.com/studio/`
5. Android Developer Fundamentals `https://developers.google.com/training/courses/android-fundamentals`
6. Android Developer Guide `https://developer.android.com/guide/`
7. Documentation for App Developers `https://developer.android.com/docs/`

Course Objectives:

Knowledge gained: At the finish of the course the student will know

1) Architecture of a typical mobile app using MVC architectural pattern.
2) Architecture of the Android platform.
3) App development using Android platform APIs and Android platform best practices for app development software lifecycle.
4) Android component life cycle management and navigation styles.
5) Importance of the concept of fragments, layouts, inter-component communication, taskbars, menus, navigation drawers

Skills acquired: The students will be able to

1) design and build app components, layouts, and navigation structure based on given set of application features (requirements).
2) build useful Android applications like location-based app, map-based app, content management app, multimedia app, web based and social media app along with rich user interfaces by utilizing existing or custom Android Views and layouts.
3) take advantage of Android background services, AsyncTask, SQLite database, Preferences, content providers and notifications.
4) implement object oriented design patterns, and architectural patterns.
5) Implement an app by going through software development lifecycle of analysis, design, implementation, integration and testing.

6) build their own Android apps and deploy in Google Playstore.
7) Ability to design and develop user interface (UI) using Android development best practices

Competence developed: The student develop the

1. Ability to transform an idea of an app to an implemented code base using Android platform by following an engineering approach.
2. Ability to take advantage of latest, advanced features of android platform such as location service, maps, broadcasting, material design and such others.

Evaluation: Midterm Lab Exam 20% Term Project 40% Endterm Theory Exam 40%

Course Outline (tentative) and Syllabus:

Week 1	Getting started - introduction to Android Studio; Android Project structure; App basics; creating the First Basic App and using Emulator and device; Android MVC - using MVC for building app
Week 2	Activities and Lifecycle
Week 3	Communication among activities and Intents
Week 4	Android UI Fragments
Week 5	UI Fragment design best practices
Week 6	Android Lists and Adapters- RecyclerView, ListView, etc.
Week 7	Android Layouts and Widgets
Week 8	Managing master-detail interfaces, Navigation Drawers Review for mid-term exam
Week 9	ViewPager
Week 10	Dialogs and Fragments
Week 11	Toolbar and Action Bars
Week 12	SQLite Databases, Cursors and Asynctasks
Week 13	Implicit Intents, background Tasks and background Services
Week 14	HTTP tasks Review for end-term exam
Week 15	Project Presentations

CS323 Discrete Event Systems

Instructor:

Course Description: A discrete event system is a mathematical model of a system (such as computational device) that communicates with its environment by atomic actions (called events). For example, a user of the system pressing a button could send a signal to a controller. These events are assumed to be discrete in the sense that they occur instantaneously (as opposed to over a period of time). The module will present an overview of various modelling and analysis techniques for discrete event systems. We start by looking at sequential systems (where no two events can occur simultaneously). Systems of this kind will be modelled by finite automata. This class is then extended to allow for events occurring simultaneously; these are modelled by Petri nets. Subsequently, we will study techniques that allow us to extract quantitative information about the behaviour of systems. This gives rise to the class of probabilistic systems (where we assume that a certain event occurs with a given probability) and we can then estimate the likelihood of situations such as system failure. Included in this section is an introduction to queuing theory.

Prerequisite(s): CS200 Automata theory.
Note(s): Syllabus changes yearly and may be modified during the term itself, depending on the circumstances. However, students will be evaluated only on the basis of topics covered in the course.
Course url:
Credit Hours: 4

Text(s):

- Introduction to Discrete Event Systems , Christos G.Cassandras, Stphane Lafortune

Course Objectives:

Knowledge acquired: At the finish of this course, students will know how to employ some basic formalisms of behavioural modelling (such as automata and Petri nets) to model real world examples;
Skills gained: The students will be able to apply mathematical formalisms to model and analyse event driven systems

Course Outline (tentative) and Syllabus: The weekly coverage might change as it depends on the progress of the class. However, you must keep up with the reading assignments.

1. Systems and Models, Supervisory Control, Petri Nets, Timed Automata.
2. Systems and Control basics, Goal of system theory, Feedback control with supervisors, Control with partial controllability, Non-blocking control, Control with modular specifications, Control with partial observation, Decentralized control, Basics-Analysis-and-control of Petri Nets, Comparison of Petri Nets with automata, Timed Automata.

CS301 Computational Complexity

Instructor:

Course Description: CS250 deals with a detailed study of principles of RDBMS.

Prerequisite(s): CS300: Theory of NP-Completeness, CS200: Theory of Computation
Note(s): Syllabus changes yearly and may be modified during the term itself, depending on the circumstances. However, students will be evaluated only on the basis of topics covered in the course.
Course url:
Credit Hours: 4

Text(s):

- Computational Complexity: A Modern Approach by Sanjeeve Arora and Boaz Barak
- Computational Complexity by Papadimitrou

Course Objectives:

Knowledge acquired: At the finish of this course, students will be quite empowered and will know
Skills gained: The students will be able to
Competence Developed:

Course Outline (tentative) and Syllabus: The weekly coverage might change as it depends on the progress of the class. However, you must keep up with the reading assignments.

1. Basic resources for computation (time, space, nondeterminism) and their associated complexity classes (P, NP, PSPACE and more).
2. Relationships among resources (P versus NP, time versus space, and more.
3. Reductions and completeness (NP completeness, PSPACE completeness, and more.
4. Counting problems,$\tilde{\#}$P. Randomness as a computational resource; associated complexity classes.
5. Nonuniform models of computation; circuit complexity; lower bounds.
6. Communication complexity.
7. Interactive proofs & IP=PSPACE.
8. Probabilistically checkable proofs (PCP) and inapproximability.

MSc in Big Data Analytics

Department of Computer Science

RKMVERI, Belur Campus

Program Outcomes

Program Specific Outcomes

Course Outcomes

Program outcomes

- Inculcate critical thinking to carry out scientific investigation objectively without being biased with preconceived notions.
- Equip the student with skills to analyze problems, formulate an hypothesis, evaluate and validate results, and draw reasonable conclusions thereof.
- Prepare students for pursuing research or careers in industry in mathematical sciences and allied fields
- Imbibe effective scientific and/or technical communication in both oral and writing.
- Continue to acquire relevant knowledge and skills appropriate to professional activities and demonstrate highest standards of ethical issues in mathematical sciences.
- Create awareness to become an enlightened citizen with commitment to deliver ones responsibilities within the scope of bestowed rights and privileges.

Program Specific Outcomes

- Basic understanding of statistical methods, probability, mathematical foundations, and computing methods relevant to data analytics.
- Knowledge about storage, organization, and manipulation of structured data.
- Understand the challenges associated with big data computing.
- Training in contemporary big data technologies
- Understanding about the analytics chain beginning with problem identification and translation, followed by model building and validation with the aim of knowledge discovery in the given domain.
- Applying dimensionality reduction techniques in finding patterns/features/factors in big data.
- Estimation of various statistics from stored and/or streaming data in the iterative process of model selection and model building.
- Future event prediction associated with a degree of uncertainty.
- Modelling optimization techniques such as linear programming, non-linear programming, transportation techniques in various problem domains such as marketing and supply chain management.
- Interpret analytical models to make better business decisions.

DA102
Basic Statistics

Time: TBA
Place: IH402 & Bhaskara Lab

Dr. Sudipta Das

jusudipta@gmail.com
Office: IH404, Prajnabhavan, RKMVERI, Belur
Office Hours: 11 pm—12 noon, 3 pm—4 pm
(+91) 99039 73750

Course Description: DA102 is going to provide an introduction to some basic statistical methods for analysis of categorical and continuous data. Students will also learn to make practical use of the statistical computer package R.

Prerequisite(s): NA
Note(s): Syllabus changes yearly and may be modified during the term itself, depending on the circumstances. However, students will be evaluated only on the basis of topics covered in the course.
Course url:
Credit Hours: 4

Text(s):

Statistics;
David Freedman, Pobert Pisani and Roger Purves

The visual display of Quantitative Information;
Edward Tufte

Mathematical Statistics with Applications;
Kandethody M. Ramachandran and ChrisP.Tsokos

Course Objectives:

Knowledge acquired: Students will get to know
(1) fundamental statistical concepts and some of their basic applications in real world.
(2) organizing, managing, and presenting data,
(3) how to use a wide variety of specific statistical methods, and,
(4) computer programming in R.

Skills gained: The students will be able to
(1) apply technologies in organizing different types of data,
(2) present results effectively by making appropriate displays, summaries, and tables of data,
(3) perform simple statistical analyses using R
(4) analyze the data and come up with correct interpretations and relevant conclusions.

Course Outline (tentative) and Syllabus:

The weekly coverage might change as it depends on the progress of the class. However, you must keep up with the reading assignments. Each week assumes 4 hour lectures. Quizzes will be unannounced.

Week	Content
Week 1	Introduction, Types of Data, Data Collection, Introduction to R, R fundamentals, Arithmetic with R
Week 2	Tabular Representation: Frequency Tables, Numerical Data Handling, Vectors, Matrices, Categorical Data Handling
Week 3	Data frames, Lists, R programming, Conditionals and Control Flow, Loops, Functions
Week 4	Graphical Representation: Bar diagram, Pie-chart, Histogram, Data Visualization in R, Basis R graphics, Different plot types, Plot customizations
Week 5	Descriptive Numerical Measures:- Measures of Central Tendency, Measures of Variability, Measure of Skewness, Kurtosis Quiz 1
Week 6	Descriptive Statistics using R:- Exploring Categorical Data, Exploring Numerical Data
Week 7	Numerical Summaries, Box and Whiskers Plot
Week 8	Problem Session, Review for Midterm exam
Week 9	Concept of sample and population, Empirical distribution, Fitting probability distribution
Week 10	Goodness of fit, Distribution fitting in R
Week 11	Analysis of bivariate data:- Correlation, Scatter plot Representing bivariate data in R
Week 12	Simple linear regression
Week 13	Linear Regression in R Quiz 2
Week 14	Two-way contingency tables, Measures of association, Testing for dependence
Week 15	Problem Session, Review for Final Exam

DA321 Modeling for Operations Management

Instructor

Sudeep Mallick, Ph.D.
Sudeep.mallick@gmail.com

Course Description:

DA321 deals with the topics in modelling techniques for accomplishing operations management tasks for business. In particular, the course will cover advanced techniques of operations research and modelling along with their applications in various business domains with a special focus on supply chain management and supply chain analytics.

Prerequisite(s): Basic course in Operations Research covering Linear Programming fundamentals.
Credit Hours: 4

Text(s):

Operations Research, seventh revised edition (2014)
P K Gupta and D S Hira
ISBN: 81-219-0218-9

Introduction to Operations Research, eighth edition
Frederick S. Hillier & Gerald J. Lieberman
ISBN: 0-07-252744-7

Operations Research: An Introduction, ninth edition
Hamdy A. Taha
ISBN: 978-93-325-1822-3

AMPL: A Modeling Language for Mathematical Programming, second Edition
www.ampl.com

Course Objectives:

Knowledge acquired:

1. Different operations research modelling techniques.
2. Application of the modelling techniques in business domains.
3. Hands-on implementation of the models using computer software such as MS-EXCEL, CPLEX solvers.

Skills acquired: Students will be able to

1. apply the appropriate operations research technique to formulate mathematical models of the business problem
2. implement and evaluate alternative models of the problem in computer software

Grade Distribution:

Assignments 20%, Internal Test 20%, Mid-term exam 30%, Final exam 30%

Course Outline (tentative) and Syllabus:

Week	Content
Week 1	• Advanced Linear Programming: Duality theory, Dual Simplex method • Reading assignment: Chapter 6, GH / Chapter 4, HT
Week 2	• Lab session on Linear Programming and Sensitivity Analysis with AMPL (CPLEX solver) • Lab assignment 1, Reading assignment: AMPL manual
Week 3	• Supply chain management modelling: supply chain management definition, modelling, production planning decisions • Reading assignment: Instructor notes
Week 4	• Lab session on modelling aggregate planning problems
Week 5	• Transportation problem: transportation model, solution techniques, variations. • Reading assignment: Chapter 3, GH / Chapter 5, HT • Transportation problem Lab sessions • Lab instructions: Instructor notes
Week 6	• Multi-stage transportation problem: formulation, solution techniques, truck allocation problem, Traveling Salesman Problem, vehicle routing problem • Reading assignment: Instructor notes • Internal test 1
Week 7	• Assignment problem: assignment, solution techniques • Reading assignment: Chapter 4, GH / Chapter 5. HT • Lab assignment 2
Week 8	• Integer programming: problem formulation and solution techniques • Reading assignment: Chapter 6, GH / Chapter 9, HT • Review for Midterm Exam
Week 9	• Non-linear Programming: problem formulation and solution techniques • Reading assignment: Chapter 16, GH / Chapter 21, HT • Lab assignment 3
Week 10	• Inventory management: deterministic inventory models, cycle inventory models • Reading assignment: Chapter 12, GH / Chapter 13, HT • Internal test 2
Week 11	• Inventory management: stochastic inventory models, safety stock models • Reading assignment: Chapter 12, GH / Chapter 13, HT • Lab session: Inventory management modeling • Reading assignment: Instructor notes
Week 12	• Lab Session: Supply chain management beer game
Week 13	• Queueing theory: pure birth and death models • Reading assignment: Chapter 10, GH / Chapter 18, HT • Reading assignment: Chapter 10, GH / Chapter 18, HT
Week 14	• Queueing theory: general poisson model, specialised poisson queues • Lab session: queueing theory • Reading assignment: Chapter 10, GH / Chapter 18, HT • Lab assignment 4
Week 15	• Queueing theory: queueing decision models • Reading assignment: Chapter 10, GH / Chapter 18, HT

DA205 Data Mining

Instructor: **Prof. Aditya Bagchi**

Course Description: The quantity and variety of online data is increasing very rapidly. The data mining process includes data selection and cleaning, machine learning techniques to "learn" knowledge that is "hidden" in data, and the reporting and visualization of the resulting knowledge. This course will cover these issues.

Prerequisite(s): First course in DBMS,
Credit Hours: 2

Text(s):

- Data Mining Concepts and techniques, J. Han and M. Kamber, Morgan Kaufmann.
- Mining of Massive datasets, A. Rajaraman, J. Leskovec, J.D. Ullman
- Mining the WEB, S. Chakrabarti, Morgan Kaufmann.

Course Objectives:

Knowledge acquired: At the finish of this course, students will be quite empowered and will know
(1) standard data mining problems and associated algorithms.
(2) how to apply and implement standard algorithms in similar problem.

Competence Developed: The student will be able to
(1) Understand a data environment, extract relevant features and identify necessary algorithms for required analysis.
(2) Accumulation, extraction and analysis of Social network data.

Course Outline (tentative) and Syllabus: The weekly coverage might change as it depends on the progress of the class. However, you must keep up with the reading assignments. Each week assumes 4 hour lectures.

1. Introduction to Data Mining concept, Data Cleaning, transformation, reduction and summarization. (1 lecture = 2 hours)
2. Data Integration - Multi and federated database design, Data Warehouse concept and architecture. (2 lectures = 4 hours)
3. Online Analytical Processing and Data Cube. (2 lectures =4 Hours)
4. Mining frequent patterns and association of items, Apriori algorithm with fixed and variable support, improvements over Apriori method - Hash-based method, Transaction reduction method, Partitioning technique, Dynamic itemset counting method. (2 Lectures = 4 Hours)
5. Frequent Pattern growth and generation of FP-tree, Mining closed itemsets. (1 Lecture = 2 Hours)
6. Multilevel Association rule, Association rules with constraints, discretization of data and association rule clustering system. (1 Lecture = 2 Hours)
7. Association mining to Correlation analysis. (1 Lecture = 2 Hours)
8. Mining time-series and sequence data. (2 Lectures = 4 Hours)
9. Finding similar items and functions for distance measures. (4 Lectures = 8 Hours)
10. Recommendation system, content based and collaborative filtering methods. (5 Lectures = 10 Hours)
11. Graph mining and social network analysis. (5 Lectures = 10 Hours)

DA220 Machine Learning

Instructor: **Tanmay Basu**

Course Description: DA220 deals with topics in supervised and unsupervised learning methodologies. In particular, the course will cover different advanced models of data classification and clustering techniques, their merits and limitations, different use cases and applications of these methods. Moreover, different advanced unsupervised and supervised feature engineering schemes to improve the performance of the learning techniques will be discussed.

Prerequisite(s): (1) Linear Algebra and (2) Probability and Stochastic processes
Credit Hours: 4

Text(s):

Introduction to Machine Learning E. Alpaydin ISBN: 978-0262-32573-8
The Elements of Statistical Learning J. H. Friedman, R. Tibshirani, and T. Hastie ISBN: 978-0387-84884-6
Pattern Recognition S. Theodoridis and K. Koutroumbas ISBN: 0-12-685875-6
Pattern Classification R. O. Duda, P. E. Hart and D. G. Stork ISBN: 978-0-471-05669-0
Introduction to Information Retrieval C. D. Manning, P. Raghavan and H. Schutze ISBN: 978-0-521-86571-5

Course Objectives:

Knowledge Acquired:

1) The background and working principles of various supervised learning techniques viz., linear regression, logistic regression, bayes and naive bayes classifiers, support vector machine etc. and their applications.
2) The importance of cross validation to optimize the parameters of a classifier.
3) The idea of different kinds of clustering techniques e.g., k-means, k-medoid, single-linkage, DBSCAN algorithms and their merits and demerits.
4) The significance of feature engineering to improve the performance of the learning techniques and overview of various supervised and unsupervised feature engineering techniques.
5) The essence of different methods e.g., precision, recall etc. to evaluate the performance of the machine learning techniques.

Skills Gained: The students will be able to

1) pre-process and analyze the characteristics of different types of standard data,
2) work on scikit-learn, a standard machine learning library,
3) evaluate the performance of different machine learning techniques for a particular application and validate the significance of the results obtained.

Competence Developed:

1) Build skills to implement different classification and clustering techniques as per requirement to extract valuable information from any type of data set.
2) Can train a classifier on an unknown data set to optimize its performance
3) Develop novel solutions to identify significant features in data e.g., identify the feedback of potential buyers over online markets to increase the popularity of different products.

Evaluation:

Assignments 50% Midterm Exam 25% Endterm Exam 25%

Course Outline (tentative) and Syllabus:

The weekly coverage might change as it depends on the progress of the class. However, you must keep up with the reading assignments. Each week assumes 4 hour lectures.

Week	Contents
Week 1	• Overview of machine learning: idea of supervised and unsupervised learning, regression vs classification, concept of training and test set, classification vs clustering and significance of feature engineering • Linear regression: least square and least mean square methods
Week 2	• Bayes decision rule: bayes theorem, bayes classifier and error rate of bayes classifier • Minimum distance classifier and linear discriminant function as derived from Bayes decision rule
Week 3	• Naive bayes classifier: gaussian model, multinomial model, bernoulli model • k-Nearest Neighbor (kNN) decision rule: idea of kNN classifier, distance weighted kNN decision rule and other variations of kNN decision rule
Week 4	• Perceptron learning algorithm: incremental and batch version, proof of convergence • XOR problem, two layer perceptrons to resolve XOR problem, introduction to multilayer perceptrons
Week 5	• Discussion on different aspects of linear discriminant functions for data classification • Logistic regression and maximum margin classifier
Week 6	• Support vector machine (SVM): hard margin • Soft margin SVM classifier
Week 7	• Cross validation and parameter tuning • Different techniques to evaluate the classifiers e.g., precision, recall and f-measure
Week 8	• The basics to work with Scikit-learn: a machine learning repository in python • How to implement different classifiers in scikit-learn, tune the parameters and evaluate the performance
Week 9	• Text classification(case study for data classification): overview of text data, stemming and stopword removal, tf-idf weighting scheme and n-gram approach. • How to work with text data in scikit-learn
Week 10	• Assignment 2: Evaluate the performance of different classifiers to classify a newswire e.g., Reuters-21578. • Review for midterm exam • Data clustering: overview, cluster validity index
Week 11	• Partitional clustering methods: k-means, bisecting k-means • k-medoid, buckshot clustering techniques
Week 12	• Hierarchical clustering techniques: single linkage, average linkage and group average hierarchical clustering algorithms • Density based clustering technique e.g., DBSCAN
Week 13	• Feature engineering: overview of feature selection, supervised and unsupervised feature selection techniques • Overview of principal component analysis for feature extraction
Week 14	• How to work with Wordnet, an English lexical database • Sentiment analysis (case study for data clustering): overview, description of a data set of interest for sentiment identification, sentiment analysis using Wordnet
Week 15	• Assignment 2: Sentiment analysis from short message texts • Practice class for the second assignment • Review for endterm exam

DA104 Probability and Stochastic Processes

Instructor

Dr. Arijit Chakraborty (ISI Kolkata)

Course Description:

DA104 deals with technologies and engineering solutions for enabling big data processing and analytics . More specifically, it deals with the tools for data processing, data management and programming in the distributed programming paradigm using techniques of MapReduce programming, NoSQL distributed databases, streaming data processing, data injestion, graph processing and distributed machine learning for big data use cases.

Prerequisite(s): (1) Basic knowledge of python and Java programming languages (2) Tabular data processing / SQL queries. (3) Basic knowledge of common machine learning algorithms.
Credit Hours: 4

Text(s):

1. Introduction to time series analysis; PJ Brockwell and RA Davis
2. Time Series Analysis and Its Applications; Robert H. Shumway and David S. Stoffer
3. Introduction to Statistical time series; WA Fuller
4. A first course in Probability, Sheldon Ross, Pearson Education, 2010
5. Time Series Analysis; Wilfredo Palma
6. P. G. Hoel, S. C. Port and C. J. Stone: Introduction to Probability Theory, University Book Stall/Houghton Mifflin, New Delhi/New York, 1998/1971.

Syllabus

1. Basic Probability

a. Introduction
b. Sample Spaces
c. Probability Measures
d. Computing Probabilities: Counting Methods
   i. The Multiplication Principle
   ii. Permutations and Combinations
e. Conditional Probability
f. Independence

2. Random Variables

a. Discrete Random Variables
   i. Bernoulli Random Variables
   ii. The Binomial Distribution
   iii. Geometric and Negative Binomial Distributions
   iv. The Hypergeometric Distribution
   v. The Poisson Distribution
b. Continuous Random Variables

i. The Exponential Density
ii. The Gamma Density
iii. The Normal Distribution
iv. The Beta Density

c. Functions of a Random Variable

3. Joint Distributions

a. Introduction
b. Discrete Random Variables
c. Continuous Random Variables
d. Independent Random Variables
e. Conditional Distributions
i. The Discrete Case
ii. The Continuous Case
f. Functions of Jointly Distributed Random Variables
i. Sums and Quotients
ii. The General Case

4. Expected Values

a. The Expected Value of a Random Variable
i. Expectations of Functions of Random Variables
ii. Expectation of Linear Combinations of Random Variables
b. Variance and Standard Deviation
c. Covariance and Correlation
d. Conditional Expectation
e. Definitions and Examples
f. The Moment-Generating Function

5. Limit Theorems

a. Introduction
b. The Law of Large Numbers
c. Convergence in Distribution and the Central Limit Theorem

6. Stochastic Process

a. Markov chain
i. State transition matrix
ii. Hitting time
iii. Different States
b. Poisson process

DA230
Enabling Technologies for Big Data Computing

Instructor

Sudeep Mallick, Ph.D.
Sudeep.mallick@gmail.com

Course Description:

DA230 deals with technologies and engineering solutions for enabling big data processing and analytics . More specifically, it deals with the tools for data processing, data management and programming in the distributed programming paradigm using techniques of MapReduce programming, NoSQL distributed databases, streaming data processing, data injestion, graph processing and distributed machine learning for big data use cases.

Prerequisite(s): (1) Basic knowledge of python and Java programming languages (2) Tabular data processing / SQL queries. (3) Basic knowledge of common machine learning algorithms.
Credit Hours: 4

Text(s):

Hadoop: The Definitive Guide, fourth edition
Tom White
ISBN: 978-1-491-90163-2

Hadoop in Action, edition: 2011
Chuck Lam
ISBN: 978-1-935-18219-1

Spark in Action, edition: 2017
Petar Zecevic & Marko Bonaci
ISBN: 978-93-5119-948-9

Data-Intensive Text Processing with MapReduce, edition: 2010
Jimmy Lin & Chris Dyer
ISBN: 978-1-608-45342-9

Course Outline (tentative) and Syllabus:

The weekly coverage might change as it depends on the progress of the class. Each week assumes 4 hour lectures.

Week	Content
Week 1	• Big data computing paradigm and Hadoop: big data, hadoop architecture • Reading assignment: Chapter 1, LD & Chapter 1, TW • Lab: setting up Hadoop platform in standalone mode
Week 2	• Hadoop MapReduce (MR): Lab session with simple MR algorithms in Hadoop standalone mode • Reading assignment: Chapter 2, LD & Chapter 2, TW
Week 3	• Hadoop Distributed File System (HDFS), YARN and MR architecture, daemons, serialization concept, command line parameters: Lab session • Reading assignment: Chapter 3-5 & 7, TW
Week 4	• Implementing algorithms in MR - joins, sort, text processing, etc.: Lab session • Reading assignment: Chapter 3, LD & Chapter 7, TW • Lab assignment 1
Week 5	• Hadoop operations in Cluster Mode, Hadoop on AWS Cloud: Lab session • Reading assignment: Instructor notes
Week 6	• Understanding NoSQL using Pig: Lab Session • Reading assignment: Chapter 16, TW • Lab assignment 2
Week 7	• Introduction to Apache Spark platform and architecture, RDD, • Reading assignment: Chapters 1-3, ZB
Week 8	• Mapping, joining, sorting, grouping data with Spark RDD: Lab session • Reading assignment: Chapter 4, ZB • Review for Mid term exam
Week 9	• Advanced usage of Spark API: Lab session • Reading assignment: Chapter 4, ZB • Lab assignment 3
Week 10	• NoSQL queries using Spark DataFrame and Spark SQL: Lab session • Reading assignment: Chapter 5, ZB
Week 11	• Using SQL Commands with Spark: Lab session • Reading assignment: Chapter 5, ZB
Week 12	• Machine Learning using Spark MLib: Lab session • Reading assignment: Chapter 7, ZB
Week 13	• Machine Learning using Spark ML: Lab session • Reading assignment: Chapter 8, ZB • Lab assignment 4
Week 14	• Spark operations in Cluster Mode, Spark on AWS Cloud: Lab session • Reading assignment: Chapter 11, ZB
Week 15	• Graph processing with Spark GraphX: Lab session • Reading assignment: Chapter 9, ZB

DA210
Advanced Statistics

Time: TBA
Place: IH402 & Bhaskara Lab

Instructor: TBA

Course Description: DA*** introduce the conceptual foundations of statistical methods and how to apply them to address more advanced statistical question. The goal of the course is to teach students how one can effectively use data and statistical methods to make evidence based business decisions. Statistical analyses will be performed using R and Excel.

Prerequisite(s): NA
Note(s): Syllabus changes yearly and may be modified during the term itself, depending on the circumstances. However, students will be evaluated only on the basis of topics covered in the course.
Course url:
Credit Hours: 4

Text(s):

Statistical Inference;
P. J. Bickel and K. A. Docksum

Introduction to Linear Regression Analysis;
Douglas C. Montgomery

Course Objectives:

Knowledge acquired: Students will get to know
(1) advance statistical concepts and some of their basic applications in real world,
(2) the appropriate statistical analysis technique for a business problem,
(3) the appropriateness of statistical analyses, results, and inferences , and,
(4) advance data analysis in R.

Skills gained: The students will be able to
(1) use data to make evidence based decisions that are technically perfect,
(2) communicate the purposes of the data analyses,
(3) interpret the findings from the data analysis, and the implications of those findings,
(4) implement the statistical method using R and Excel.

Course Outline (tentative) and Syllabus:

The weekly coverage might change as it depends on the progress of the class. However, you must keep up with the reading assignments. Each week assumes 4 hour lectures. Quizzes will be unannounced.

Week	Content
Week 1	Point Estimation, Method of moments, Likelihood function, Maximum likelihood equations, Unbiased estimator
Week 2	Mean square error, Minimum variance unbiased estimator, Consistent estimator, Efficiency
Week 3	Uniformly minimum variance unbiased estimator, Efficient estimator, Sufficient estimator, Jointly sufficient Minimal sufficient statistic
Week 4	Interval Estimation, Large Sample Confidence Intervals: One Sample Case
Week 5	Small Sample Confidence Intervals for μ, Confidence Interval for the Population Variance, Confidence Interval Concerning Two Population Parameters
Week 6	Type of Hypotheses, Two types of errors, The level of significance, The p-value or attained significance level,
Week 7	The NeymanPearson Lemma, Likelihood Ratio Tests, Parametric tests for equality of means and variances.
Week 8	Problem Session, Review for Midterm exam
Week 9	Linear Model, Gauss Markov Model
Week 10	Inferences on the Least-Squares Estimators
Week 11	Analysis of variance.
Week 12	Multiple linear regressionn Matrix Notation for Linear Regression
Week 13	Regression Diagnostics, Forward, backward and stepwise regression,
Week 14	Logistic Regression.
Week 15	Problem Session, Review for Final Exam

DA330
Advanced Machine Learning

Tanmay Basu

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Course Description: DA330 deals with topics in supervised and unsupervised learning methodologies. In particular, the course will cover different advanced models of data classification and clustering techniques, their merits and limitations, different use cases and applications of these methods. Moreover, different advanced unsupervised and supervised feature engineering schemes to improve the performance of the learning techniques will be discussed.

Prerequisite(s): (1) Machine Learning, (2) Linear Algebra and (3) Basic Statistics.
Note(s): Syllabus changes yearly and may be modified during the term itself, depending on the circumstances. However, students will be evaluated only on the basis of topics covered in the course.
Course URL:
Credit Hours: 4

Text(s):

Introduction to Machine Learning
E. Alpaydin
ISBN: 978-0262-32573-8

The Elements of Statistical Learning
J. H. Friedman, R. Tibshirani, and T. Hastie
ISBN: 978-0387-84884-6

Neural Networks and Learning Machines
S. Haykin
ISBN: 978-0-13-14713-99

Deep Learning
I. Goodfellow, Y. Bengio and A. Courville
ISBN: 978-0262-03561-3

Pattern Recognition and Machine Learning
C. M. Bishop
ISBN: 978-0387-31073-2

Probabilistic Graphical Models: Principles and Techniques
D. Koller and N. Friedman
ISBN: 978-0262-01319-2

Introduction to Information Retrieval
C. D. Manning, P. Raghavan and H. Schutze
ISBN: 978-0-521-86571-5

Course Objectives:

Knowledge acquired: (1) Different advanced models of learning techniques,
(2) their merits and limitations, and,
(3) applications.
Skills gained: The students will be able to
(1) analyze complex characteristics of different types of data,
(2) knowledge discovery from high dimensional and large volume of data efficiently, and,
(3) creating advanced machine learning tools for data analysis.

Grade Distribution:

Assignments 50%, Midterm Exam 20%, Endterm Exam 30%

Course Outline (tentative) and Syllabus:

The weekly coverage might change as it depends on the progress of the class. However, you must keep up with the reading assignments. Each week assumes 4 hour lectures.

Week	Contents
Week 1	• Overview of machine learning: concept of supervised and unsupervised learning • Decision tree classification: C4.5 algorithm
Week 2	• Random forest classifier • Discussion on overfitting of data. Boosting and bagging techniques
Week 3	• Non linear support vector machine (SVM): Method and Applications • Detailed discussion on SVM using kernels
Week 4	• Neural network: overview, XOR problem, two layer perceptrons • Architecture of multilayer feedforward network
Week 5	• Backpropagation algorithm for multilayer neural networks • Neural network using radial basis function: method and applications
Week 6	• Design and analysis of recurrent neural networks • Deep learning: a case study
Week 7	• Assignment 1: design of efficient neural networks for large and complex data of interest • Overview of data clustering and expectation maximization method
Week 8	• Spectral clustering method • Non negative matrix factorization for data clustering • Review for midterm exam
Week 9	• Fuzzy c-means clustering technique • Overview of recommender systems
Week 10	• Different types of recommender systems and their applications • Probabilistic graphical model: an overview
Week 11	• Learning in Bayesian networks • Markov random fields
Week 12	• Hidden markov model: methods and applications • Temporal data mining
Week 13	• Conditional random fields (CRF) • Overview of named entity recognition (NER) in text: A case study
Week 14	• Named entity recognition: Inherent vs contextual features, rule based method • Rule based text mining using regular expressions
Week 15	• Gazetteer based and CRF based method for NER • Assignment 2: Automatic de-identification of protected information from clinical notes • Review for endterm exam

Ramakrishna Mission Vivekananda Educational and Research Institute
Syllabus for Linear Algebra I
Prepared by: Dr. Soumya Bhattacharya

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1 Linear equations

- Systems of linear equations
- Matrices and elementary row operations
- Row reduced Echelon matrices
- Matrix multiplication
- Invertible matrices
- Transpose of a matrix
- Systems of homogeneous equations
- Equivalence of row rank and column rank of a matrix
- Determinant and volume of the fundamental parallelepiped
- Permutation matrices
- Cramer's rule

2 Vector spaces

- Vector spaces and subspaces
- Bases and dimensions
- Coordinates and change of bases
- Direct sums

3 Linear transformations

- The Rank-Nullity theorem
- Matrix of a linear transformation
- Linear operators and isomorphism of vector spaces
- Determinant of a linear operator
- Linear functionals
- Annihilators
- The double dual

4 Eigenvalues and eigenvectors

- Eigenvalues and eigenvectors of matrices
- The characteristic polynomial
- Algebraic and geometric multiplicities of eigenvalues
- Diagonalizability
- Cayley-Hamilton theorem
- Solving linear recurrences

5 Bilinear forms

- Matrix of a bilinear form
- Symmetric and positive definite bilinear forms
- Normed spaces
- Cauchy-Schwarz inequality and triangle inequality
- Angle between two vectors
- Orthogonal complement
- Projection
- Gram-Schmidt orthogonalization
- Hermitian operators
- The Spectral theorem

6 Introduction to linear programming

- Bounded and unbounded sets
- Convex functions
- Convex cone
- Interior points and boundary points
- Extreme points or vertices
- Convex hulls and convex polyhedra
- Supporting and separating hyperplanes
- Formulating linear programming problems
- Feasible solutions and optimal solutions
- Graphical method
- The basic principle of Simplex method
- Big-M method

Reference books

1. M. Artin, *Algebra*, Prentice Hall.
2. K. M. Hoffmann, R. Kunze, *Linear Algebra*, Prentice Hall.
3. G. Strang, *Introduction to Linear Algebra*, Wellesley-Cambridge Press.
4. L. I. Gass, *Linear Programming*, Tata McGraw Hills.
5. G. Hadley, *Linear Programming*, Narosa Publishing House.

The students by the end of the course will be able to explain:

- How to check whether a given system of linear equations has any solution or not.
- How to find the solutions (if any) of a system of linear equations.
- Why a system of linear equations with more variables than equations always has a solution, whereas a system of such equations with more equations than variables may not have any solution at all.
- How to find the rank and nullity of a matrix.
- Why each permutation matrix is of full rank.

- Why a matrix is invertible if and only if it has nonzero determinant and how to find the inverse of such a matrix.
- Why a matrix with more columns than rows (resp. more rows than columns) does not have a left (resp. right) inverse.
- How to extend a basis of a subspace of a vector space V to a basis of V.
- How a change of basis affects the coordinates of a given vector.
- Why both the ranks of a matrix A and its transpose A^{T} are the same as that of $A^{\mathrm{T}}A$.
- Why the determinant of the matrix of a linear operator does not depend on the choice of the basis of the ambient space.
- Why the sum of the dimension of a subspace W of a vector space V and the dimension of the annihilator of W is the dimension of V.
- Why the double dual of a vector space V is canonically isomorphic to V itself.
- Why the fact that a certain conjugate of a given matrix A is diagonal is equivalent to the fact that the space on which A acts by left multiplication is a direct sum of the eigenspaces of A.
- Why every idempotent matrix is diagonalizable.
- Why conjugate matrices have the same eigenvalues with the same algebraic and geometric multiplicities.
- What Cayley-Hamilton theorem states and why replacing the variable t by the square matrix A in $\det(tI - A)$ does not lead to a proof of this theorem.
- How to solve a linear recurrence whose associated matrix is diagonalizable.
- Why the determinant of an upper or lower triangular matrix is the product of its diagonal entries.
- Why two diagonalizable matrices commute if and only if they are simultaneously diagonalizable.
- Why for a matrix which represent the dot product with respect to some basis, it is necessary and sufficient to be symmetric and positive definite.
- Why for a symmetric matrix to be positive definite, it is necessary and sufficient for it to have strictly positive eigenvalues.
- What is the role of the Cauchy-Schwarz inequality in defining the angle between two vectors.
- Why the elements in a basis a subspace W of V and the elements in a basis of the orthogonal complement of W are linearly independent.
- How to orthogonalize a given basis of an inner product space.

- Why each inner product on a real vector space V induces an isomorphism between V and its dual.
- Why any symmetric matrix is diagonalizable and why all its eigenvalues are real.
- Why in a closed and bounded convex region, a convex function attains its maximum at the boundary.
- Why it suffices to check only the corner points to find a solution to a given linear programming problem, whose feasible region is a convex polyhedron.

Sample questions

Linear equations

1. Let A be a square matrix. Show that the following conditions are equivalent:

(i) The system of equations $AX = 0$ has only the trivial solution $X = 0$.

(ii) A is invertible.

2. Show that a matrix with more columns than rows (resp. more rows than columns) does not have a left (resp. right) inverse.

3. Explain why a system of linear equations with more variables than equations always has a solution, whereas a system of such equations with more equations than variables may not have any solution at all.

4. Let $A^n = 0$. Let I denote the identity matrix of the same size as that of A. Compute the inverse of $A - I$.

5. Prove that if A is invertible, then $(A^t)^{-1} = (A^{-1})^t$.

6. Compute the determinant of the following matrix:

$$\begin{pmatrix} 2 & 1 & & & & \\ 1 & 2 & 1 & & \mathbf{0} & \\ & 1 & 2 & 1 & & \\ & & \ddots & \ddots & \ddots & \\ & \mathbf{0} & & 1 & 2 & 1 \\ & & & & 1 & 2 \end{pmatrix}_{n\times n}.$$

7. Let n be a positive integer and let

$$A = \begin{pmatrix} 2 & -1 & & & & \\ -1 & 2 & -1 & & \mathbf{0} & \\ & -1 & 2 & -1 & & \\ & & \ddots & \ddots & \ddots & \\ & \mathbf{0} & & -1 & 2 & -1 \\ & & & & -1 & 2 \end{pmatrix}_{n\times n}.$$

Find the value of the determinant of the matrix A.

8. Show that every permutation matrix is of full rank.

9. Compute the determinant of the following matrix:

$$\begin{pmatrix} 2 & -2 & & & & \\ -1 & 5 & -2 & & \mathbf{0} & \\ & -2 & 5 & -2 & & \\ & & \ddots & \ddots & \ddots & \\ & & & -2 & 5 & -2 \\ & \mathbf{0} & & & -2 & 5 & -1 \\ & & & & & -2 & 2 \end{pmatrix}_{n\times n}.$$

10. Compute the determinant of the following matrix:

$$\begin{pmatrix} 3 & 2 & & & & \\ 1 & 3 & 2 & & \mathbf{0} & \\ & 1 & 3 & 2 & & \\ & & \ddots & \ddots & \ddots & \\ & \mathbf{0} & & 1 & 3 & 2 \\ & & & & 1 & 3 \end{pmatrix}_{n\times n}.$$

11. If possible, find all the solutions of the equation $XY - YX = I$ in 3×3 real matrices X, Y.

12. Let $A \in M_{n,n}(\mathbb{R})$. Show that

$$(\det A)^2 \leq \prod_{i=1}^{n} \left(\sum_{k=1}^{n} A_{k,i}^2 \right),$$

where $A_{k,i}$ denotes the k,i-th entry of A.

13. Let

$$A = \begin{pmatrix} 2 & -2 & -4 \\ -1 & 3 & 4 \\ 1 & -2 & -3 \end{pmatrix} \in M_{3,3}(\mathbb{R}).$$

Find the inverse of the matrix $\left(37 \cdot A^{372} + 2 \cdot I\right)$.

Vector spaces and linear transformations

14. Let f and g be two nonzero linear functionals on a finite dimensional real vector space V such that their nullspaces (i.e. kernels) coincide. Show that there exists a $c \in \mathbb{R}$ such that $f = cg$.

15. Show that if the product of two $n \times n$ matrices is 0, then sum of their ranks is less than or equal to n.

16. The cross product of two vectors in $\mathbb{R}^3$ can be generalized for $n \geq 3$ to a product of $n-1$ vectors in $\mathbb{R}^n$ as follows: For $x^{(1)}, \ldots, x^{(n-1)} \in \mathbb{R}^n$, define

$$x^{(1)} \times \ldots \times x^{(n-1)} := \sum_{i=1}^{n} (-1)^{i+1} (\det A_i) \cdot e_i,$$

where $A \in M_{n-1,n}(\mathbb{R})$ is the matrix, whose rows are $x^{(1)}, \ldots, x^{(n-1)}$ and A_i is the submatrix of A obtained by deleting the i-th column of A. Similarly as in the case $n = 3$, the cross product $x^{(1)} \times \cdots \times x^{(n-1)}$ is given by the formal expansion of

$$\det \begin{pmatrix} e_1 & e_2 & \cdots & e_n \\ x_1^{(1)} & x_2^{(1)} & \cdots & x_n^{(1)} \\ \vdots & \vdots & & \vdots \\ x_1^{(n-1)} & x_2^{(n-1)} & \cdots & x_n^{(n-1)} \end{pmatrix}$$

w.r.t. the first row. Show that the following assertions hold for the generalized cross product:
a) $x^{(1)} \times \ldots \times x^{(i-1)} \times (x+y) \times x^{(i+1)} \times \ldots \times x^{(n-1)} = x^{(1)} \times \ldots \times x^{(i-1)} \times x \times x^{(i+1)} \times \ldots \times x^{(n-1)} + x^{(1)} \times \ldots \times x^{(i-1)} \times y \times x^{(i+1)} \times \ldots \times x^{(n-1)}$.
b) $x^{(1)} \times \ldots \times x^{(i-1)} \times \lambda x \times x^{(i+1)} \times \ldots \times x^{(n-1)} = \lambda \left(x^{(1)} \times \ldots \times x^{(i-1)} \times x \times x^{(i+1)} \times \ldots \times x^{(n-1)}\right)$.
c) $x^{(1)} \times \ldots \times x^{(n-1)} = 0 \;\Leftrightarrow\; x^{(1)}, \ldots, x^{(n-1)}$ are linearly dependent.
d) $\langle x^{(1)} \times \ldots \times x^{(n-1)}, y \rangle = \det \begin{pmatrix} y_1 & y_2 & \cdots & y_n \\ x_1^{(1)} & x_2^{(1)} & \cdots & x_n^{(1)} \\ \vdots & \vdots & & \vdots \\ x_1^{(n-1)} & x_2^{(n-1)} & \cdots & x_n^{(n-1)} \end{pmatrix}$.
e) $\langle x^{(1)} \times \ldots \times x^{(n-1)}, x^{(i)} \rangle = 0$ for $i \in \{1, \ldots, n-1\}$.

17. For any matrix A, show that the ranks of A and $A^{\mathrm{T}}A$ are the same.

18. Let $n \geq 3$, $A \in \mathrm{O}_n$ and $x^{(1)}, \ldots, x^{(n-1)} \in \mathbb{R}^n$. Define the linear map $\varphi_A : \mathbb{R}^n \longrightarrow \mathbb{R}^n$ by $\varphi(v) = Av$ and let the generalized cross product of $n-1$ vectors in $\mathbb{R}^n$ be defined as in the last exercise. Show that:

$$\varphi_A\big(x^{(1)}\big) \times \cdots \times \varphi_A\big(x^{(n-1)}\big) = \det A \cdot \varphi_A\big(x^{(1)} \times \cdots \times x^{(n-1)}\big).$$

19. Let V and W be finite dimensional vector spaces and let $i_V : V \to V$ and $i_W : W \to W$ be identity maps. Let $\phi : V \to W$ and $\psi : W \to V$ be two linear maps. Show that $i_V - \psi \circ \phi$ is invertible if and only if $i_W - \phi \circ \psi$ is invertible.

20. If W_1 and W_2 are two subspaces of a vector space V, then show that

$$(W_1 + W_2)^0 = W_1^0 \cap W_2^0.$$

21. If W_1 and W_2 are two subspaces of a vector space V, then show that

$$(W_1 \cap W_2)^0 = W_1^0 + W_2^0.$$

22. Let $V = \mathbb{R}^3$ and let $\mathbb{B} = \left\{ \begin{pmatrix}1\\0\\3\end{pmatrix}, \begin{pmatrix}1\\1\\2\end{pmatrix}, \begin{pmatrix}0\\1\\1\end{pmatrix} \right\}$ be a basis of V. Compute the dual basis $\mathbb{B}^*$ of V^*.

23. Let V, W finite dimensional vector spaces over a field $\mathbb{K}$ and let $\varphi : V \to W$ be a linear map.
(1) Show that $\varphi^* : W^* \to V^*$ is a linear map.
(2) Show that $\psi : \mathrm{Hom}_{\mathbb{K}}(V, W) \longrightarrow \mathrm{Hom}_{\mathbb{K}}(W^*, V^*)$, $\varphi \mapsto \varphi^*$ is an isomorphism.

24. Let V, W be finiet dimensional vector spaces over a field $\mathbb{K}$ and let $\varphi : V \to W$ be a linear map.
(1) Show that if φ is surjective, then φ^* injective.
(2) Show that if φ is injective, then φ^* is surjective.

Eigenvalues and eigenvectors

25. Let A be a diagonalizable matrix. Show that A and A^{T} are conjugate.

26. Let $v, w \in \mathbb{R}^n$ are eigenvectors of a matrix $A \in M_{n,n}(\mathbb{R})$ with corresponding eigenvalues λ and μ respectively. Show that if $v + w$ is also an eigenvector of A, then $\lambda = \mu$.

27. Let $V = \mathbb{R}^n$ and $A \in M_{n,n}(\mathbb{R})$ be a diagonalizable matrix. Show that:

$$V = (\ker \varphi_A) \oplus (\mathrm{Im}\ \varphi_A),$$

where the map $\varphi_A : V \longrightarrow V$ is defined by $\varphi_A(v) := Av$ for all $v \in V$.

28. Find a closed formula for the n-th term of the linear recurrence defined as follows: $F_0 = 0, F_1 = 1$ and

$$F_{n+1} = 3F_n - 2F_{n-1}.$$

29. Let $A \in \mathrm{O}_n$ with $\det A = -1$. Show that -1 is an eigenvalue of A with an odd algebraic multiplicity.

30. Let n be a positive odd integer and let $A \in \mathrm{SO}_n$. Show that 1 is an eigenvalue of A.

31. If each row sum of a real square matrix A is 1, show that 1 is an eigenvalue of A.

32. Let A be a 2017×2017 matrix with all its diagonal entries equal to 2017. If all the rest of the entries of A are 1, find the distinct eigenvalues of A.

33. Let λ be an eigenvalue of the $n \times n$ matrix $A = (a_{ij})$. Show that there exists a positive integer $k \leq n$ such that

$$|\lambda - a_{kk}| \leq \sum_{j=1, j\neq k}^{n} |a_{jk}|.$$

34. Let A be a diagonalizable matrix. Show that A and A^{T} have the same eigenvalues with the same algebraic and geometric multiplicities.

35. (a) Let A be a 3×3 matrix with real entries such that $A^3 = A$. Show that A is diagonalizable.
(b) Let n be a positive integer. Let A be a $n \times n$ matrix with real entries such that $A^2 = A$. Show that A is diagonalizable.

36. Let A be a diagonalizable matrix. Show that A and A^{T} have the same eigenvalues with the same algebraic and geometric multiplicities.

37. Let A be a 3×3 matrix with positive determinant. Let $\mathcal{P}_A(t)$ denote the characteristic polynomial of A. If $\mathcal{P}_A(-1) > 1$, show that A is diagonalizable.

38. Let A be a 3×3 matrix with real entries. If $\mathcal{P}_A(-1) > 0 > \mathcal{P}_A(1)$, where $\mathcal{P}_A(t)$ denotes the characteristic polynomial of A, show that A is diagonalizable.

39. (a) Show that similar matrices (i.e. conjugate matrices) have the same eigenvalues with the same algebraic and geometric multiplicities.
(b) Give examples of two matrices with the same characteristic polynomial but with an eigenvalue which does not have the same geometric multiplicity.

40. Let A be a 3×3 matrix with real entries such that $A^3 = A$. Show that A is diagonalizable.

41. Let n be a positive integer and let A be a $n \times n$ matrix with real entries such that $A^3 = A$. Show that A is diagonalizable.

42. For an $n \times n$ matrix A and be the characteristic polynomial $\mathcal{P}_A(t)$ of A, is the following a correct proof of Cayley-Hamilton theorem?

$$\mathcal{P}_A(A) = \det(A \cdot I_n - A) = \det(A - A) = 0.$$

Justify your answer.

43. Determine the eigenvalues of the orthogonal matrix

$$A = \frac{1}{2} \cdot \begin{pmatrix} 1 + \frac{1}{\sqrt{2}} & -1 & \frac{1}{\sqrt{2}} - 1 \\ 1 - \frac{1}{\sqrt{2}} & 1 & -\frac{1}{\sqrt{2}} - 1 \\ 1 & \sqrt{2} & 1 \end{pmatrix}.$$

44. (a) Find a closed formula for the n-th term of the linear recurrence defined as follows: $F_0 = 0, F_1 = 1$ and

$$F_{n+1} = 2F_n + F_{n-1}$$

by diagonalizing the matrix $\begin{pmatrix} 2 & 1 \\ 1 & 0 \end{pmatrix}$.
(b) Explain why the above method fails to help us in finding a closed formula for the n-th term of the linear recurrence defined as follows: $F_0 = 0, F_1 = 1$ and

$$F_{n+1} = 2F_n - F_{n-1}.$$

45. Let A be a 5×5 real matrix with negative determinant. If $\mathcal{P}_A(\pm 2) > 0 > \mathcal{P}_A(\pm 1)$, where $\mathcal{P}_A(t)$ denotes the characteristic polynomial of A, show that A is diagonalizable.

46. We say that two matrices A and B are *simultaneously diagonalizable* if there exists an invertible matrix P such that both PAP^{-1} and PBP^{-1} are diagonal. Show that two diagonalizable matrices A and B commute with each other if and only if they are simultaneously diagonalizable.

47. Find a closed formula for the n-th term of the linear recurrence defined as follows: $F_0 = 0$, $F_1 = 1$ and

$$F_{n+1} = 3F_n - 2F_{n-1}.$$

48. Solve the following equation for a 2×2 matrix X:

$$X^2 = \begin{pmatrix} 5 & 4 \\ 4 & 5 \end{pmatrix}.$$

49. Let

$$A = \begin{pmatrix} 3 & -1 & 1 \\ 1 & -1 & 1 \\ 1 & -1 & 3 \end{pmatrix} \quad \text{and} \quad B = \begin{pmatrix} 3 & 1 & 1 \\ -1 & -1 & -1 \\ 1 & 1 & 3 \end{pmatrix}.$$

Without doing any calculations, explain for which one of the matrices $A + B$ and AB, the eigenvectors form a basis of $\mathbb{R}^3$.
(b) (3 points) Determine that basis of eigenvectors of $\mathbb{R}^3$ for one of the matrices $A + B$ or AB.

50. Construct and example of the scenario where $\alpha, \beta, \gamma \in \mathbb{R}^n$ such that $\alpha \perp \beta$, $\gamma \neq 0$ and A, B are $n \times n$ matrices such that $A \cdot \alpha = a\gamma$ and $B \cdot \beta = b\gamma$, where a is a nonzero eigenvalue of A and b is a nonzero eigenvalue of B.

Bilinear forms

51. How many $n \times n$ real matrices are both symmetric and orthogonal? Justify your answer.

52. We call a linear map $\mathbb{R}^n$ an *isometry* if it preserves the dot product on $\mathbb{R}^n$. Show that left multiplication by a real square matrix A defines an isometry on $\mathbb{R}^n$ if and only if A is orthogonal.

53. How many $n \times n$ complex matrices are there which are positive definite, self-adjoint as well as unitary?

54. For any complex square matrix A, show that the ranks of A and A^* are equal.

55. Show that if the columns of a square matrix form an orthonormal basis of $\mathbb{C}^n$, then its rows do too.

56. Let $B \in M_{n,n}(\mathbb{R})$. Show that

$$\ker \varphi_B := (\text{Im } \varphi_{B^{\mathrm{T}}})^{\perp},$$

where the map $\varphi_B : \mathbb{R}^n \longrightarrow \mathbb{R}^n$ is defined by $\varphi_B(v) = Bv$.

57. Let $V = \mathbb{R}^4$ and let $f : V \longrightarrow V$ such that $f^2 = 0$. Show that for each triplet $v_1, v_2, v_3 \in \text{Im } f$, we have

$$\text{Vol}(v_1, v_2, v_3) = 0.$$

58. Let $V = \mathbb{C}^2$ and let s be a symmetric bilinear form on V. Let $q : V \longrightarrow \mathbb{R}$ be the quadratic form corresponding to s. Suppose, for all $z_1, z_2 \in \mathbb{C}$, we have

$$q\left(\begin{pmatrix} z_1 \\ z_2 \end{pmatrix}\right) = |z_1|^2 + |z_2|^2 + i(\overline{z_1}z_2 - z_1\overline{z_2}).$$

Compute the determinant of the matrix representing s with respect to the basis $\mathbb{B} = \left\{ \begin{pmatrix} 1 \\ i \end{pmatrix}, \begin{pmatrix} 1+i \\ 1 \end{pmatrix} \right\}$.

59. Let V be a real vector space with inner product s and let $v_1, \ldots, v_n \in V \setminus \{0\}$ such that $s(v_i, v_j) = 0$ for all $i, j \in \{1, \ldots, n\}$. For $v \in V$, we define $\|v\| = \sqrt{s(v, v)}$.
(1) Show that for all $v \in V$, we have

$$\sum_{i=1}^{n} \frac{s(v, v_i)^2}{\|v_i\|^2} \leq \|v\|^2 . \tag{1}$$

(2) Determine all the cases when the equality holds in (1).

60. Let V be a finite dimensional vector space and let P and Q be projection maps from V to V. Show that the following are equivalent:

(*a*) $P \circ Q = Q \circ P = 0$.

(*b*) $P + Q$ is a projection.

(c) $P \circ Q + Q \circ P = 0$.

61. Let $V = \mathbb{R}^3$ be the three dimensional euclidean space with the usual dot product and let U be the subspace of V which is spanned by $\begin{pmatrix} 1 \\ -1 \\ 0 \end{pmatrix}$ and $\begin{pmatrix} 1 \\ 0 \\ 1 \end{pmatrix}$. Determine the matrix of the orthogonal projection P_U with respect to the standard basis of V.

62. Do the following exercise without using the Spectral Theorem:
(1) Let $A = \begin{pmatrix} a & b \\ b & d \end{pmatrix} \in M_{2,2}(\mathbb{R})$. Show that A is diagonalizable.
(2) Let $B \in M_{3,3}(\mathbb{R})$ be a symmetric matrix. Show that B is diagonalizable.

63. Let V be a finite dimensional real vector space. For $v, w \in V \setminus \{0\}$, we define the *angle* $\measuredangle(v, w)$ between the vectors v und w as the uniquely determined number $\vartheta \in [0, \pi]$, for which

$$s(v, w) = \cos\vartheta \, \|v\|\|w\|.$$

We call $\varphi \in \mathrm{End}(V)$ *conformal* if φ is injective and if

$$\measuredangle(v, w) = \measuredangle(\varphi(v), \varphi(w)) \text{ for all } v, w \in V \setminus \{0\}.$$

Show that a linear map φ is conformal if and only if there exists an isometry $\psi \in \mathrm{End}(V)$ and a $\lambda \in \mathbb{R} \setminus \{0\}$ such that $\varphi = \lambda \cdot \psi$.

64. Find all the unitary matrices A such that $s(v, w) := \langle v, Aw \rangle$ defines an inner product on $\mathbb{C}^n$, where $\langle\ ,\ \rangle$ denotes the canonical inner product on $\mathbb{C}^n$.

65. Let V be a finite dimensional vector space over $\mathbb{R}$. Show that each bilinear form on V can be uniquely written as the sum of a symmetric and a skew-symmetric bilinear form.

66. Let s be a symmetric bilinear form on a vector space V. If there are vectors $v, w \in V$, such that $s(v, w) \neq 0$, show that there is a vector $v \in V$, such that $s(v, v) \neq 0$.

67. Let V be the vector space of the complex-valued continuous functions on the unit circle in $\mathbb{C}$. a) Show that

$$\langle f, g \rangle := \int_0^{2\pi} f(e^{i\theta})\overline{g(e^{i\theta})}d\theta$$

defines an inner product on V.
b) Define the subspace $W \subseteq V$ by $W := \{f(e^{i\theta}) : f(x) \in \mathbb{C}[x] \text{ and } \deg(f) \leq n\}$. Find an orthonormal basis of W w.r.t. the above inner product.

68. Let A be the following 3×3 matrix:

$$\begin{pmatrix} 1 & 1 & 1 \\ 1 & -1 & -1 \\ 1 & -1 & 1 \end{pmatrix}.$$

(a) Without any computation, explain why there must exist a basis of $\mathbb{R}^3$ consisting only of the eigenvectors of A.
(b) Find such a basis of $\mathbb{R}^3$.
(c) Determine whether or not the bilinear form $s : \mathbb{R}^3 \to \mathbb{R}$ given by $s(u, v) := u^{\mathrm{T}} A v$ defines an inner product on $\mathbb{R}^3$.

69. (a) Let V be a finite dimensional vector space over $\mathbb{R}$ and let f and g be two linear functionals on V such that $\ker f = \ker g$. Show that there exists an $r \in \mathbb{R}$ such that $g = rf$.
(b) Let $\varphi_1, \varphi_2, \ldots, \varphi_5$ be linear functionals on a vector space V such that there does not exist any vector $v \in V$ for which $\varphi_1(v) = \varphi_2(v) = \cdots = \varphi_5(v)$. Show that $\dim V \leq 5$.

70. Let $w = \begin{pmatrix} 1 \\ 2 \\ 3 \end{pmatrix}$ and let the linear map $f : \mathbb{R}^3 \to \mathbb{R}$ be defined by

$$f(v) = v^{\mathrm{T}} w$$

for all $v \in \mathbb{R}^3$.
a) Find an orthonormal basis of $\operatorname{Ker} f$ w.r.t. dot product.
b) Extend this orthonormal basis of $\operatorname{Ker} f$ to an orthonormal basis of $\mathbb{R}^3$.

71. Let $P_2(\mathbb{R})$ denote the set of polynomials of degree ≤ 2 with real coefficients. Define the linear map $\phi : P_2(\mathbb{R}) \to \mathbb{R}$ by $\phi(f) = f(1)$. Determine $(\operatorname{Ker} \phi)^{\perp}$ with respect to the following inner product:

$$s(f, g) = \int_{-1}^{1} f(t) g(t) dt.$$

72. Let $P_3(\mathbb{R})$ denote the set of polynomials of degree ≤ 3 with real coefficients. On $P_3(\mathbb{R})$, we define the symmetric bilinear form s by

$$s(f, g) = \int_{-1}^{1} f(t) g(t) dt.$$

a) Determine the matrix representtation of s w.r.t. the basis $\{1, t, t^2, t^3\}$.
b) Show that s is positive definit.
c) Determine an orthonormal basis of $P_3(\mathbb{R})$.

73. Show that the eigenvectors associated with distinct eigenvalues of a self-adjoint matrix are orthogonal.

74. Let $A \in M_{n,n}(\mathbb{R})$ have eigenvalues $\lambda_1, \lambda_2, \ldots, \lambda_n \in \mathbb{R}$ which are not necessarily distinct. Suppose $v_1, v_2, \ldots, v_n \in \mathbb{R}^n$ are eigenvectors of A associated with the eigenvalues $\lambda_1, \lambda_2, \ldots, \lambda_n$ respectively, such that $v_i \perp v_j$ if $i \neq j$. Show that A is symmetric.

75. Let $A \in M_{n,n}(\mathbb{R})$ a skew symmetric matrix. Let v und w be two eigenvectors of A corresponding respectively to the distinct eigenvalues λ_1 and λ_2. Show that v and w are orthogonal to each other (w.r.t. the dot product).

76. Let $A \in M_{n,n}(\mathbb{C})$ be a self-adjoint matrix. Show that the eigenvalues of A are real.

77. How many orthonormal bases (w.r.t. the dot product) are there in $\mathbb{R}^n$, so that all the entries of the basis vectors are integers?

78. Let $V = \mathbb{C}^n$, let $A \in M_{n,n}(\mathbb{C})$ a self-adjoint Matrix and let the linear operator $\phi_A : V \longrightarrow V$ be defined by $\phi_A(v) = Av$. Let W be a subspace of V, so that $\phi_A(W) \subseteq W$ (i.e. $\phi_A(w) \in W$ for all $w \in W$). Show that

$$\phi_A(W^\perp) \cap W = \{0\}.$$

79. Let $V = \mathbb{R}^2$ and let s a symmetric bilinear form on V. let $q : V \longrightarrow \mathbb{R}$ be the quadratic form corresponding to s given by

$$q\left(\begin{pmatrix} x \\ y \end{pmatrix}\right) = x^2 + 5xy + y^2.$$

Determine the matrix of s w.r.t. the basis $\mathbb{B} = \left\{ \begin{pmatrix} 2 \\ 1 \end{pmatrix}, \begin{pmatrix} -1 \\ 2 \end{pmatrix} \right\}$ of $\mathbb{R}^2$.

80. Let V be a finite dimensional vector space over $\mathbb{R}$ with an inner product $\langle\ ,\ \rangle$ and let $f : V \to \mathbb{R}$ be a linear map. Show that there is an uniquely determined vector v_f such that for all $v \in V$, we have

$$f(v) = \langle v, v_f \rangle.$$

81. Given

$$A = \begin{pmatrix} 3 & -1 & 0 \\ -1 & 0 & 1 \\ 0 & 1 & -1 \end{pmatrix} \in M_{3,3}(\mathbb{R}),$$

find a matrix $g \in \mathrm{GL}_3(\mathbb{R})$, such that $g^{\mathrm{T}} A g$ is of the form

$$\begin{pmatrix} I_k & & \\ & -I_l & \\ & & \mathrm{O} \end{pmatrix}.$$

82. Draw the curve $C := \left\{ \begin{pmatrix} x \\ y \end{pmatrix} \in \mathbb{R}^2 \middle| \, 3x^2 + 4xy + 3y^2 = 5 \right\}$.

83. Let $X \in M_{n,n}(\mathbb{C})$ be a self-adjoint matrix and suppose m be a positive integer such that $X^m = I$. Show that $X^3 - 2X^2 - X + 2I = 0$.

84. Let $n \in \mathbb{Z}_{\geq 2}$. Show that $s(A, B) := \mathrm{tr}(A \cdot B^{\mathrm{T}})$ defines an inner product on $V = M_{n,n}(\mathbb{R})$. Let $\varphi \in \mathrm{End}(V)$ be defined by

$$\varphi(A) = A^{\mathrm{T}}.$$

(1) Show that φ is hermitian.
(2) Show that φ is an isometry.
(3) Find the eigenvalues of φ.
(4) Find an orthonormal basis $\mathbb{B}$ of V, made up of the eigenvectors ef φ.
(5) Find the algebraic multiplicities ef the eigenvalues of φ.

85. Let for $x \in \mathbb{R}$, the matrix A_x defined by

$$A_x := \frac{1}{1 + x + x^2} \begin{pmatrix} -x & x + x^2 & 1 + x \\ 1 + x & -x & x + x^2 \\ x + x^2 & 1 + x & -x \end{pmatrix}.$$

(1) Show that for all $x \in \mathbb{R}$, we have $A_x \in SO_3$.
(2) Conclude from (1) that for all real $x \neq \pm 1$, there exists a $g_x \in O_3$ and an $\alpha_x \in (0, \pi) \cup (\pi, 2\pi)$ such that

$$g_x A_x g_x^{-1} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & \cos \alpha_x & -\sin \alpha_x \\ 0 & \sin \alpha_x & \cos \alpha_x \end{pmatrix}.$$

(3) Determine the complex eigenvalues of A_x for $x = 1 + \sqrt{2} + \sqrt{3} + \frac{1+\sqrt{3}}{\sqrt{2}}$.

86. (1) Find a matrix $g \in O_2$ which diagonalizes the matrix $A = \begin{pmatrix} 13 & 12 \\ 12 & 13 \end{pmatrix}$.
(2) Find a matrix $X \in M_{2,2}(\mathbb{R})$, which defines a scalar product through $s(v, w) = \langle v, Xw \rangle$ on $\mathbb{R}^2$ and which satisfies the following equation:

$$X^2 - A = 0.$$

87. Let $A \in M_{n,n}(\mathbb{R})$ be a symmetric matrix and let $B \in M_{n,n}(\mathbb{R})$ be a skew-symmetric matrix. Let $M = A + iB$ and let $v := \begin{pmatrix} \lambda_1 \\ \vdots \\ \lambda_n \end{pmatrix}$, where $\lambda_1, \ldots, \lambda_n$ are the eigenvalues of M. Show that

$$\|v\| = \sqrt{\sum_{j,k=1}^{n} |M_{jk}|^2},$$

w.r.t. the canonical norm on $\mathbb{C}^n$.

88. Let $\phi : \mathbb{C}^n \to \mathbb{C}^n$ be a nilpotent, hermitian endomorphism. Show that: $\phi = 0$.

89. Let $A, B \in M_{n,n}(\mathbb{C})$ be two self-adjoint matrices. Show that the following are equivalent:
(1) There is an unitary matrix g such that both gAg^{-1} and gBg^{-1} are diagonal matrices.
(2) The matrix AB is self-adjoint.
(3) $AB = BA$.

90. (1) Let $A, B \in M_{n,n}(\mathbb{C})$ be nilpotent matrices such that $AB = BA$ holds. Show that $A + B$ is nilpotent.
(2) Let $A, B \in M_{n,n}(\mathbb{C})$ and $r, s \in \mathbb{Z}_{>0}$ such that $A^r = I$, $B^s = 0$ and $AB = BA$. Show that $A - B$ is invertible.

91. Let

$$A = \begin{pmatrix} 1 & -2 & 2 \\ 0 & -2 & 1 \\ -2 & 1 & -2 \end{pmatrix} \in M_{3,3}(\mathbb{R}).$$

(1) Find a decomposition $A = D+N$, where D is a diagonal matrix an N is a nilpotente Matrix.
(2) Berechnen Sie A^{2012}.

92. Let $A \in M_{n,n}(\mathbb{R})$ be a nilpotent matrix and let $V = M_{n,n}(\mathbb{R})$. Let $\varphi \in \mathrm{End}(V)$ defined by

$$\varphi(B) = AB - BA \quad \text{for } B \in V.$$

Show that φ is nilpotent on V.

93. Let $V = \mathbb{R}^n$ with $s = \langle \cdot, \cdot \rangle$ and let $\mathbb{B} = \{v_1, \ldots, v_n\}$ an orthonormal basis of V. Let $U_i = (\mathrm{span}\{v_i\})^\perp$ for $i \in \{1, \ldots, n\}$. Show that

$$S_{U_i} \circ S_{U_j} = S_{U_j} \circ S_{U_i}$$

for $i, j \in \{1, \ldots, n\}$, where S_{U_i} and S_{U_j} are the reflections in U_i and U_j.

94. Let V be a finite dimensional vectore space and let $P \in \mathrm{End}(V)$ be a projektion. Let $\mathrm{Id} \in \mathrm{End}(V)$ the identity map of V (i.e. $\mathrm{Id}(v) = v$ for all $v \in V$). Show that
(1) $\mathrm{Id} - P$ is a projektion.
(2) $\mathrm{Id} - 2P$ is bijective.
(3) $E_0 \oplus E_1 = V$, where E_0 and E_1 are respectively the eigenspaces of P corresponding to the eigenvalues 0 and 1.

95. Let $A \in M_{n,n}(\mathbb{C})$ and let $B = A - A^*$. Show that B is diagonalizable and the real parts of all the eigenvalues of B are zero.

96. Let $A \in \mathrm{SO}_2$. Show that there is a skew symmetric matrix $X \in M_{2,2}(\mathbb{R})$, such that

$$\exp(X) = A.$$

97. Let $V = \mathbb{R}^5$ and let $\ell \in V^*$ be given by $\ell(v) = v_1 + 2v_2 + 3v_3 + 4v_4 + 5v_5$ für $v = \begin{pmatrix} v_1 \\ \vdots \\ v_5 \end{pmatrix} \in V$.

(1) Find an orthonormal basis of $\ker \ell$ w.r.t. the dot product.
(2) Extend this basis of $\ker \ell$ to an orthonormal basis of V.

98. Let $V = \mathbb{R}^4$, let

$$A = \frac{1}{2} \begin{pmatrix} 2 & 1 & 2 & -3 \\ 1 & 2 & -3 & 2 \\ 2 & -3 & 2 & 1 \\ -3 & 2 & 1 & 2 \end{pmatrix} \in M_{4,4}(\mathbb{R})$$

and let s be the symmetric bilinear form whose associated matrix is A.
(1) Determine a basis $\mathbb{A}$ of V, such that $M_{\mathbb{A}}(s)$ is a diagonal matrix.
(2) Determine a basis $\mathbb{B}$ of V, such that

$$M_{\mathbb{B}}(s) = \begin{pmatrix} I_k & & \\ & -I_l & \\ & & \mathrm{O} \end{pmatrix}.$$

99. Let $V = \mathbb{R}^3$ with $s = \langle \cdot, \cdot \rangle$ (the dot product), let $U = \mathrm{span} \left\{ \begin{pmatrix} 2 \\ 1 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 \\ 0 \\ -1 \end{pmatrix} \right\}$ be a subspace of V and let S_U be the reflection in in U.
(1) Determine a matrix representation of S_U, w.r.t. the canonical basis $\mathbb{A}$ of V.
(2) Show that $M(S_U)_{\mathbb{A}} \in \mathrm{O}_3$ and decide whether $M(S_U)_{\mathbb{A}} \in \mathrm{SO}_3$ oder $M(S_U)_{\mathbb{A}} \notin \mathrm{SO}_3$ or not.

Introduction to linear programming

100. Maximize $f(x, y, z) := 6x + 3y + 10z$ using Simplex method under the following constraints:

$$4x + y + z \leq 5,$$

$$2x + y + 4z \leq 5,$$

$$x + 5y + z \leq 6,$$

where x, y and z are non-negative rational numbers.

101. Minimize $f(x, y, z) := x + 2y + 9z$ using big-M method under the following constraints:

$$2x + y + 4z \geq 5,$$

$$2x + 3y + z \geq 4,$$

where x, y and z are non-negative rational numbers.

102. (a) A convex linear combination of $v_1, v_2, \ldots, v_n \in \mathbb{R}^m$ is a a linear combination of the form $t_1v_1 + \cdots + t_nv_n$, where $t_1 + \cdots + t_n = 1$.For example, the points on the straight line connecting v_1 and v_2 is given by $tv_1 + (1-t)v_2$, where t lies in the interval $[0, 1] \subset \mathbb{R}$. Show that any arbitrary point in a triangle in $\mathbb{R}^m$ with vertices v_1, v_2 and v_3 is given by a convex linear combination of its vertices.
(b) Show that any arbitrary point in a tetrahedron in $\mathbb{R}^m$ with vertices v_1, v_2, v_3 and v_4 is given by a convex linear combination of its vertices.

103. Let $f : \mathbb{R}^2 \to \mathbb{R}$ be defined by $f(x, y) := 2x + 3y$. Find the maximum value attained by f in the region where $2y - x \leq 10$, $3x + 2y \leq 9$ and $2x + 5y \geq 8$.

104. Maximize $f(x, y, z) := 2x+5y+3z$ using Simplex method under the following constraints:

$$14x + 8y + 5z \leq 15,$$

$$12x + 7y + 8z \leq 14,$$

$$3x + 17y + 9z \leq 16,$$

where x, y and z are non-negative rational numbers.

105. Minimize $f(x, y, z) := x + 9y + 9z$ using big-M method under the following constraints:

$$6x + y + 5z \geq 11,$$

$$4x + 7y + 2z \geq 9,$$

where x, y and z are non-negative rational numbers.

106. (a) Recall that any arbitrary point in a convex polyhedron is given by a convex linear combination of its vertices. Using this, show that the minimum and the maximum values attained by a linear functional $f : \mathbb{R}^n \to \mathbb{R}$ in a convex polyhedron $\mathcal{P} \subset \mathbb{R}^n$ is the same as the minimum and the maximum values attained by f at the set of the vertices of $\mathcal{P}$.
(b) Let $f : \mathbb{R}^2 \to \mathbb{R}$ be defined by $f(x, y) := 5x - 3y$. Find the maximum value attained by f in the region where $4y - 3x \leq 10$, $7x + 2y \leq 9$ and $2x + 5y \geq 8$.

107. Maximize $f(x, y, z) := 3x + y + 3z$ using Simplex method under the following constraints:

$$2x + y + z \leq 2,$$

$$x + 2y + 3z \leq 5,$$

$$2x + 2y + z \leq 6,$$

where x, y and z are non-negative rational numbers.

108. Maximize $f(x, y, z) := 3x + y + 4z$ using big-M method under the following constraints:

$$x + 3y + 4z \leq 20,$$

$$2x + y + z \geq 8,$$

$$3x + 2y + 3z = 18,$$

where x, y and z are non-negative rational numbers.

CS 244 : Introduction to Optimization Techniques

Course Overview: The process of making optimal judgement according to various criteria is known as the science of decision making. A mathematical programming problem, also known as an optimization problem, is a special class of problem where we are concerned with the optimal use of limited resources to meet some desired objective(s). Mathematical models (simulation based and/or analytical based) are used in providing guidelines for making effective decisions under constraints. This course covers three major analytical topics in mathematical programming [linear, nonlinear and integer programming]. On each topic, the theory and modeling aspects are discussed first, and subsequently solution techniques or algorithms are covered.

Prerequisite(s): Linear Algebra
Credit Hours: 4
Course Objectives: Optimization techniques are used in various fields like machine learning, graph theory, VLSI design and complex networks. In all these applications/fields, mathematical programming theory supplies the notion of optimal solution via the optimality conditions, and mathematical programming algorithms provide tools for training and/or solving large scale models. Students will have knowledge of theory and applications of several classes of math programs.

Text(s): The course material will be drawn from multiple book chapters, journal articles, reviewed tutorials etc. However, the following two books are recommended texts for this course.

- *Linear programming and Network Flows*, Wiley-Blackwell; 4th Edition, 2010
  M. S. Bazaraa, John J. Jarvis and Hanif D. Sheral, **ISBN-13:** 978-0470462720
- *Nonlinear Programming: Theory and Algorithms*, Wiley-Blackwell; 3rd Edition (2006)
  M. S. Bazaraa, Hanif D. Sherali, C. M. Shetty, **ISBN-13:** 978-0471486008

Course Policies:

- **Grades**

  Grades in the **C** range represent performance that **meets expectations**; Grades in the **B** range represent performance that is **substantially better** than the expectations; Grades in the **A** range represent work that is **excellent**.

- **Assignments**

  1. Students are expected to work independently. Discussion amongst students is encouraged but offering and accepting solutions from others is an act of dishonesty and students can be penalized according to the *Academic Honesty Policy*.
  2. **No late assignments will be accepted under any circumstances**.

- **Attendance and Absence**

  Students are not supposed to miss class without prior notice/permission. Students are responsible for all missed work, regardless of the reason for absence. It is also the absentee's responsibility to get all missing notes or materials.

Grade Distribution:

Assignments	40%
Midterm Exam	20%
Final Exam	40%

Grading Policy: *Approximate grade assignments:*

>= 90.0 %	A+
75.0 – 89.9 %	A
60.0 – 74.9 %	B
50.0 – 59.9 %	C
about 35.0 – 49.9 %	D
<= 34.9%	F

Table 1: **Topics Covered**

Mathematical Preliminaries

- Theory of Sets and Functions,
- Vctor spaces,
- Matrices and Determinants,
- Convex sets and convex cones,
- Convex and concave functions,
- Generalized concavity

Linear Programming

- The (Conventional) Linear Programming Model
- The Simplex Method: Tableau And Computation
- Special Simplex Method And Implementations
- Duality And Sensitivity Analysis

Integer Programming

- Formulating Integer Programing Problems
- Solving Integer Programs (Branch-and-Bound Enumeration, Implicit Enumeration, Cutting Plane Methods)

Nonlinear Programming: Theory

- Constrained Optimization Problem (equality and inequality constraints)
- Necessary and Suffiecent conditions
- Constraint Qualification
- Lanrangian Duality and Saddle Point Optimality Criteria

Nonlinear Programming: Algorithms

- The concept of Algorithm
- Algorithms for Uconstrained Optimization
- Constraint Qualification
- Algorithms for Constrained Optimization (Penalty Function, Barrier Function, Feasible Direction)

Special Topics (if time permits)

- Semi-definite and Semi-infinte Programs
- Quadratic Programming
- Linear Fractional programming
- Separable Programming

DA311

Time Series

Time: TBA
Place: IH402 & Bhaskara Lab

Dr. Sudipta Das

jusudipta@gmail.com
Office: IH404, Prajnabhavan, RKMVERI, Belur
Office Hours: 11 pm—12 noon, 3 pm—4 pm
(+91) 99039 73750

Course Description: DA311 is going to provide a broad introduction to the most fundamental methodologies and techniques used in time series analysis.

Prerequisite(s): (1) Probability & Stochastic Process and (2) Linear Algebra.
Note(s): Syllabus changes yearly and may be modified during the term itself, depending on the circumstances. However, students will be evaluated only on the basis of topics covered in the course.
Course url:
Credit Hours: 4

Text(s):

Introduction to time series analysis;
PJ Brockwell and RA Davis

Time Series Analysis and Its Applications;
Robert H. Shumway and David S. Stoffer

Introduction to Statistical time series;
WA Fuller

Time Series Analysis;
Wilfredo Palma

Course Objectives:

Knowledge acquired: Students will get to know
(1) Different time series models MA, AR, ARMA, ARIMA
(2) Autocorrelation and Partial Autocorrelation functions,
(3) Method of time series modelling, in presence of seasonality, and,
(4) Different non-linear time series models such as ARCH and GARCH.

Skills gained: The students will be able to
(1) explore trend and seasonality in time series data by exploratory data analysis,
(2) implement stationary as well as non-stationary models through parameter estimation,
(3) compute forecast for time series data.

Grade Distribution:

Assignments	20%
Quizzes	10%
Midterm Exam	20%
Final Exam	50%

Grading Policy: There will be relative grading such that the cutoff for A grade will not be less than 75% and cutoff for F grade will not be more than 34.9%. Grade distribution will follow normal bell curve (usually, A: $\geq \mu + 3\sigma/2$, B: $\mu + \sigma/2 \ldots \mu + 3\sigma/2$ C: $\mu - \sigma/2 \ldots \mu + \sigma/2$, D: $\mu - 3\sigma/2 \ldots \mu - \sigma/2$, and F: $< \mu - 3\sigma/2$)

Approximate grade assignments:

>= 90.0	A+
75.0 – 89.9	A
60.0 – 74.9	B
50.0 – 59.9	C
about 35.0 – 49.9	D
<= 34.9	F

Course Policies:

- **General**

  1. Computing devices are not to be used during any exams unless instructed to do so.
  2. Quizzes and exams are closed books and closed notes.
  3. Quizzes are unannounced but they are frequently held after a topic has been covered.
  4. **No makeup quizzes or exams will be given.**

- **Grades**

  Grades in the **C** range represent performance that **meets expectations**; Grades in the **B** range represent performance that is **substantially better** than the expectations; Grades in the **A** range represent work that is **excellent**.

- **Labs and Assignments**

  1. Students are expected to work independently. **Offering** and **accepting** solutions from others is an act of dishonesty and students can be penalized according to the *Academic Honesty Policy*. Discussion amongst students is encouraged, but when in doubt, direct your questions to the professor, tutor, or lab assistant. Many students find it helpful to consult their peers while doing assignments. This practice is legitimate and to be expected. However, it is not acceptable practice to pool thoughts and produce common answers. To avoid this situation, it is suggested that students not write anything down during such talks, but keep mental notes for later development of their own.
  2. **No late assignments will be accepted under any circumstances**.

- **Attendance and Absences**

  1. Attendance is expected and will be taken each class. Students are not supposed to miss class without prior notice/permission. Any absences may result in point and/or grade deductions.
  2. Students are responsible for all missed work, regardless of the reason for absence. It is also the absentee's responsibility to get all missing notes or materials.

Course Outline (tentative) and Syllabus:

The weekly coverage might change as it depends on the progress of the class. However, you must keep up with the reading assignments. Each week assumes 4 hour lectures. Quizzes will be unannounced.

Week	Content
Week 1	• The Nature of Time Series Data • Financial, Economic, Climatic, Biomedical, Sociological Data. • Reading assignment: Chapter 1, BD
Week 2	• Time Series Statistical Models • Components of time series: Trend, Seasonality and randomness • Whiteness Testing • Quiz 1
Week 3	• Stationary time series • Linear process • Strong and weak stationarity • Causality, invertibility and minimality • Reading assignment: Chapter 2, BD
Week 4	• Auto Regressive model • Moving Average model • Auto Regressive model • Moving Average models
Week 5	• Auto-covariance Function • Auto-correlation Function • Partial Auto-correlation Function • Reading assignment: Chapter 3, BD
Week 6	• Estimating Sample mean, • Estimating Auto-correlation function • Estimating Partial autocorrelation functions • Quiz 2
Week 7	• YuleWalker estimation • Burgs algorithm • Maximum Likelihood Estimation • Reading assignment: Chapter 5, BD
Week 8	• Order Selection • The AIC, BIC and AICC criterion • Review for Midterm Exam

Week	Content
Week 9	• Forecasting • Minimum MSE Forecast • Forecast Error
Week 10	• Forecasting Stationary Time Series • The DurbinLevinson Algorithm • The Innovations Algorithm
Week 11	• Non-stationarity time series • Unit root tests • Reading assignment: Chapter 6, BD
Week 12	• ARIMA Processes • Forecasting ARIMA Models • Quiz 3
Week 13	• Modelling seasonal time series • Seasonal ARIMA Models • Forecasting SARIMA Processes
Week 14	• Nonlinear Time Series • Testing for Linearity • Heteroskedastic Data
Week 15	• Auto-regressive conditional heteroskedastic model • Generalized auto-regressive conditional heteroskedastic model • Reading assignment: Chapter 5, SS • Review for Final Exam

DA101
Computing for Data Science

Time: TBA

Place: MB212 / Vijnana Computing Lab

Instructor: Dhyanagamyananda

dhyangamyananda@gmail.ac.in, swathyprabhu@gmail.com
url: http://cs.rkmvu.ac.in/šwat/
Office: MB205, Medhabhavan, RKMVERI, Belur
Office Hours: 10 pm—12 noon, 3 pm—5 pm
(+91) 033-2654 9999

Course Description: DA101 is an introductory course in Data Science giving an overview of programming, and computing techniques. This course is specially designed for students of Mathematics, Physics, and Statistics.

Prerequisite(s): (1) Basic logic and mathematics.
Note(s): Syllabus changes yearly and may be modified during the term itself, depending on the circumstances. However, students will be evaluated only on the basis of topics covered in the course.
Moodle url: http://moodle.rkmvu.ac.in/course/view.php?id=58
Credit Hours: 4

Text(s):

Algorithms in Data Science, First edition
Brian Steele, John Chandler, & Swarna Reddy

How to proram in Python
Louden & Louden

How to proram in Java
Louden & Louden

Relevant Internet resources

Course Objectives:

Knowledge acquired: .

(1) Turing machine model of computing.
(2) Computer programming in python and java.
(3) Algorithm design and analysis
(4) Simulation.

Skills gained: The students will be able to

1. distinguish between computing and non-computing tasks.
2. read and understand a program written in Python, and Java.
3. represent basic data as data structures suited to computing.
4. break down a computing problem into individual steps and code them in python or java.
5. measure the performance and efficiency of an algorithm in terms of time and space complexity.
6. understand graph theoritical concepts applied to algorithm.
7. interact with relational database using sql.
8. use simulation techniques in solving computational problems.

Grade Distribution:

Assignments	20%
Quizzes	10%
Midterm Exam	20%
Final Exam	40%

Grading Policy: There will be relative grading such that the cutoff for A grade will not be less than 75% and cutoff for F grade will not be more than 34.9%. Grade distribution will follow normal bell curve (usually, A: $\geq \mu+3\sigma/2$, B: $\mu+\sigma/2 \ldots \mu+3\sigma/2$ C: $\mu-\sigma/2 \ldots \mu+\sigma/2$, D: $\mu-3\sigma/2 \ldots \mu-\sigma/2$, and F: $< \mu-3\sigma/2$)

Approximate grade assignments:

>= 90.0	A+
75.0 – 89.9	A
60.0 – 74.9	B
50.0 – 59.9	C
about 35.0 – 49.9	D
<= 34.9	F

Course Policies:

- **General course policies, Grades, Labs and assignments, Attendance and Absences** These clauses are common to all courses. And it can be found in the program schedule.

Course Outline (tentative) and Syllabus:

The weekly coverage might change as it depends on the progress of the class. However, you must keep up with the reading assignments. Each week assumes 4 hour lectures. Quizzes will be unannounced.

Week	Content
Week 1	• Definition of computing, Binary representation of numbers intergers, floating point, text. • Reading assignment:
Week 2	• Unconventional / application specific file formats, like media. Bitmap representation for monochromatic image and generalizing the representation for RGB. File metadata, Speed of CPU, Memory, Secondary storage, DMA. Hardisk organization into Cylinder, Track, and Sectors for storing data. • Reading assignment: XBitmap from Wiki. • Programming assignment 1: • Quiz 1
Week 3	• Using and understanding the basics of Linux. • Lab activity.
Week 4	• Learning programming using Python. arrays([], [][]), conditional structures (if), and iterative structures (while, for), defining functions, using library functions. • Programming assignment:
Week 5	• Dictionary data structure in python, File access in python, Sorting and Searching algorithms, appreciating complexity of algorithms. Programming using numerical methods. • Programming assignment: • Quiz 2
Week 6	• Basics of Turing machine as a model of computing, analysing the performance of a program, time complexity, space complexity, difference between efficiency and performance, Analyse the first sorting algorithm. • Home assignment:
Week 7	• Basic notations of complexity like Big Oh, omega etc, and their mathematical definitions, given a programme to compute the complexity measures. • Reading assignment: Chapter 2.4, BJS • Home assignment: • Quiz 3
Week 8	• Discussion on the reading assignment, and implementing in the lab. • Review for Midterm Exam

Week	Content
Week 9,10,11	• Programming in SQL (Structured query language) to query relational databases. • Home assignment 4 • Quiz at the end of three weeks.
Week 12	• Representation of graphs, basic algorithms like minimum spanning tree, matching etc. • Home assignment 7 • Quiz 5
Week 13	• Monte-Carlo simulation • Reading assignment: • Home assignment 8
Week 14,15,16	• Object oriented programming using Java

DA310 Multivariate Statistics

Instructor: **Sudipta Das**

Course Description: This course DA310 deals with a broad introduction to the most fundamental method- ologies and techniques used in time series analysis

Prerequisite(s): Basic Statistics, Probability and Stochastic Processes
Note(s): Syllabus changes yearly and may be modified during the term itself, depending on the circumstances. However, students will be evaluated only on the basis of topics covered in the course.
Credit: 2 (four), approximately 32 credit hours

Text(s):

1. Applied multivariate statistical analysis: Richard A. Johnson and Dean W. Wichern, Prentice Hall 2002.

Evaluation: Theory 60% + Practical/lab 40%

Course Objectives:

Knowledge gained : At the finish of the course the student will know

- Different matrix operations and SVD
- Multivariate normal distribution and its properties
- Multivariate hypothesis testing
- Multivariate analysis of variance and covariance
- Regression analysis
- principal component analysis
- Discriminant analysis
- Factor analysis

Skills acquired : The student will be able to

- Carry out exploratory multivariate data analysis in R and Excel
- To plot multivariate data and compute descriptive statistics
- Test a data for multivariate normality by graphically and computationally in R
- Perform statistical inference on multivariate means including hypothesis testing, confidence ellipsoid calculation and different types of confidence intervals estimation
- Build multivariate regression model in R
- Extract the features of the data by principal component analysis in R
- Express the data as functions of a number of important causes by the method of factor analysis in R
- To assign objects (or data points) to one group among a number of groups by the method of discriminant analysis in R

Competence developed : The course covers theoretical, computational, and interpretive issues of multivariate data analysis using R and Excel. Overall, given real data from varied disciplines, students will be able to apply their mathematical knowledge, methodologies and computational tools to characterize and analyse it. As a result, important features of the data can be extracted as well some statistical conclusion can be made.

Course Outline (tentative) and Syllabus:

1. Representation of multivariate data, bivariate and multivariate distributions, multinomial distribution, multivariate normal distribution, sample mean and sample dispersion matrix, concepts of location depth in multivariate data.(20hrs)
2. Principal component analysis (10hrs)
3. Classification (10hrs)
4. Factor Analysis (10hrs)
5. Clustering (10hrs)

DA320 Operations Research

Instructor: **Sudeep Mallick**

Course Description: CS3210 deals with the topics in problem formulation, modelling and basic solution techniques in operations research. It is deemed as a first course in this area. It is intended that the course will enable students to take up advanced study in operations research and analytics based on operations research.

Prerequisite(s): Basic course in Linear Algebra.
Credit Hours: 4

Text(s):

1. Operations Research, seventh revised edition (2014), P K Gupta and D S Hira, ISBN: 81-219-0218-9
2. Introduction to Operations Research, eighth edition, Frederick S. Hillier & Gerald J. Lieberman, ISBN: 0-07-252744-7
3. Operations Research: An Introduction, ninth edition, Hamdy A. Taha, ISBN: 978-93-325-1822-3
4. AMPL: A Modeling Language for Mathematical Programming, second Edition, `www.ampl.com`

Course Objectives:

Knowledge gained: At the finish of the course the student will know

1) Problem formulation in operations research for problems in various application domains such as operations management, marketing, production, finance and others.
2) Modelling techniques such as linear programming and translation of any given problem description to a linear programming mathematical model.
3) Solution techniques such as simplex method and its variations and special cases.
4) Effect to change of parameters on a model using basic algebraic sensitivity analysis techniques.
5) Use of software tools to solve simple models

Skills acquired: The students will be able to

1) develop a mathematical model, clearly state model building assumptions starting from a problem description.
2) apply the appropriate operations research technique to formulate optimization models.
3) implement and evaluate alternative models of optimization problems using CPLEX software in AMPL modelling language as well as MS-EXCEL.

Competence developed: The student develop the

1. Ability to translate a given problem description into a mathematical model for optimization.
2. Ability to identify and elicit information about the essential parameters of any given optimization problem.
3. Ability to identify and use appropriate optimization modelling tools (software) for a given problem size and description..

Evaluation: Midterm Lab Exam 20% Term Project 40% Endterm Theory Exam 40%

Course Outline (tentative) and Syllabus:

Week 1	• Problem formulation for linear programming problems I • Reading assignment: Chapter 1, HT
Week 2	• Problem formulation for linear programming problems II • Reading assignment: Chapter 2, HT
Week 3	• Problem formulation for linear programming problems III • Reading assignment: Chapter 2, HT
Week 4	• Problem formulation for linear programming problems IV • Reading assignment: Chapter 1-3, HL
Week 5	• Problem formulation for linear programming problems V • Reading assignment: Chapter 1-3, HL
Week 6	• Solving linear programming problem graphical approach • RReading assignment: Chapter 3, HT • Internal test 1
Week 7	• Solving linear programming problem algebraic approach • Reading assignment: Chapter 3, HT / Chapter 4, HL
Week 8	• Solving linear programming problem simplex method • Reading assignment: Chapter 3, HT

Week 9	• Solving linear programming problem simplex method variations Big M method and Artificial variables • Reading assignment: Chapter 3, HT / Chapter 4, HL
Week 10	• Solving linear programming problem simplex method special cases degeneracy, alternative optima, unbounded solution and infeasible solution • Reading assignment: Chapter 3, HT / Chapter 4, HL
Week 11	• Lab Session: Solving LP problems using AMPL / CPLEX I
Week 12	• Lab Session: Solving LP problems using AMPL / CPLEX - II • Internal test 2
Week 13	• Sensitivity analysis graphical approach • Reading assignment: Chapter 3, HT / Chapter 4, HL
Week 14	• Sensitivity analysis algebraic approach • Reading assignment: Chapter 3, HT / Chapter 4, HL
Week 15	• Lab Session: Sensitivity analysis of LP problems using AMPL / CPLEX • Course review

DA240 Introduction to Econometrics

Instructor:

Course Description: This course is going to provide a broad introduction to the most fundamental methodologies and techniques used in Econometrics. Students will learn the details of regression analysis and its applications in real life scenario.

Prerequisite(s): None
Credit: 2 (four), approximately 32 credit hours

Text(s):

1. Introduction to Econometrics by G. S. MADDALA.

Knowledge: The students get to know

- Assumptions of Linear Regression and why are they required.
- The "BLUE" properties of Least Square Estimators.
- Relation between R2 and r2, where r is correlation coefficient between x and y.
- Pairwise correlation tells nothing about multicolinearity except very high correlation near to 1. Even with less correlation coefficient value (like 0.2) multicolinearity may occur.
- Test of Multicolinearity. VIF test and its threshold value.
- Dropping a variable from model due to multicolinearity is not a right one.
- Distribution of β (the LS estimator) applying Law of Large Number.
- Detection of heteroscedasticity using different statistical hypothesis testing like Gold-Fields Quandt test, Gleizer test.
- Impact of heteroscedasiticity on β.
- Generalized Least Square Estimation of β.
- Linear Regression when x is stochastic.
- Definition of Exogeneity and Endogeneity.
- Problem of Endogeneity.
- Hypothesis testing (Housman test) to detect Endogeneity
- Handling of Endogeneity by IV estimator(Instrumental Variable).

Evaluation: Theory 60% + Practical/lab 40%

Course Outline (tentative) and Syllabus:

1. Brief discussion about regression analysis.
2. Least Square Estimators
3. Multicolinearity
4. Heteroscedasticity
5. Generalized Least Square Estimation.
6. Exogeneity and Endogeneity.
7. IV estimator(Instrumental Variable)

DA241 Introduction to Finance

Instructor:

Course Description: DA241 covers theoretical, computational, and interpretive issues of Finance using R, Python and excel.

Prerequisite(s): Basic Statistics, probability and stochastic processes.
Credit: 2 (four), approximately 32 credit hours

Text(s):

1. John C.Hull- Options, Futures and Other Derivatives
2. Sheldon M. Ross- An elementary introduction to mathematical finance
3. Chi-fu Huang, Robert H. Litzenberger- Foundations for financial economics
4. Gopinath Kallianpur, Rajeeva L. Karandikar- Introduction to option pricing theory

Knowledge gained: The students get to know

- Overview of portfolio, asset, stock
- Optimal portfolio selection
- Portfolio frontier
- Minimum variance portfolio, zero co-variance portfolio and Risk Neutral portfolio
- Overview of Option Pricing, call and put option, Payoff, arbitrage and derivative
- Overview of Hedging parameter
- Trading strategy and self financing
- Binomial model for option pricing and complete market
- American and European option pricing
- Distribution of stock prices by Cox-Ross-Rubinstein formula
- Derivation and application of Black Sholes formula

Skills acquired: The student will be able to

- Optimize portfolio on the collected historical Sensex data of different company for giving maximum return with minimum risk.
- Analyze the pattern of return of different company from historical Sensex data.
- Predict the return for a certain amount of time for different company and to check their prediction accuracy from the actual data.
- Apply Binomial Model in real life Put Call parity problems and also understand model working procedure by simulated data.
- Apply Black Sholes formula in real life scenarios and also on simulated data

Course Syllabus:

1. Concept of portfolio, portfolio optimization, Different kind of portfolios
2. Concept of options, Assets , Stocks , Derivatives, Put and Call options (American and European),
3. Arbitrage and Hedging, Uses of them in market scenario
4. Binomial model, Cox-Ross-Rubinstein formula, Black-Sholes formula and their derivation

RAMAKRISHNA MISSION VIVEKANANDA UNIVERSITY

Belur Math, Howrah,

West Bengal: 711 202

DEPARTMENT OF SPORTS SCIENCE & YOGA

Programme: PhD (Sports Science and Yoga)

Programme Outcomes

PO1. Have an integrated knowledge of the various disciplines in multidisciplinary field of Sports Science

PO2. Acquire and be equipped with skills in the application of theoretical knowledge on different subjects within the board filed of Sports science.

PO3. Be able to practice for real life problem solving in an increasing complex and dynamic sports world.

PO4. Develop ability of focused research and thinking process mastering complex skills that are grounded in and guided by systematic theory and research

PO5. Be well informed, ethical and committed citizens contributing to the sports development

Programme Specific Outcomes

Of late, utilization of scientific concepts in sports to achieve higher level of performance could be observed all over world. In India, Sports Science is an emerging discipline in higher education. Sports or exercise science is a multidisciplinary approach encompassing various subjects like exercise physiology, biomechanics, sports psychology, sports medicine, nutrition and so on. A higher University degree is a requirement for working in sports and exercise science in Clinics, Sports Clubs, Fitness Centres and evaluation of professional athletes for a scientific back up in high performance sports. Professional players requires a much higher standard of care from the sports scientists who should hold postgraduate university qualifications and be proficient in their job. Considering the future need in the

country and shortage of persons trained to support different sporting teams, the Ramakrishna Mission Vivekananda University has embarked in research and academic courses in this field. The present course is an integrated course for M.Phil. and Ph.D.

By the end of the program post graduating students should

- Be able to display competencies and knowledge in key sports science functional areas
- Be able to work collaboratively with the coaches, administrators, sports persons and other scientists from various disciplines.
- Be able to identify research problems, carry out research and tests on sports persons.
- Be able to prepare research reports and research projects.

Course Outcomes

Title of the Course	No.	Course Outcomes
Introduction to Sports	CO1	The students will be able to understand the expanse of the field encompassed by Spots Science and Sports Medicine.
	CO2	They will also become well conversant with the rules and regulations of different sports and games.
	CO3	Students will be having adequate knowledge regarding the preparation of fitness programs. Be well conversant with the process of training, training camps, training cycles, competition cycles and the likes.
	CO4	They will be able to play a number of sports and games; also be able to train others. Develop added confidence in handling training classes.
	CO5	Practical classes on the field will help to understand theories in relation to the real life situation.
Fundamentals of Physical and biological sciences	CO1	Learn the basic principles of physics and calculations in relation with games and sports.
	CO2	They will learn methods of different measurements and calculation in physics as applied to sports and biomechanical analysis of sports.
	CO3	The students will develop capability in understanding mechanics of human motion and be able to do logical analysis.
	CO4	The students will be able to understand the structure and mechanism of human body function at the general level. He will learn the interrelation of the body systems and their implication to the function control.
	CO5	They will be able to measure the basic responses of the cardiovascular and respiratory system and interpret the data obtained.
Research Methodology	CO1	They will learn about the different varieties of research, methods of research design, ethical guidelines for carrying out research on human volunteers, methods of research review, searching of literature and methods of evaluation of scientific

		literature.
	CO2	They will learn the statistical methods applied in the field of sports sciences
	CO3	The students will learn to identify the research problems and design a research plan. Through practice of literature search they will be able to search literature for their own research work.
	CO4	Be competent to analyze and apply current development and research works in the field of sport science and Yoga.
	CO5	The students will be able to apply technologies in organizing different types of data, present results effectively by making appropriate displays, summaries, and tables of data, perform simple statistical analyses using R.
Communicative English & Dissertation writing	CO1	A basic knowledge of selected literary texts, movements and concepts in literature; The process of research oriented study and critical thinking.
	CO2	Human values and perspectives available in literary texts that embody the essence of multiple societies and cultures;
	CO3	Written and oral communication essential to participate in a global community;
	CO4	Comprehensive presentation skills and confidence in facing interviews
	CO5	The students will develop reading and writing ability in English language
Sports Science I	CO1	To learn the changes in human body systems due to exercise and sporting activities in an integrated manner.
	CO2	To gain skill in measurement of various physiological responses. Students will be able to measure the changes and interpret them in the context of sports Students will be ready to study effect of exercise in detail and in application perspective.
	CO3	They will understand the kinematic and kinetic aspects of human motion and sporting actions.
	CO4	They will learn the methods of calculation of centre of mass and its utility in sports.
	CO5	They will also learn the kinesiological analysis of movements.
Sports Science II	CO1	To learn Common acute and chronic sports related and orthopedic injuries, including soft tissue, bone & nerve injury; and their management in the field.
	CO2	To learn First aid, Cardio Pulmonary Resuscitation and special issues of women and disabled athletes
	CO3	To learn Basic concepts about different types of disability, classification of disability and Inclusive Adapted Physical Activity.
	CO4	To understand basic psychological procedures and simple psychological testing.
Seminar & Dissertation	CO1	The students will learn the methods of preparation of material and content for presentation, putting them

		into presentation software, intricacy of spoken word in a presentation.
	CO2	Learn to prepare varieties of diagrams and charts with interwoven pictures, photographs and flow charts.
	CO3	They will be competent to give presentation in various conferences, meetings, and deliver lectures.
	CO4	They will learn to execute research project by planning, collecting data, calculating the data and finally preparing a dissertation.

Programme: Post Graduate Diploma in Yoga (PGDY)

Programme Outcomes

PO1. At the end of the course the students will be able to understand traditional Indian Yoga systems; the philosophy of the Yoga systems and the new thought in Yoga movement in the country.

PO2. The students will be able to understand the principles of Hatha Yoga and the texts in this field.

PO3. The programme will develop basic understanding of the human anatomy, the human physiology and a deeper understanding of the human systems.

PO4. The students will be introduced to the essential elements of a yogic life style, the concept of health and disease and their remedies through yoga practice. They will also learn the overview of the five sheath human existence.

PO5. The students will be introduced to regular and rigorous practice (sadhana) of yoga practices that would make them disciplined and knowledgeable Yoga teachers.

Programme Specific Outcomes

The aim of the programme is to propagate and promote yoga for positive health. This programme will

1) introduce basic concepts of preventive health and health promotion through yoga

2) introduce concepts of Human Body to the students so as to making their

3) Develop clear understanding about the benefit and contraindication of Yoga practice and to train teachers on preventive health and promotion of positive health through yoga and personality development.

Course Outcomes

Title of the Course	No.	Course Outcomes
Foundations of Yoga	CO1	To learn Traditional Indian Yoga systems
	CO2	To understand The philosophy of the Yoga systems
	CO3	To learn new thought in Yoga movement in the country
	CO4	Will gain in-depth understanding of fundamental and applied scientific concepts and methods of Yogic Science and allied Science
	CO5	After completing the course, a student of yoga sciences & Holistic Health can find a career to teach and spread the knowledge in schools, colleges, health centers.
Hatha Yoga	CO1	To give an introduction of Hatha yoga
	CO2	To give an understanding of the prerequisites of Hatha Yoga
	CO3	To learn methods of performing asanas, pranayama, mudras and bandhas
	CO4	To introduce the principles of Hatha Yoga
	CO5	To introduce essential Hatha Yoga text
Human Anatomy and Physiology	CO1	To give a basic understanding of the human anatomy
	CO2	To give a basic understanding of the human physiology
	CO3	To give a deeper understanding of the human systems
	CO4	To understand the physiological functions
	CO5	To explain underlying mechanism of changes in body due to Yoga practice
Yogic Lifestyle	CO1	To introduce the essential elements of a yogic life style
	CO2	To introduce the concept of health and disease
	CO3	To give an understanding of the concept of ill health and their remedies through yoga
	CO4	To give an overview of the five sheath human existence
	CO5	To learn methods of natural healing methods
Yoga Practicum-I	CO1	To introduce a regular and rigorous practice (sadhana) of yoga practices
	CO2	The students will learn the procedures of Shat Karmas and be able to execute these
	CO3	The students will learn the Yogasanas and be able to guide others in practice.
Yoga Practicum-II	CO1	The students will learn the procedures of Pranayama and be able to execute these
	CO2	The Meditation and be able to guide others in practice.
	CO3	The procedures of executing Bandha and Mudra
Assignments & Self Appraisal	CO1	To introduce the principles of teaching Yoga
	CO2	To introduce class and lesson management

	CO3	To help overcome obstacles in self practice through self-appraisal
	CO4	To assess through regular viva voce and help deepen the understanding.
Essence of Principal Upanishads and BhagavadGita	CO1	To teach the essence of the principal Upanishads
	CO2	To teach the essence of the Bhagavad Gita
	CO3	Practice Yoga according to the principles of Upanishads
	CO4	Holistic living according to the precepts of Upanishads and Gita
Patanjala Yoga Darshana	CO1	To teach an overview of the Patanjali Yoga Sutras
	CO2	To teach the essence of the Patanjali Yoga Sutras
	CO3	Explain the basics of Samkhya and Yoga darshanas (Philosophies)
	CO4	Differentiate between various types of parinamas (transformations) of Chitta, meditation techniques & Samadhis and can explain the meaning and glory of Kaivalya.
	CO5	Define Mind (from Eastern and Western perspectives) especially the subconscious-mind – its various states and its various expressions in our daily lives.
Applied Yoga	CO1	To give an overview of the applications of yoga
	CO2	To teach the concept of yoga and psychology
	CO3	To teach the concept of yoga and personality development
	CO4	To teach the concept of yoga and stress management
	CO5	To teach the concept of yoga and sports
Methods of Teaching Yoga & Value Education	CO1	To learn teaching techniques to the studentsTo
	CO2	teach class management and lesson planning
	CO3	To introduce educational tools of Yoga teaching
	CO4	To teach the concept of Yoga education and values
	CO5	
Yoga Practicum-III	CO1	To help maintain the yoga practise or Sadhana
	CO2	To teach yoga modules specific to Physical Stamina, Voice Culture, Eye sight, Memory, Concentration, Creativity, IQ, Anger Management
Yoga Practicum-IV	CO1	To get the practical experience and training to teach Advance Yoga techniques
	CO2	The students will be able to perform advanced level of Yoga.
	CO3	To learn about Cyclic Meditation (S-VYASA)**;** Mindfulness based Stress Reduction Technique (Kabatzin)
	CO4	To learn about Mind Sound Resonance Technique (S-VYASA) ; Raja Yoga Meditation (Brahmakumaris), Transcendental Meditation (Mahesh Yogi); ZEN Buddhist Meditation
Teaching Practice	CO1	To inculcate the practice of teaching with a teaching

		internship to junior students in certificate and post-graduate diploma programmes
	CO2	The students will gain the ability to manage Yoga training classes.
	CO3	The students have to organize Yoga camps/ Workshops. Each students of Diploma would organize at least one Yoga Training Camp / Workshops under the supervision of a Yoga teacher.