VEERMATA JIAJABAI TECHNOLOGICAL INSTITUTE, MUMBAI

Circular / Open Elective / Semester VI/ AY 2023-24 /01 Date 27th December 2023

Course Name, Detail Curriculum and Eligibility criteria of Open Elective Courses to be offered for VI semester of the Academic Year 2023-24 are given below. Students are requested to submit Google form for open elective of semester VI (from 27th December 2023 to 2nd January 2024).

Link of Google form: https://forms.gle/pXZZS9xJsf3Ug5hJ7

Guidelines:

1. Once selected, the course will not be changed under any circumstances. Therefore students should be careful while selecting the course
2. In case number of students opting for a particular course is less than 25, the course will not be offered.
3. Opting open elective from other department is recommended but not mandatory.
4. Students should not study same course as core course/ programme elective and open elective.

Dr. Arvind Deshpande
Associate Dean Academics

Open Elective at Institute Level (Group wise)
(B. Tech VI Semester AY 2023-24)

Sr No	Course Title	Department Offering Elective Course	Following Discipline Students are Eligible for respective elective
1	Network Security	Computer and IT	Electrical, Electronics, Electronics and Telecommunication, Computer and IT
2	Electric Vehicles	Electrical	Electrical, Electronics, Electronics and Telecommunication, Computer, IT, Production, Civil, Mechanical, Textile
3	Transducers and Sensors	Electrical	
4	Industry 4.0 and Industrial Internet of Things	Electrical	
5	Numerical Methods in Engineering	Structural	
6	Geographical Information System	Civil	
7	Optimization and Decision Science	Mechanical	
8	Project Management	Production	
9	Polymer & Fibres for Engineering Applications	Textile	

Course Code R4CO3601S Course Title: Network Security

Prerequisite: Computer Network, Operating System

COURSE OUTCOMES:

Students will be able to

1. Demonstrate the concept of cryptography
2. Apply the fundamentals of security in programs, operating systems and databases.
3. Evaluate network security threats and counter measures.
4. Implement and analyze the web security and ESAPI security mechanism.

COURSE CONTENTS:

Module I	Mathematical Foundations: Basic Number Theory, Congruences , Chinese Remainder theorem, Modular exponentiation, Fermat and Euler's theorem , Finite fields, Discrete Logarithms
Module II	Symmetric key Ciphers: Modern Block Ciphers - DES, AES, Modes of Operation of Block Ciphers, Differential Cryptanalysis ,Triple DES , Stream Ciphers ,Pseudorandom Functions
Module III	Asymmetric key Cryptography: RSA Cryptosystem, El Gamal Cryptosystem, Elliptic Curve based Cryptography, Diffie Hellman Key Exchange. Cryptographic Hash Functions: Merkle Damgard Construction, Applications of Cryptographic Hash Functions, Secure Hash Algorithm, Message Authentication Code-Message Authentication Requirements and Functions, HMAC, Digital Signature Schemes.
Module IV	Program Security: Security, Attacks, the meaning of computer security, Computer Criminals, Methods of Defense, Network security fundamentals: vulnerability and attacks, defense mechanism, Vulnerability based intrusion analysis. Secure Software Architecture and Design: Secure Software Lifecycle, Architectural Risk Analysis, Threat Analysis, Security Principles, Security Guidelines, Attack Patterns. Secure Coding and Testing: Secure Programs, non-malicious Program errors, virus and other malicious code, Targeted malicious code, Control against threats
Module V	System Security: Protection in General-purpose Operating System: Security and Controls – Protected objects and Methods of Protection –Memory and address Protection – Control of Access to General Objects – Local access Control – Case study-Hardening Linux Operating Systems: Workstation Security, Server Security and Network Security
Module VI	Database Security: Databases Security requirements – Reliability and Integrity – Sensitive data – Inference – Multilevel database – Proposal for multilevel security, RBAC, MAC and DAC using ORACLE database
Module VII	Network Security: TCP/IP Stack: TCP/IP Protocol and its Vulnerabilities, Attacks and Defense Mechanism, Open source tools for defense mechanism. Network Design: Routing attacks and defense mechanism, Network Security controls – Firewalls – Intrusion prevention Systems, IPS architecture-Intrusion detection engine, analysis engine, recommendation engine, packet capture and preprocessing engine, How to use network analysis tool: Wireshark and NMAP.
Module IX	OWASP: Web Application Security and the OWASP top 10: Injection, Vulnerability, Cross Site Scripting (XSS) Vulnerability, Broken Authentication and Session Management, Insecure Direct Object References, Cross Site Request Forgery (CSRF) Vulnerability, Failure to Restrict URL Access, Invalidated Redirects and Forwards ESAPI structure: security mechanism to mitigate the top 10 threats of OWASP.
Module X	Advances in network security

Text Books:	1. Charles P. Pfleeger, Security in Computing, Prentice Hall India, 5th edition, 2015. 2. Dr. B.B. Meshram, Ms K.A. Shirsath, TCP/IP and Network Security: Attacks and Defence Mechanisms With Open Source Tools, Shroff Publishers & Distributors PVT. LTD, 1st edition, 2017.
Reference Books:	1. Julia H. Allen, Sean Barnum, Robert J. Ellison, Gary McGraw, Nancy Mead. Software Security Engineering – A guide for project Managers, Pearson Education, 1st edition, 2008. 2. ISECOM, Hacking Exposed Linux: Linux Security Secret and Solutions, McGraw Hill Education, 3rd edition, 2008.

Course Code R4EE3612S **Course Title: ELECTRIC VEHICLES**

Prerequisites: Nil

COURSE OUTCOMES:

Students should be able to

1. Distinguish different types of Drive trains used in Electric Vehicle
2. Analyze different types of energy storage devices used in Electric Vehicles
3. Provide the correct sizing of various components in a Drive system
4. Demonstrate energy management strategies required for an electric vehicle

COURSE CONTENTS:

Module I	**Introduction**
	Specifications and ratings of any vehicle. Vehicle power source characterization, transmission characteristics, and mathematical models to describe vehicle performance. Conventional Hybrid and Electric vehicles
Module II	**Vehicle drive System**
	Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drives-trains on energy supplies. Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive train topologies, power flow control in hybrid drive-train topologies, Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Induction Motor drives, Permanent Magnet Motor drives, Switch Reluctance Motor drives, drive system efficiency.
Module III	**Energy Storage**
	Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery Parameters, Battery Charging, Battery Modelling and Analysis, Fuel Cells – Principle, Types, Analysis of Fuel Cell in EV, Super Capacitor: Principle, Integration of different energy storage devices.
Module IV	**Sizing the drive system**
	Series Hybrid Electric Drive Train - Operation Patterns, Control Strategies, Sizing of major components , Parallel Hybrid Electric Drive Train - Control Strategies, Design of Drive Train Parameters : Engine Power Capacity, Electric Motor Drive Power Capacity, Energy Storage Design
Module V	**Fundamentals of Regenerative Braking**
	Energy Consumption in Braking, Principle of regeneration in vehicles, Brake System of EVs and HEVs, Antilock Brake System (ABS),

Text Books:	1. "Electric Vehicle Technology Explained ",Larminie and Lowry, Wiley 2. "Modern Electric, Hybrid Electric & Fuel Cell Vehicles",Mehrdad Ehsani CRC Press, 2005 3. Electric and Hybrid Vehicles: Design Fundamentals, Iqbal Hussein, CRC Press, 2003.
Reference Books:	1. "Power Electronics - Circuits, Devices and Applications", H. Rashid, Pearson Education. 2. "Generalized Theory of Electric Machines",P. S. Bhimbra, Khanna publication.

Course Code R4EC 3601S **Course Title: TRANSDUCERS AND SENSORS**

Prerequisites: Nil

Course Outcome:

After learning the course students should be able to:

1. Classify and characterize different types of transducers and sensors.
2. Identify transducers and sensors for measurement of various quantities.
3. Analyze the use of transducers and sensors for various applications in electronics engineering.
4. Design schematic diagrams and circuits using transducers and sensors for various applications.

COURSE CONTENTS

Module 1	**Introduction**
	Measurement systems, Basic electronic measuring system, Classification of transducers, General transducer characteristics, Criteria for transducer and sensor selection.
Module 2	**Resistive, Capacitive and Inductive Transducers**
	• Resistance Potentiometers-Principles of operation, construction, theory, advantages and disadvantages, applications of Potentiometers • Strain gauges, (metallic and semi-conductor type) • Resistance Thermometer and Thermistors. • Types of Inductive transducer, Principles of operation, construction, Advantages & disadvantages and applications. Various variable Inductive Transducers, LVDT (Linear variable differential transformer). • Types of capacitive transducer, Principles of operation, construction, advantages,disadvantages and applications of capacitive transducers .
Module 3	**Elastic and Active Transducer**
	Principle of operation, construction, theory, advantages and disadvantages and applications of following transducers: • Thermocouple, Piezo-electric transducer. • Spring bellows, diaphragm, bourdon tube – their special features and application.
Module 4	**Other Important Transducers**
Module 5	**Capacitive Sensors**
	• Capacitive sensors: variable distance-parallel plate type, variable area- parallel plate, serrated plate/teeth type and cylindrical type, variable dielectric constant type. • Stretched diaphragm type: microphone.
	• Proximity sensor.
Module 6	**Thermal sensors**
	• Various types and applications
Module 7	**Magnetic sensors:**

	• Sensors based on • Villari effect.Wiedemann effect , Thomson effect, Hall effect and applications • Radiation sensors.
Module 8	**Introduction to smart sensors**
	• Introduction • Components of smart sensors • Architecture and evolutions of smart sensors • Advantages and disadvantages • Industrial applications

Text Books:	1. Sensor & transducers, D. Patranabis, 2nd edition, PHI 2009 . 2. Transducers and Instrumentation by D. V. S. Murthy, Publisher: Prentice Hall India Learning Private Limited; 2 edition (2008); Language: English; ISBN-10: 8120335694; ISBN-13:
Reference Books:	1. Instrument transducers, H. K. P. Neubert, Oxford University press 1975. 2. Measurement systems: application & design, E. A. Doebelin, Mc Graw Hill, Publisher: McGraw-Hill Higher Education; 5 edition (1 September 2003); 3. Language: English; ISBN-10: 0071194657; ISBN-13: 978- 4. Electrical and Electronics Measurements and Instrumentation, by Sawhney A K, Dhanpat Rai and Sons, New Delhi,2010. 5. Electronic Instrumentation by Kalsi H S, Tata McGraw Hill, New Delhi, 4th Ed 2010.

Course Code R4ET3601S **Course Title**: INDUSTRY 4.0 AND INDUSTRIAL INTERNET OF THINGS

Prerequisites: Nil

COURSE OUTCOME

After completion of course, the students should be able to:

1. Summarize the concepts of supervised and unsupervised learning, and different application areas of ANNs.
2. Design suitable network architecture and use appropriate learning algorithm (supervised and unsupervised) for a given application.
3. Summarize different learning methods and their application areas, including graphical and MEM models.

COURSE CONTENTS

Module 1 **Introduction & Industry 4.0**	
	Sensing & actuation, Communication-Part I, Communication-Part II, Networking-Part I, Networking-Part II. Globalization and Emerging Issues, The Fourth Revolution, LEAN Production Systems, Smart and Connected Business Perspective, Smart Factories
Module 2: **Cybersecurity in Industry 4.0**	
	Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality, Artifical Intelligence, Big Data and Advanced Analysis Cybersecurity in Industry 4.0, Basics of Industrial IoT: Industrial Processes-Part I, Industrial Processes-Part II, Industrial Sensing & Actuation, Industrial Internet Systems.
Module 3: **Basics of Industrial IoT**	
	IIoT-Introduction, Industrial IoT: Business Model and Referece Architerture: IIoT-Business Models-Part I, IIoT-Business Models -Part II, IIoT Reference Architecture-Part I, IIoT Reference Architecture- Part II;
Module 4: **Industrial IoT- Layers**	
	Industrial IoT- Layers: IIoT Sensing-Part I, IIoT Sensing-Part II, IIoT Processing-Part I, IIoT Processing-Part II, IIoT Communication-Part I. IIoT Communication-Part II, IIoT Communication-Part III, IIoT Networking-Part I, IIoT Networking-Part II, IIoT Networking-Part III.
Module 5: **Big Data Analytics and Software Defined Networks**	
	Industrial IoT Analytics - Introduction, Machine Learning and Data Science - Part I, Data Science - Part II, R and Julia Programming, Data Management with Hadoop. Industrial IoT Software Defined Networks-Part I, Industrial IoT Software Defined Networks-Part II, Data Center Networks, Industrial IoT: Security and Fog Computing: Cloud Computing in IIoT-Part I, Part II.

Module 6: **Security and Fog Computing**	
	Industrial IoT: Security and Fog Computing - Fog Computing in IIoT, Security in IIoT-Part I, Security in IIoT-Part II, Industrial IoT- Application Domains: Factories and Assembly Line, Food Industry Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security (Including AR and VR safety applications), Facility Management.

Text Books:	1. "Industry 4.0: The Industrial Internet of Things", by Alasdair Gilchrist (Apress) 2. "Industrial Internet of Things: Cyber manufacturing Systems" by Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat (Springer).
Reference Books:	Research papers

Course Code : R4CE3101S-1 **Course Title : Geographical Information System**

Prerequisites: Geomatics, Geospatial Laboratory

Course Outcomes

After completion of course, students will be able to

1. Acquire a basic understanding of GIS modeling concepts, components, requirements and applications
2. Create spatial and non-spatial models for presentation, analysis and decision-making
3. Use of GIS software modules
4. Design and execute a workflow using GIS techniques appropriate to an applied field

COURSE CONTENTS

Module I	Basic concepts of GIS Information systems, spatial and non-spatial information, geographical concepts and terminology, advantages of GIS, basic components of GIS, commercially available GIS hardware and software, organization of data in GIS
Module II	GIS data Field data, statistical data, Maps, aerial photographs, satellite data, points, line and area feature, vector and raster data, advantages and disadvantages, data entry through keyboard, digitizers and scanners, digital data, preprocessing of data-rectification and registration, interpolation techniques, use of different plugins.
Module III	Data management DBMS, various data models, run-length encoding, quadtrees, data analysis-data layers, analysis of spatial and non-spatial data, data overlay and modeling, data processing: raster based and vector based, data presentation –hardcopy devices, softcopy devices
Module IV	Remote sensing and GIS integration Principles of electromagnetic remote sensing, imaging characteristics of remote sensing systems, extraction of metric and descriptive information from remotely sensed images, integration of remote sensing and GIS
Module V	Application of GIS Map revision, land use land cover (LULC), agriculture, forestry, archeology, municipal geology, water resources, dam site selection, canal site selection, catchment area detection, rivers and its tributaries location finding, Environmental Impact Assessment,. Oceanography, soil erosion, land suitability analysis, change detection

Text Books:	1. Lo C P, Yeung A K W, Concepts and Techniques of Geographic Information Systems, 2nd edition, Prentice Hall India (August 20, 2006), (ISBN: 013149502X). 2. Kang-tsung Chang, Introduction to Geographic Information Systems, Tata mcGraw Hill, 2007- 7th edition, (ISBN: 9780078095139)
Reference Books:	1. Lo C P, Yeung A K W, Concepts and Techniques of Geographic Information Systems, 2nd edition, Prentice Hall India (August 20, 2006), (ISBN: 013149502X). 2. Kang-tsung Chang, Introduction to Geographic Information Systems, Tata mcGraw Hill, 2007- 7th edition, (ISBN: 9780078095139) 3. K. Anji Rao, Remote sensing and Geographical Information System, BS Publications, 3rd edition, 2008, (ISBN: 9788178001357)

Course Code : R4ME3601S **Course Title : Optimization and Decision Science**

Prerequisites: Nil

COURSE OUTCOMES The student should be able to –

1. Employ basic knowledge of optimization and choose appropriate optimization technique for engineering applications.
2. Use single and multivariable optimization as well as linear programming tools for constrained as well as unconstrained problems.
3. Apply Multi-attribute decision-making approaches in engineering problems solving.
4. Solve decision-making problems using utility theory and outranking methods.

COURSE CONTENTS

Module I	Basics of Optimization Introduction to optimization, Engineering Applications of Optimization, Statement of Optimization Problem, Design Vector, Design Constraints, Constraint Surface, Objective Function, objective function surfaces.
Module II	Classical Optimization Techniques Single variable optimization, Multivariable optimization without constraints, Multivariable Optimization with equality constraints, Multivariable Optimization with inequality constraints.
Module III	Linear Programming: Simplex Method Introduction, Standard form of a linear programming problem, geometry of linear programming problems, definitions and theorems, solution of a system of linear simultaneous equations, pivotal reduction of a general system of equations, motivation to the simplex method, simplex algorithm
Module IV	Multi-attribute Decision-Making Introduction, Simple Additive Weighing Method, Weighted Product Method, Analytic Hierarchy Process, Problems on engineering applications.
Module V	Utility Theory Methods of optimization Introduction, Utility Additive Method, Multi-objective optimization on the basis of Ratio Analysis, Engineering problems.
Module VI	Outranking Methods for optimization Introduction of outranking comparison, Preference Ranking Organization Method for Enrichment Evaluations (PROMETHEE), Compromise Ranking Method: Vlse Kriterijumska Optimizacija I Kompromisno Resenje(VIKOR) as applications to solve engineering problems.

Text Books:	1. Singiresu S. Rao, Engineering Optimization: Theory and Practice by John Wiley and Sons, 4th Edition, 2009. 2. R. Venkata Rao, Decision Making in the Engineering Environment, Using Graph Theory and Fuzzy Multiple Attribute Decision Making, Springer, 2010.

Course Code : R4PE3601S **Course Title : Project Management**
Prerequisites: Nil

Course Outcomes: On the completion of this course, the learner will able to
1. Demonstrate the fundamental principles of project management.
2. Analyse the feasibility of project.
3. Apply the software tools for project implementation.
4. Evaluate the performance of the project.

COURSE CONTENTS

Module I	Background of Project Management Elements of project, project tasks, evolution of project management, the need of project management, characteristics of projects, characteristics of project management, Projects in contemporary organizations, phases of projects. Project success criteria, skills of project managers
Module II	Project Selection and Appraisal Brainstorming and concept evolution, Project selection and evaluation, Selection criteria and models, Types of appraisals, SWOT analysis, Cash flow analysis, Payback period, and Net present value. Project risk analysis.
Module III	Project Organization and Planning Project manager, Cross-functional team, Dedicated project organization, Influence project organization, Matrix organization, Advantages and disadvantages of project organizations, Selection of project organization, Work Breakdown Structure (WBS), Integration of project organization and WBS, WBS and responsibility matrix. Project scheduling, project monitoring.
Module IV	Project Scheduling and Resource Management Gantt chart, Milestone chart, Network techniques: PERT and CPM, AON and AOA representation, Three time estimates, Using probability distributions for time computation, Probability of project completion, Time scale version of network, Early start and late start schedules, Resource allocation, Resource loading and levelling, Constrained resource scheduling, Multi-project scheduling and resource allocation, Crashing a project. Procurement in projects.
Module V	Project Risk Analysis Different methods of project risk evaluation and analysis.
Module VI	Project Cost and Financing Controlling of project cost, project financing, financial control of projects, project termination, conflict resolution and application of ICT in project management.
Module VII	Computerized Project Management Computerized PMIS, Choosing software for project management, using software for project management. Case studies in project management in specific industries such as Electrical industry, Electronics industry, IT/ITeS industry, Manufacturing industries, fashion industries, infrastructure sector, etc.

Text Books:	1John Nicholas, Project Management for Business and technology: Principles and Practice. Pearson Prentice Hall, New Delhi. 2.Shtub, Bard and Globerson : Project Management: Engineering, Technology, and Implementation, PHI.
Reference Books:	1. A Guide to the Project Management Body of Knowledge (PMBOK Guide) Latest Edition. PMI. 2. Horald Kerzner : Project Management - A Systemic Approach to Planning, Scheduling and Controlling, CBS Publishers. 3 .L.S. Srinath: PERT and CPM: Principles and Applications, Affiliated East West Press Ltd. 4. Choudhury: Project Scheduling and Monitoring in Practice. 5. K. Joy: Total Project Management: The Indian Context, Macmillan India Ltd.

Course Code : R4TT3601S Course Title : Polymer & Fibres for Engineering Applications

Prerequisites :Knowledge of chemistry and physics.

Course Outcomes: On the completion of this course, the learner will able to

1.Describe the basic concept of polymer and its products.
2.Explain the major fibres, plastics and rubbers used for engineering applications.
3.Outline the methods for the production of fibres, rubbers and plastics.
4.Discuss the various testing and evaluation methods for fibres and polymers.
5.Demonstrate the various applications of fibres and polymers.

COURSE CONTENTS

Module I	Introduction to polymers and textile fibres: Definition and classification. Molecular size and interaction, Molecular orientation and crystallinity in fibres, Polymers as fibres, plastics and rubbers. Properties and Structure of fibres, plastics and rubbers. Melting and Glass Transition Temperatures of Polymers. Fibre forming processes. Importance of polymer in the field of Medical, Military, Agriculture, Composites, etc.
Module II	Manufacturing techniques overview: Spinning of Manmade fibres via melt spinning and solution spinning. Manufacturing of plastics by injection molding and other techniques. Rubberprocessing via calendering.
Module III	Fibre properties and applications: Natural fibres like Cotton,Wool, Jute, Etc. Regenerated fibres like Viscose. Man-made fibres like PET, PP, PA, PAN, Glass, Carbon, etc..
Module IV	Polymers properties and applications: Polyethylene, LDPE, HDPE, LLDPE, UHMWPE, Poly(Vinyl Chloride), Poly(Vinylidene Chloride), Polytetrafluoroethylene, Polyisobutylene, Polystyrene, Acrylonitrile, butadiene styrene, etc.
Module V	Elastomer properties and applications: Natural rubber, Styrene–Butadiene Rubber, Nitrile Rubber, Ethylene–Propylene–Elastomer, Butyl Rubber, Thermoplastic Elastomers, Polybutadiene (Butadiene Rubber),etc.
Module VI	Testing of fibres, plastics and rubbers: Identification of material, Tensile testing, Impact testing, Flexural testing, water absorption, Flame resistance, etc.

Text Books:	1. Industrial Polymers, Specialty Polymers, and Their Applications, Manas Chanda Salil K. Roy, CRC press 2009. 2. Manufactured Fibre Technology, V.B. Gupta and V.K. Kothari, Springer Science + Business Media, 2003. 3. Plastics End Use Applications, Donald V. Rosato, springer, 2011.
Reference Books:	1 High-performance Fibres, Edited by J W S Hearle, 2001, WPI.

Course Code: R4SE3003S-1 Course Title: Numerical Methods in Engineering

Prerequisites: Mathematics for Engineers.

Course Outcomes: On the completion of this course, the learner will able to

1 Identify and use of the attributes to model any phenomenon or situation in the field of Civil engineering into a set of mathematical equations.

2 Identify the suitable methods and obtain the solution of various types of mathematical Equations.

3 Perform curve fitting into a data set and perform extrapolation and interpolation of data From a given data set.

4 Apply the principles of optimization to get optimal solutions to problems in civil Engineering. Describe the basic concept of polymer and its products.

COURSE CONTENTS

Module I	Mathematical model: Model, Purpose of modelling, Types of model, Steps in modelling process - Problem definition, Purpose definition. Errors in engineering calculations (sources of errors, significant digits, rounding off, propagation of maximum error, propagation of variance, bias & precision).
Module II	Root finding : Bisection Methods, False position Methods, Newton – Raphson Methods, Secant Methods.
Module III	Interpolation and extrapolation : Langrange's Interpolation, Newton's Interpolation - Forward, Backward; Applications to Civil Engineering like elevation contour map, iso-hyetal map.
Module IV	Numerical differentiation and numerical integration : Newton Raphson method, Modified Newton - Raphson method, Trapezoidal rule, Simpson's rules (1⁄3 rd, 3⁄8 th), Gauss Quadrative Techniques.
Module V	Curve fitting and errors : Least square curve fitting (linear regression) procedures for linear and non-linear curves. Quantifying errors in curve fitting.
Module VI	Numerical solution of ordinary differential equations : Solution of Initial value problems by Euler's method, Taylor's series, Runge – Kutta Method of order 2 and 4.
Module VII	Finite difference and finite element method : Basics of Finite Difference Method (numerical solution to partial differential equations) and Finite Element Method (limited to 1D elements). Basic understanding of finite element Method including elements types and their formulation.
	Optimization : Concept of Optimization, Linear Programming, Application of numerical method in the different area of Civil Engineering such as Environmental Engineering, Water Resources Engineering, Structural Engineering.

Text Books:	1. M. K. Jain, SRK Iyengar, R K Jain, Numerical Methods for scientific and engineering Computation, New Age International (P) Ltd., Fourth Edition, 2. S. S. Rao, Engineering Optimization Theory and practice, New Age international (P) Ltd. Third edition 2004.
Reference Books:	1. S. C. Gupta and V. K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand and Sons, 2007. 2. S.C Chapra, and, R. P. Canale, Numerical methods for Engineers, McGraw hill Int.2012. 3. Y. M. Desai, T. I. Eldho and A. H. Shah, Finite Element Method with Applications in Engineering, Dorling Kindersely Pvt. Ltd., Licensees of Pearson Education in South Asia. 4. J. N. Sharma, Numerical Methods for Engineers and Scientists, 2nd Edition, Narosa Publishing House, New Delhi. 2007. 5. T. J. Akai, Applied Numerical Methods for Engineers, John Wiley & Sons, Singapore.