With effect from the Academic year 2021-22

DEPARTMENT OF CIVIL ENGINEERING

Scheme of Instruction

And

Syllabi of

B.E. VII & VIII Semesters

2021-2022

AICTE MODEL CURRICULUM

UNIVERSITY COLLEGE OF ENGINEERING

(AUTONOMOUS)

OSMANIA UNIVERSITY

HYDERABAD – 500 007 TELANGANA

SCHEME OF INSTRUCTION FOR B.E. (CIVIL ENGG)
VII SEMESTER

S. No.	Course Code	Course Title	Scheme of Instruction		Contact hr/week		Scheme of Examination		Credits
			L	T	P		CIE	SEE	
1	ES 701 CE	Estimation Costing and Specifications	2	1	-	3	30	70	3
2	PE – IV	Professional Elective – IV	3	-	-	3	30	70	3
3	PE – V	Professional Elective – V	3	-	-	3	30	70	3
4	PE – VI	Professional Elective – VI	3	-	-	3	30	70	3
5	PE – VII	Professional Elective – VII	3	-	-	3	30	70	3
6	HS 701 MC	Constitution of India	3	-	-	2	30	70	0
7	OE -II	Open Elective-II	3	-	-	-	30	70	3
8	PC 752 CE	Computer Applications in Civil Engineering Lab	-	-	2	2	25	50	1
9	PW762 CE	Major Project Phase-I or Seminars	-	-	4	4	50	-	2
10	PW 653 CE	Summer Internship/ Seminar	-	-	-	-	50	-	-
			21	**1**	**06**	**23**	335	540	**21**

PROFESSIONAL ELECTIVE-IV			**PROFESSIONAL ELECTIVE-V**		
1	PE 701CE	Design of Bridges	1	PE 704 CE	Pre-Stressed Concrete
2	PE 702CE	Applied Hydrology	2	PE 705CE	Railway Infrastructure Planning & Design
3	PE 703CE	Retrofitting and Rehabilitation of Structures	3	PE 706CE	Groundwater Management
	PROFESSIONAL ELECTIVE-VI		**PROFESSIONAL ELECTIVE-VII**		
1	PE 707 CE	Advanced Concrete Technology	1	PE 710 CE	Finite Element Analysis
2	PE 708 CE	Elements of Earth Quake Resistant Design of Buildings	2	PE 711 CE	Urban Transportation Planning
3	PE 709 CE	Watershed Management	3	PE 712 CE	Ground Improvement Techniques

S. No.	Course Code	**Open Elective Course - II**
1	OE701BM	Micro Electro-Mechanical Systems
2	OE702CE	Green Building Technology
3	OE703CS	Information Security
4	OE704CS	Data Base Management Systems
5	OE705EC	Embedded Systems
6	OE706EC	Very log HDL
7	OE707EC	Satellite Communication and Applications
8	OE708EE	Optimization Techniques
9	OE709EE	Non-Conventional Energy Sources
10	OE710ME	Startup Entrepreneurship
11	OE711ME	Nano Technology

ES 701 CE

ESTIMATION COSTING AND SPECIFICATIONS

Instruction: 3 hours per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives

- Understand the basic principles and specifications for estimations.
- Know the basic procedures for Tenders and Tender documents.
- Understand the detailed estimation of buildings, roads and Irrigation structures.
- Understand the usage of software in preparation of Estimations.

Course Outcomes

1. Will be able to prepare detailed specifications for Civil Engineering works.
2. Ability to prepare tender documents and schedules for Civil Engineering related works
3. Able to prepare estimates by long wall and shortfall methods for structures
4. Will be able to prepare estimates for culverts and bridges
5. Get familiar with bar bending schedules and use of software for estimation

UNIT – I

Basic principles and specifications: General and detailed specification of works types of estimates various types of contracts turnkey projects. Essentials of contracts and conditions of contracts Schedule of rates standard data rate analysis bill of quantities.

UNIT- II

Tenders and documentation: Tenders preparation of tenders, tender documentation, tender notice work order, Earnest money deposit security money deposit comparative statements additional conditions mentioned by tender.

Measurement book and muster role advances in tender procedures, National bidding /international bidding shopping, BOT, BOOT and PPP project's role of it in tenders and construction industry

UNIT – III

Estimation of buildings and roads: Traditional residential buildings advanced buildings (earth work footings columns beams and slabs etc…) by long wall and short wall method and centre line method.
Estimation of road works using levels (Cross section and longitudinal sections).

UNIT – IV

Estimation of irrigation structure: Pipe culvert, slab culvert and Simple bridge
Irrigation on canal including earth work (cutting and banking),Retaining walls, overhead water tank and aqueduct.

UNIT – V

Bar vending schedules, estimation of reinforcement quantity. Preparation of estimates using computer software viz. B-EST software V 5.0, MS office, MS Excel.

Suggested Readings:

1. Dutta, B.N. (2016). Estimating and Costing in Civil Engineering: Theory and Practice. UBS Publishers' Distributers Pvt. Ltd., New Delhi.
2. Chakraborthi, M. (2002). Estimating, Costing and Specifications in Civil Engineering. M/S. Laxmi Publications, New Delhi.
3. Jagjit Singh. (1996). Estimating and Costing in Civil Engineering. Galgotia Publications, New Delhi.

PE 701CE

DESIGN OF BRIDGES
(Professional Elective - IV)

Instruction: 3 hours per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- Understand various materials and loading standards for bridge designs
- Know the current technologies in concrete slab bridges.
- Understand concepts and importance of composite bridge designs
- Know the different substructure designs in bridges
- To understand the design of long span bridges and various construction techniques in bridges.

Course Outcomes:

1. Able to understand different high strength materials and IRC loads in bridge designs.
2. Competent to design the bridges with latest technologies and approaches with various concretes.
3. Ability to design composite bridges with IRC loading standards.
4. Ability to understand and design different sub structure designs in bridges.
5. Able to design long span bridges and current construction technologies in bridges.

UNIT - I

Introduction - Introduction to bridge Engineering: Types of bridges, materials of construction, codes of practice (Railway and Highway bridges), aesthetics, loading standards (IRC, RDSO, AASHTO), recent developments, box girder bridges, historical bridges (in India and overseas), planning and layout of bridges, hydraulic design, geological and geotechnical considerations, Developments in road and urban infrastructure.

UNIT - II

Concrete Bridges - Materials requirements, precast systems and materials used for precast and cast in-situ bridges. Bridge deck and approach slabs, design of bridge deck systems, slab-beam systems design philosophies.

UNIT - III

Composite Bridges - Importance of composite bridges, orthotropic decks, box girders, composite structures, concrete bridges, analysis and design of composite sections.

UNIT - IV

Sub-structures –Introduction to sub structures**,** design of Piers, columns and towers, analysis .and design, shallow and deep foundations, caissons, abutments and retaining walls.

Bridge components - Introduction, Expansion joints, design of joints, types and functions of bearings, design of elastomers bearing, railings, drainage system, lighting.

UNIT - V

Long Span Bridges - Introduction, design specifications, Design principles of continuous box girders, curved and skew bridges, cable stayed and suspension bridges, seismic resistant design, seismic isolation and damping devices.

Construction Techniques - Cast in-situ, prefabricated, incremental launching, free cantilever construction, inspection, maintenance and rehabilitation, current design and construction practices, innovative materials, construction techniques and methodologies.

Suggested Reading:

1. Wai-Fah Chen Lian Duan, Bridge Engineering Handbook, CRC Press, USA,2000.
2. R. M. Barker, and J. A. Puckett, Design of Highway Bridges, John Wiley & Sons, New York,1997.
3. P. P. Xanthakos, Theory and Design of Bridges, John Wiley & Sons, New York, 1994.

PE 702 CE

APPLIED HYDROLOGY
(Professional Elective - IV)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- Understand the basic applied principles of hydrology, design considerations of culverts.
- To acquire the knowledge about drainage problems in urban areas and infiltration process
- Comprehend the synthetic hydrographs principles and statistical methods of hydrology.

Course Outcomes:

1. Ability to understand the circulation and hydrologic processes.
2. Attainment of knowledge about urban hydrology and design of culverts
3. Understand the infiltration process and its measurement
4. Comprehensive understanding of hydrographs and ability to develop IUH
5. Competence in applying statistical methods to hydrologic problems.

UNIT – I

Introduction to hydrological applications, Hydro metrology, circulation, and storage of water on the earth's surface. Principles of hydrologic processes and present methods of analysis and their applications to Engineering and Environmental problems.

UNIT – II

Introduction to Urban Hydrology, drainage problems; discussion of overland and drainage channel flows; hydraulics of storm-drain systems and culverts; determination of design flow; runoff for highways, airports, and urban areas; design of drainage gutters, channels, sewer networks, and culverts.

UNIT - III

Infiltration: Introduction, factors affecting infiltration, Initial abstraction, measurement of infiltration, Infiltration indices (ϕ, w, and w_{min}) seasonal changes in infiltration capacity.

UNIT – IV

Runoff: Process, factors affecting runoff, rational formula for relation between precipitation and runoff, hydrograph analysis, unit hydrograph, instantaneous unit hydrograph. Synthetic unit hydrograph including numerical problems and Nash model.

UNIT – V

Statistics in Hydrology: Random variables, probability of hydrologic events, probability (Gumbel, Log-Pearson type-III distribution) and statistical methods for flood frequency, trend analysis for hydrologic events.

Suggested Reading

1. Ven-Te-Chow, '*Hand book of Applied Hydrology'*, McGraw-Hill Book Company, New York. 1988
2. Dr. P. Jayarami Reddy. ' A text book of Hydrology' M/S University Science Press'New Delhi 3rd Edition
3. Subramanya, K. '*Hydrology for Engineers'*, Tata McGraw-Hill Publishing Company, New Delhi. (1984).
4. Raghnath, H. M. '*Hydrology',* New Age International Pvt. Ltd., New Delhi. 1985
5. Gupta, R.S. '*Hydrology and Hydraulic systems*', Prentice Hall of India, New Delhi.1989
6. Ralph A. Wurbs& Wesley P. James, Water Resources Engineering' M/S Printice Hall India Pvt. Ltd. 2002
7. Warren Veissman, Jr & Garry L.Lewis 'Introduction to Hydrology', M/S Eastran Economy Edition, V Edition, M/S PHI Learning Pvt Ltd, New Delhi

PE 703 CE

RETROFITTING AND REHABILITATION OF STRUCTURES
(Professional Elective - IV)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- Understand the basic concepts of deterioration of structures
- Understand the corrosion aspect of steel structures
- Learning the principle of retrofit techniques

Course Outcomes:

1. Will be able to diagnosis and suggest methods to repair of cracks in structures.
2. Will be able to diagnosis and suggest methods to prevent deterioration of R C structures
3. Will be able to diagnosis and suggest methods to prevent deterioration of Steel structures
4. Will be able to diagnosis and suggest methods to prevent deterioration of Masonry structures
5. Will be able to diagnosis and suggest methods to Strengthen of Existing Structures

UNIT - I

Introduction - Need for study, types of maintenance, routine maintenance works in buildings, inspection, structural appraisal, economic appraisal, general causes of deterioration, general steps for repair and rehabilitation.

Cracks in Buildings - Cracks due to moisture changes, thermal variations, elastic deformation, creep, chemical reactions, foundation settlement and vegetation, diagnosis and repair of cracks.

Moisture Penetration - Sources and effects of dampness, reasons for ineffective damp proof course, remedies for damp masonry walls, leakage of RCC roofs and pitched roofs, causes and remedial measures, Ferro cement overlay, chemical coatings, flexible and rigid coatings.

UNIT - II

Reinforced Concrete Structures - Causes of deterioration, diagnosis of causes, corrosion of reinforcement and its control, repair of cracks, repair of spalling and disintegration, repair of floors and pavements, conventional methods of repair, special methods, use of polymers, epoxy resins, classification of retrofit techniques – global and local retrofit methods.

UNIT - III

Steel Structures - Causes and types of deterioration, mechanism of corrosion, prevention of deterioration, influence of design details, design and fabrication errors, stresses due to erection, methods of repair, plating.

UNIT – IV

Masonry Structures - Causes of deterioration, biocidal treatment, preservatives, repair of crack in masonry walls, mortar joint repair, and removal of stains from masonry walls, classification of retrofit techniques – global and local retrofit methods.

UNIT – V

Strengthening of Existing Structures - Relieving existing load, strengthening of superstructure, conversion to composite construction, post stressing, jacketing, bonded overlays, addition of reinforcement, strengthening of substructure, underpinning, design for rehabilitation.

Suggested Reading

1. Johnson.S.M., (1980), Deterioration, Maintenance and Repair of Structures, Krieger Publishing, Melbourne, Florida.
2. Guha. P.K., (1998), Maintenance and Repairs of Buildings, New Central Book Agency Ltd., Kolkata.
3. SP: 25-1984, (1999), Handbook on Causes and Prevention of Cracks in Buildings, BIS, New Delhi.
4. Richardson. B.A., (1980), Remedial Treatment of Buildings, Construction Press, London.
5. Chudley. R., (1981), The Maintenance and Adaptation of Buildings, Longman Group Ltd., New York.
6. Agarwal. P., and Shirkhande.M., (2006), Earthquake Resistant Design of Structures, Prentice Hall India, New Delhi.
7. Macdonald.S, (2003), Concrete – Building Pathology, Blackwell Science Ltd.,

With effect from the Academic year 2021-22

PE 704 CE

PRESTRESSED CONCRETE
(Professional Elective - V)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

- Understand the basic concept of prestressed concrete and materials used
- Learn the analysis prestress and load balancing concept
- Study the flexural and shear design of prestressed concrete beam sections
- Know the concepts of deflections and end blocks of prestressed concrete sections

Outcomes:

1. Apply the concept of prestressing and determine the losses of prestress
2. Analyze the prestressed concrete beam and suggest the cable profile for beam
3. Design the prestressed concrete beam for flexure and shear
4. Analyze the prestressed continuous beam and determine the concordant cable profile
5. Estimate the deflection of a prestressed concrete beam and design the end block

UNIT - I

Introduction to prestressed concrete: Historical development, principles of prestressed concrete. Definition, classification and systems of prestressing. Materials for prestressed concrete.
Loss of prestress: Losses of prestress in pre-tensioned and post-tensioned members.

UNIT - II

Analysis of prestress: Basic assumptions, analysis of prestress, resultant stress, pressure line, kern points, cable profiles, load balancing concept, stress diagrams for prestress, dead load and live load.

UNIT - III

Simply supported continuous beams: concordant cable profile, analysis of continuous prestressed concrete beams.
Design of sections: Flexural strength design of rectangular, I and T sections using IS code provisions.

UNIT - IV

Design for shear: Basic concept of shear design, shear failure, flexural shear failure, shear compression failure, shear tension failure, shear strength of beams (a) unfrocked in flexure and (b) cracked in flexure.

UNIT - V

Deflections: Necessity of deflection estimation, limitations of deflections. Deflections of pre-stressed concrete beams with uniformly distributed and point loads.
End Block: Types of end blocks and Importance of end block, Analysis and design of end block by Guyon method and IS method for not more than two cables.

Suggested Reading:

1. T.Y. Lin and N.H. Burns, *Design of prestressed concrete structure*, Jon Wildy and sons, 1982.
2. A.H. Nilson, *Design of prestressed concrete*, John Wiley and Sons, 1982.
3. N. Krishna Raju, *Design of prestressed concrete structure*, Tata McGraw Hill Book Co., 1996.
4. G.S. Pandit and S.P. Gupta, *Prestressed Concrete*, CBS Publishers, 1995.

PE 705 CE

RAILWAY INFRASTRUCTURE PLANNING & DESIGN

(Professional Elective - V)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- To understand basics related to alignment of Railway lines
- To know the various track components
- To know the elements of geometric design of track
- To understand the various methods of signaling interlocking methods

Course Outcomes:

1. Understand general features and alignment of railway lines
2. Understand the concepts related to rails, sleepers, track and track stresses
3. Able to design the geometrics of railway track
4. Understand the concepts related to sub grade, formation and ballast
5. Understand the concepts related to points and crossings with modern signaling system

UNIT-I

*General Features and Alignment of Railway Lines***:** Development in Indian railways, modes of transport, organization of Indian railways, finances and their control commission of railway safety, long term planning process, classification of railway lines, general features of Indian railways, impartment statistics. Alignment of railway lines, railway track gauge, engineering surveys.

UNIT-II

Rails, Sleepers, Track and Track Stresses: Requirements of good track, Maintenance of permanent way, track as an elastic structure, coning of wheels, tilting of rails. Functions of creep, creep adjuster, measures to reduce creep. Sleepers; functions and requirements, sleeper density and spacing of sleepers, types of sleepers, Rails: types, requirements for an ideal rail section, rail manufacture, rail wear, defects in rails and rail flaw detection. Creep: causes, effects of creep, measurement trough, cast iron, concrete etc.

UNIT-III

*Geometric Design of Track***:** Necessity of Geometric design, design of track, curves and super elevation, transition curve, reverse curve, extra clearance of curves, widening of gauge on curves, vertical curves, cutting rails on curves, check rails on curves.

UNIT-IV

Sub grade Formation and Ballast: Slope of formation, execution of earthwork in embankments and cuttings, blanketing Material, Failure of railway embankment, site investigations. Ballast: functions, types, sizes of ballast, requirement of good ballast, design of ballast section, collection and transportation of ballast, methods of measurement, laboratory tests for physical properties of ballast track

UNIT – V

Points and Crossings, Signaling and Interlocking: Important terms, Crossings, number and angle of crossing, reconditioning of worn-out crossings, Switches, turnouts, layout of turnout, trends in turnout design on Indian Railways, inspection and maintenance of points and crossings. Level crossing: Classification, types, dimensions, accidents and remedial measures, maintenance and inspection. Signaling and interlocking: Objectives, types, signaling systems, systems for controlling train movement, interlocking, modern signaling installations.

Suggested Reading

1. Chandra,S.and Agarwal.M.M. "Railway Engineering". Oxford University Press, New Delhi, 2007.
2. Rangwala, K. S. "Principles of Railway Engineering", Charotar publishing House, India, 1991
3. Mundrey J.S. "Railway Track Engineering". McGraw Hill Education (India) Private Limited, 2009.
4. Clifford F. Bonnett.. "Practical Railway Engineering" (2nd Edition), Imperial College Press, 2005.

PE 706 CE

GROUNDWATER MANAGEMENT
(Professional Elective - V)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- A pathway to understand the basic physical principles of groundwater flow, differential
- Equations, boundary condition and groundwater quality.
- Knowledge of various aspects of recharge of groundwater.
- Use the numerical solutions to solve problems with realistic situations.

Course Outcomes:

1. Knowledge of groundwater hydrology and hydraulics of the movement of water in aquifers to manage groundwater resources.
2. Comprehensive understanding of the issues pertaining to unsteady radial flows in aquifers.
3. Analyze the results obtained from geophysical methods and use them to identify the zones for feasibility of groundwater recharge.
4. Understand the contaminant transport in unsaturated zones and decide the appropriate remediation methods and treat them effectively.
5. Conduct simulation studies for future state of groundwater systems and application of knowledge to solve problems of contaminant transport by modeling techniques.

UNIT-I

Introduction: Ground water in hydrologic cycle, Distribution of subsurface water, ground water potential, occurrence of groundwater in hydro geologic formations, components of groundwater studies, Darcy's law and its validity. Governing equations of groundwater flow in aquifers: 3-D Ground water flow equations in Cartesian and polar coordinates, equations for steady radial flow into a well in case of confined and unconfined aquifers, equations for effect of uniform recharge in a fully penetrating unconfined aquifer, well flow near aquifer boundaries.

UNIT-II

Equations for unsteady radial flow into a well in case of confined aquifer, determination of Storage coefficient and Transmissibility (S and T) by Theis's graphical method, Cooper-Jacob's and Chow's method. Image well theory, partial penetration of wells, multiple well systems.

UNIT-III

Artificial recharge of aquifers: Introduction, current trends in artificial recharge, spreading methods, injection wells, technical feasibility and economic viability.-Geophysical methods in groundwater Exploration: surface geophysical methods: electrical resistivity method, seismic method.

UNIT-IV

Sources and types of groundwater contamination: Introduction, underground storage tanks, landfills, surface impoundments, waste disposal of injection wells, radioactive contaminants, classification of organic compounds, inorganic compounds in ground water. Non aqueous phase liquids (NAPL'S): types, general processes, transport, fate of NAPL'S in subsurface. *Contaminant transport mechanisms: Introduction,* advection process, diffusion and dispersion process, mass transport equation, governing flow and transport equations, analytical methods, tests for dispersivity.

UNIT-V

Models in groundwater analysis: Major applications of ground water models, sand models, viscous fluid models. Contaminant transport models, applying numerical model to field sites numerical modeling of ground water systems.

Suggested Reading:

1. Ven-Te-Chow, '*Hand book of Applied Hydrology'*, McGraw-Hill Book Company, New York. 1964
2. Raghunath H.M, '*Ground water'* Wiley Eastern Ltd, New Delhi. 1982
3. Rastogi, A.K. '*Numerical Groundwater Hydrology'*, Penram International publishing (India) Pvt Ltd. 2007.
4. Philip. B. Bedient, Hanadis. Rifai ,and Charles. J. Newell '*Groundwater Contamination: Transport and Remediation*', Prentice-Hall, New Jersey. (1999),
5. Lakshmi.N.Reddi, Hilary, I.Inyang '*Geo-Environmental Engineering: Principles and Applications',* CRC Press, Florida. 2000
6. Zheng ZhengChunmiao and Gordon. D. Bennett '*Applied Contaminant Transport Modeling (Theory and Practice)'*, John Wiley and Sons, New York. 1995

PE 707 CE

ADVANCED CONCRETE TECHNOLOGY

(Professional Elective - VI)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- Learn the microstructure characterization of concrete.
- Design high strength concrete mix and various special concretes.
- Study the different factors influencing durability of concrete.

Course Outcomes:

1. Comprehend the microstructure of concrete.
2. Acquire the knowledge durability properties of normal concrete and special concrete.
3. Design concrete mixes by various methods of mix design
4. Study different types of special concrete and their importance.
5. Familiarize with the types of non destructive testing methods.

UNIT-I

Introduction to micro structure of concrete- Hydrated Cement Paste-calcium silicate hydrate and calcium hydroxide, Aggregate Phase, Voids, Water-capillary water, adsorbed water, interlayer water, Interfacial Zone- significance, Relationship between microstructure and properties of concrete. Micro structure variation with time, Micro structural aspects of special concretes.

UNIT-II

Durability of concrete- Durability concept, factors affecting, reinforcement corrosion,; fire resistance, frost damage, sulfate attack, chloride attack, creep and shrinkage, deterioration of concrete, alkali silica reaction, concrete in sea water, quality control, acceptance criteria as per BIS code Durability aspects of special concrete- High strength concrete, Self compacting concrete, Geopolymer concrete, Self curing concrete.

UNIT- III

Mix design of conventional concrete, High strength concrete, Self compacting concrete using IS method; DOE method, ACI method, Mix design of Geopolymer concrete, Self compacting concrete, Self curing concrete, Fibre reinforced concrete, Polymer concrete.

UNIT - IV

Special processes and technology for particular types of structure - Sprayed concrete; underwater concrete, mass concrete; slip form construction, Prefabrication techniques, Precast concrete and its ingredients, MIVAN shuttering, 3 D Printing in construction

UNIT - V

Non-destructive testing of concrete: Need and importance of NDT tests, different type of tests- Rebound hammer, Ultrasonic pulse velocity, core cutting ,Infra red thermography camera, Ground penetrating radar, corrosion analyser, bar locating instruments, etc.- Test procedures and analysis of NDT tests.

Suggested Reading:

1. John Newman, Ban Seng Choo, Advanced Concrete Technology Constituent materials-volume 1, - Amsterdam- London , Elsevier, Butterworth-Heinemann, 2003, London.
2. P. Kumar Mehta, Paulo J.M. Monteiro, Concrete, Microstructure, properties, materials, TaTa Mc Graw Hill, 2006.
3. J. Prasad, C. G. K. Nair, Non-Destructive Test and Evaluation of Materials, McGraw Hill Education, 2011.
4. B K Marsh, Design of normal concrete mixes, Construction Research Communications Ltd, BRE publications, 1997.
5. A. M. Nevellie, Properties of concrete, Pearson Education Limited, 2011.
6. M. S. Shetty, Concrete Technology, S. Chand Publishers, 2013.
7. Jay.G.Sanjayan, Ali Nazari, Behzad Nematollahi Dr., 3D Concrete Printing Technology: Construction and Building Applications

PE 708 CE

ELEMENTS OF EARTH QUAKE RESISTANT DESIGN OF BUILDINGS
(Professional Elective - VI)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

- Understand concepts and characteristics of Earthquakes and its motions
- Describe the seismic design philosophy and the forces involves
- Impart knowledge on rehabilitation and retrofitting and remedial measures

Outcomes:

1. Will be able to Understand the causes and effect of Seismology
2. Able to do dynamic analysis of MDOF
3. Able to compute Seismic forces on structures as per IS codes
4. Able to perform seismic analysis & design R C structure using IS codes
5. Able to do ductile detailing of different element in R C Structure

UNIT - I

*Engineering Seismology***:** Causes of earthquakes, seismic waves, magnitudes, intensity and energy release, characteristics of strong earthquake ground motions, soils effects and liquefaction.

UNIT - II

Theory of Vibrations: Introduction, long and short period structure. Single, two and multi-degree of freedom systems. Concepts of damped and un-damped vibrations, response spectrum, response spectrum analysis.

UNIT - III

Structural Systems for Seismic Design: Requirements of an efficient earth quake resistant Structural System, Seismic Response Control Concepts, Seismic Behavior of Masonry Structures Base Isolation, Damping Device

Rehabilitation and retrofitting: seismic retrofitting, repair, rehabilitation and retrofitting

UNIT - IV

Computation of Seismic Forces on the Structures- Earthquake Resistant Design of RCC Structures as per IS code -Equivalent Lateral Force Procedure, Dynamic Analysis Procedure, Lateral drift and P-Δ Analysis, Load Combination, Provision for the analysis and design of frames with soft storey, Effect of soil –structure Interaction

UNIT - V

*Design and Detailing of RCC Building Structures***:** Ductility in RCC Structures, Ductile Detailing of Column and flexural members subjected to combined bending and axial load as per IS code. Reinforced Concrete Shear Wall.

Suggested Reading:

1. Chopra, A.K.(2004).“Dynamics of structures, Theory and application to earthquake Engineering.” Pearson Education.
2. Pankaj Agarwal and Manish Shrihkande (2006). “Earthquake Resistance Design of Structures.” Prentice Hall of India.
3. Kramer, S. L. (2004). Geotechnical Earthquake Engineering, Pearson Education.
4. Mario Paz. (1995). International Handbook of Earthquake Engineering: Codes, programs and examples, Springer Verlag.
5. D.S.Prakash Rao. (2005). Design principles and detailing of concrete structures, Tata McGraw-hill publishing company.
6. Vinod Hosur (2016) “Earthquake Resistance Design of Structures.” Wiley India Pvt Ltd

With effect from the Academic year 2021-22

PE 709 CE

WATERSHED MANAGEMENT

(Professional Elective - VI)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- Describe the concept of watershed and watershed management systems
- Understand the characteristics of watershed parameters
- Enhance the working knowledge to create the data base of watershed using geospatial techniques

Course Outcomes:

1. Able to know the watershed developments and approaches of watershed management.
2. Perform characteristics of watershed.
3. Ability to estimate erosion in watershed
4. Assimilate knowledge of water harvesting and land management
5. Ability to apply watershed activities

UNIT-I

Definition and concept of Watershed: Concept of watershed development, objectives of watershed development, need for watershed development in India, Integrated and multidisciplinary approach for watershed management.

UNIT-II

Characteristics of Watershed: Size, shape, physiography, slope, climate, drainage, land use, vegetation, geology and soils, hydrology and hydrogeology, socio-economic characteristics, basic data on watersheds.

UNIT-III

Principles of Erosion: Types of erosion, factors affecting erosion, effects of erosion on land fertility and land capability, estimation of soil loss due to erosion, Universal soil loss equation.
Measures to Control Erosion: Contour techniques, ploughing, furrowing, trenching, bunding, terracing, gully control, rockfill dams, brushwood dam, Gabion.

UNIT-IV

Water Harvesting: Rainwater harvesting, catchment harvesting, harvesting structures, soil moisture conservation, check dams, artificial recharge, farm ponds and percolation tanks.
Land Management: Land use and land capability classification, management of forest, agricultural, grassland and wild land, reclamation of saline and alkaline soils.

UNIT-V

Ecosystem Management: Role of Ecosystem, crop husbandry, soil enrichment, inter mixed and strip cropping, cropping pattern, sustainable agriculture, bio-mass management, dry land agriculture, silvi pasture, horticulture, social forestry and afforestation.
Applications: Planning of watershed management activities, people's participation, preparation of action plan, administrative requirements. Social aspects of watershed management, community participation, private sector participation, industrial issues, socio-economy, integrated development, water legislation and implementations, case studies, applications of geospatial techniques in watershed management systems.

Suggested Reading:

1. JVS Murthy, *Watershed Management*, New Age International publ., New Delhi, 1998
2. R. Awurbs and WP James, *Water Resources Engineering*, Prentice Hall Publishers
3. VVN Murthy, *Land Water Management*, Kalyani Publishers
4. D.K. Majumdar, *Irrigation and Water Management*, Prentice Hall, New Delhi, 2000.
5. C.T. Haan, H.P. Johnson, D.L. Brakensiek, *Hydrologic Modeling of Small Watersheds*, ASAE, Michigan, 1982.

PE 710 CE

FINITE ELEMENT ANALYSIS
(Professional Elective - VII)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:
The objectives of this course is to impart knowledge of

- Learn concepts of finite difference method, finite element method and potential-energy approach.
- Study 1-D analysis using 2-node axial bar element with application problems.
- Learn 2-D analysis using 3-node triangular element and 4-node quadrilateral with application problems.
- Study 3-D analysis using 3-node triangular ring element, 4-node Tetrahedron element and 8-node hexahedron element with application problems.
- Apply FEM concepts to Civil Engineering problems such as 2-D plane trusses, beams and 2-D plane frames using appropriate elements.

Course Outcomes:
After completing this course, the student will be able to:

1. Answer problems of finite difference method, finite element method and potential-energy approach.
2. Solve 1-D problems using 2-node axial bar element.
3. Work out 2-D problems using 3-node triangular element and 4-node quadrilateral.
4. Answer 3-D problems using 3-node triangular ring element, 4-node Tetrahedron element and 8-node hexahedron element.
5. Solve Civil Engineering problems such as 2-D plane trusses, beams and 2-D plane frames.

UNIT – I

*Finite Difference Method with Central Differences***:** Solving ODE's and PDE's with central differences - Application to beam, column and plate bending problems of simple geometry.

Introduction to FEM: Types of problems – Types of materials – Elastic / inelastic situations – Types of forces - Body forces / Surface Traction / Point loads – Types of deformations – Homogeneous / Non homogeneous problems – Equations of equilibrium for elastic 2-D / 3-D continua - Equilibrium equations for 2-D / 3-D boundary elements – Boundary conditions – Strain-displacement relation - Stress-strain relation for 2-D / 3-D problems – Plane stress / Plane strain problems – Initial strain - Displacement model - Criterion for convergence - Conforming and non-conforming elements – Subparametric / Superparametric / Isoparametric formulations.

Potential-Energy / Variational Approach: Rayliegh-Ritz Method – Galerkin's Method – Application to discrete connected system and 1-D axial bar.

UNIT – II

1-D Bar Elements: 1-D 2-node axial bar element - Finite element modeling – Natural coordinates - Shape functions – Strain-displacement relation matrix - Potential-energy approach - Stiffness matrix – Body force vector – Traction force vector – Assembly of global stiffness matrix and load vector – Finite element equations – Treatment of boundary conditions – Elimination approach – Penalty approach – Multipoint constraints – Temperature effects – Application problems.

UNIT – III

*2-D Triangular Elements***:** 2-D 3-node triangular element - CST - Shape functions – Area coordinates -Isoparametric formulations - Strain-displacement matrix – Potential-energy approach - Stiffness matrix – Body force vector – Traction force vector - Temperature effects – Application problems.

2-D Isoparametric Quadrilateral elements: 2-D 4-node quadrilateral - Shape functions – Jacobian matrix - Strain-displacement matrix - Potential-energy approach - Stiffness matrix – Body force vector – Traction force vector – Numerical integration - Gaussian quadrature – 1-D and 2-D integrals - Application problems.

UNIT – IV

3-D Axisymmetric Problems: Axisymmetric formulation - Finite element modeling - 3-node triangular ring element - Strain-displacement matrix - Potential-energy approach - Stiffness matrix – Body force vector – Traction force vector - Temperature effects – Application problems.

*3-D Tetrahedron / Hexahedron Elements***:** Finite element formulation – 3-D 4-node Tetrahedron element - 3-D 8-node hexahedron / brick element - Shape functions – Volume coordinates - Jacobian matrix - Strain-displacement matrix - Potential-energy approach - Stiffness matrix – Body force vector – Traction force vector – Application problems.

UNIT – V

Civil Engineering Problems:

*2-D Trusses***:** 2-D Plane Truss – Local and global coordinate systems – Transformation matrix – Potential-Energy approach - Stiffness matrix – Strain-displacement matrix - Stress – Temperature effects – Application problems.

Beams: Finite element formulation - Hermite shape functions – Potential-energy approach - Stiffness matrix – Load vector – Shear force – Bending moment – Reaction – Application problems.

2-D Plane Frames: 2-D Plane frame element – Local-global transformation matrix – Potential-energy approach - Stiffness matrix – Load vector – Application problems.

Suggested Reading:

1. Cook, R. D. (1981). ―Concepts and Application of Finite Element Analysis‖, John Wiley and Sons.
2. Zienkiewicz, O. C. And Taylor, R. L, (1989). ―The Finite Element Method‖, Vol.1, McGraw Hill Company Limited, London.
3. Reddy, J. N, (1993). ―An Introduction to the Finite Element Method‖, McGraw Hill, New York.
4. Chandrupatla, T. R. And Belegundu, A. D, (2001). ―Introduction to Finite Elements in Engineering‖, Prentice Hall of India, New Delhi.
5. Seshu. P, (2003). ―Finite Element Analysis‖, Prentice Hall of India Private Limited, New Delhi.
6. David V. Hutton, (2005). ―Fundamentals of Finite Element Analysis‖, Tata McGraw-Hill Publishing Company Limited, New Delhi.
7. Bathe, K. J, (2006). ―Finite Element Procedures‖, Prentice Hall of India, New Delhi

With effect from the Academic year 2021-22

PE 711 CE

URBAN TRANSPORTATION PLANNING
(Professional Elective - VII)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- To discuss various urban transportation planning process and its components
- To understand data collection processes and travel surveys
- To review different travel demand forecasting models
- To examine integrated land use trapsort models

Course Outcomes:

1. Able to apply various planning methodologies
2. To identify the appropriate data collection methods
3. Able to perform travel demand forecasting
4. Perform trip distribution and model split analysis
5. Perform trip assignment and prepare master plan.

UNIT -I

Components of Urban Transportation: urban transportation components, urban transportation issues and challenges, demand and supply, measure of effectiveness, measure of collectiveness, planning and management, models, planning methodologies.

UNIT - II

Travel Surveys and Data Collection: concept of surveys, design of survey format, organization of surveys and analysis, study area definition, zoning system, types and sources of data, Collection of data, road side interview method, home interview survey, in-vehicle surveys, sampling, types, various techniques, expansion factors, logical checks, use of secondary sources of data, planning variables, vehicles ownership, projection of data and statistical techniques.

UNIT-III

Travel Demand Forecastin:; short and long term planning process, different kinds of variables, travel attributes, traffic analysis zones, trip generation, category analysis and regression analyisis. Formulation of trip generation models.

UNIT-IV

*Trip Distribution Models***:** concept of trip distribution, Growth factor models, synthetic pattern models, various growth factor models and its conceptual procedures with merits and demerits. **G**ravity model, calibration of gravity model, importance of deterrence function and other models of synthetic pattern models.

UNIT-V

Model Split Analysis and Traffic Assignment: Factors affecting mode choice, aggregate models and disaggregate models, trip interchange, Toronto transit model, service ratio model, probabilistic models, discriminate analysis and sensitivity analysis. Nodes, links, transport. network, coding, rout characteristics, network skims, various methods, judgment, towpath method, diversion curves, network, assignment, all or nothing assignment, capacity restraint techniques, multi-path assignment technique. Introduction to land use transportation models.

Suggested Reading:

1. Hutchinson, E.G., Principles of Urban Transport Systems Planning, McGraw Hill, New York, 1974.
2. Ortuzar, J. and Williamson, E.G., Modelling Transport, Wiley, Chinchestor, 1994.
3. Oppenheim, N., Urban Travel Demand Modeling: From Individual Choices to General Equilibrium, Wiley, New York, 1995.
4. Thomas, R., Traffic Assignment Techniques, Avebury Technical, Aldershot, 1991.
5. Taniguchi, E., Thompson, R.G, Yamada, T. and Van Duin, R., City Logistics - Network Modelling and Intelligent Transport Systems, Elsevier, Pergamon, Oxford, 2001.
6. Bruton, M.I, Introduction to Transportation Planning, Hutchinson, .London, 1985.
7. Dickey, J.W, Metropolitan Transportation Planning, Tata McGraw Hill, New Delhi, 1975.

With effect from the Academic year 2021-22

PE 712 CE

GROUND IMPROVEMENT TECHNIQUES

(Professional Elective - VII)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- To understand the objectives, necessity and scope of ground improvement techniques
- To learn different methods of in situ densification of cohesive, cohesion less soils
- To learn the classification, functions and applications of Geo synthetics in ground improvement
- To learn the process of identification of necessity for ground improvement, finding alternative methods and recommendation of the ideal technique through case studies

Course Outcomes:

1. Ability to understand the necessity of ground improvement potential.
2. Comprehensive understanding about the improvement of in-situ cohesive soils as well as Cohesion less soils
3. Ability to understand and implement the Geosynthetic applications
4. Competence to analyze, identification of ground improvement techniques
5. Selection of the ideal method, its implementation and evaluation of improvement level.

UNIT – I

Introduction: Objectives and necessity of Ground Improvement – Formation of Rock and soils – Alteration of ground after its formation – Reclaimed soils – , Types and distribution of Soils in India - marine, black cotton soils (expansive), lateritic, alluvial, desert, peaty Soils etc - Ground improvement potential – Geotechnical processes.

UNIT – II

Surface Compaction methods: Compaction Mechanism - moisture density relationship – Factors affecting compaction – Laboratory evaluation of Compaction Characteristics – Field Surface Compaction Methods – Compaction procedure – Specification – Quality Control aspects. In-situ Densification of Cohesion less Soils : Necessity for Deep compaction – Vibration methods –Vibro-compaction methods (Blasting, Vibratory probe, Dynamic compaction / heavy tamping), Vibro-displacement Methods (Displacement Piles, Sand Compaction Piles), vibro-replacement cum displacement methods (Vibro-floatation, Stone Columns).

UNIT – III

In-situ Densification of Cohesive Soils:

Drainage methods – Methods of dewatering systems - selection of pumps and accessories Pre-compression methods – Concept & benefit of pre-compression -consolidation of Clayey soils – Pre-loading technique – consolidation acceleration methods - consolidation aided with vertical drains – S and Drains - Pre-fabricated vertical drains, Consolidation by Electro-osmosis and vacuum compression methods - Compression monitoring.

UNIT - IV

Grouting: Aspects of grouting – Types of grout materials – Classification based on GroutabilityRatio -grouting procedure – Applications of grouting in ground improvement.

Soil Stabilization: Types and suitability of stabilization methods - Mechanical, Cementing methods – Aggregates and dispersants – Stabilization procedure – quality control in Soil Stabilization.

UNIT – V

Geo-Synthetics: Classification of Geos ynthetics – Functions and applications – Concept of design by function. Reinforced Soil Walls – Components of a RSW – Types of facia – Types of Reinforcement & factors influencing the selection - Design of RSW – construction procedure - Gabions.

Suggested Reading:

1. H.R. Hausmann, (2013), Principles of Ground Modification, Mc-Graw Hill Publications.
2. P.Nicholson, (2015), Soil Improvement and Ground Modification Methods, Butterworth-Heinemann Ltd.
3. Purushotham Raj, (2016), Ground Improvement Techniques, Laxmi Publications.
4. R.M.Koerner, (2012), Designing with Geosynthetics Vol-1&2, Prentice Hall Inc.
5. Indrarathna, Chu, Cholachat, (2015), Ground Improvement Case Histories, Butterworth-Heinemann Publications.

HS 701 MC

CONSTITUTION OF INDIA

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 0

Course Objectives:

- The history of Indian Constitution and its role in the Indian democracy.
- Address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
- Have knowledge of the various Organs of Governance and Local Administration.

Course Outcomes:

1. Understand the making of the Indian Constitution and its features.
2. Understand the Rights of equality, the Right of freedom and the Right to constitutional remedies.
3. Have an insight into various Organs of Governance - composition and functions.
4. Understand powers and functions of Municipalities, Panchayats and Co-operative Societies.
5. Understand Electoral Process, special provisions.

UNIT-I

History of making of the Indian constitutions: History, Drafting Committee(Composition & Working).

Philosophy of the Indian Constitution: Preamble, Salient Features.

UNIT-II

Contours of Constitutional Rights and Duties Fundamental Rights, Right toEquality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT-III

Organs of Governance: Parliament: Composition, Qualifications, Powers andFunctions, Union executives : President, Governor, Council of Ministers, Judiciary, appointment and transfer of judges, qualifications, powers and functions

UNIT-IV

Local Administration - District's Administration head: Role and importance. Municipalities: Introduction, ayor and role of Elected Representative, CEO of Municipal Corporation. Panchayati Raj: Introduction, PRI: Zilla Panchayat, Elected Officials and their roles, CEO Zilla Panchayat: positions and role. Block level: Organizational Hierarchy (Different departments) Village level: role of elected and appointed officials. Importance of grass root democracy.

UNIT-V

Election commission: Election Commission: Role and functioning, Chief ElectionCommissioner and Election Commissioners, State Election Commission :Role and functioning. Institute and Bodies for the welfare of SC/ST/OBC and women**.**

Suggested Reading:

1. "The Constitution of India", 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar, "Framing of Indian Constitution", 1st Edition, 2015.
3. M. P. Jain, "Indian Constitution Law", 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, "Introduction to the Constitution of India", Lexis Nexis, 2015.

Web Resource:

1. http://www.nptel.ac.in/courses/103107084/Script.pdf

With effect from the Academic year 2021-22

OE 701BM

MICRO ELECTRO-MECHANICAL SYSTEMS

(OPEN ELECTIVE-II)

Instruction: 3 Periods per week *Duration of SEE: 3 hours*
CIE: 30 Marks *SEE: 70 Marks*
Credits: 3

Course Objectives:

- To introduce to basics of Micro-electro-mechanical systems
- To understand properties of materials involved in MEMS
- To pertain fabrication methods involved in MEMS manufacturing
- To apply the concepts for various applications

Course Outcomes: Upon completion of the course, the student will be able to

1. Elucidate basic concepts involved in MEMS technologies
2. Realize the properties of various materials involved in MEMS technologies
3. Apply the concepts and technologies involved in designing of MEMS
4. Relate different manufacturing processes involved in fabrication of MEMS
5. Recognize micro sensors, micro actuators and their applications in various fields.

UNIT- I

Introduction to MEMS: What is MEMS, Historical Background, classification, Micro-engineering, importance of micro-engineering. Technological advancements in MEMS, advantages and disadvantages of MEMS.

UNIT- II

MEMS materials: Materials used in MEMS. Material properties: electrical, mechanical, thermal, chemical, biological, optical and processing. Reliability issues of materials

UNIT - III

Designing of MEMS: Design and analysis process for MEMS. Initial design process, structured design process. Commonly used design flow, structured design flow. Design flow for MEMS cad design. Design and verification flow for integrated MEMS.

UNIT - IV

MEMS fabrication Techniques: Photolithography, materials for micromachining, bulk micromachining Surface micromachining, High aspect-ration-micromachining, assembly and system integration.

UNIT- V

MEMS structures and devices: Mechanical sensors, mechanical actuators, micro-fluidic devices, optical/photonic micro-systems, biological transducers.

Suggested Readings:

1. Adams TM, Layton RA., *"Introductory MEMS: Fabrication and applications"*, 2010.
2. Tobergte DR, Curtis S., *"An Introduction to Micro-electro-mechanical Systems Engineering"* Second Edition. vol. 53. 2013.
3. Kreith F, Kreider JF., *"The MEMS Handbook*" CRC Press 2002.
4. Reza Ghodssi, Pinyen Lin, *"MEMS Materials and Processes Handbook"* Springer 2013
5. Gad-el-Hak M, *"MEMS applications"* 2nd edition, CRC press 2006.

OE 702CE

GREEN BUILDING TECHNOLOGY

(Open Elective - II)

Instruction: 3L hours per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- Exposure to the green building technologies and their significance.
- Understand the judicial use of energy and its management.
- Educate about the Sun-earth relationship and its effect on climate.
- Enhance awareness of end-use energy requirements in the society.
- Develop suitable technologies for energy management.

Course Outcomes: Student will be

1. Understand the fundamentals of energy use and energy processes in building.
2. Identify the energy requirement and its management.
3. Know the Sun-earth relationship vis-a-vis its effect on climate.
4. Be acquainted with the end-use energy requirements.
5. Be familiar with the audit procedures of energy.

UNIT- I

Overview of the significance of energy use and energy processes in building: Indoor activities and environmental control - Internal and external factors on energy use and the attributes of the factors - Characteristics of energy use and its management - Macro aspect of energy use in dwellings and its implications.

UNIT- II

Indoor environmental requirement and management: Thermal comfort - Ventilation and air quality – Air-conditioning requirement - Visual perception - Illumination requirement - Auditoryrequirement.

UNIT- III

Climate, solar radiation and their influences: Sun-earth relationship and the energy balance on the earth's surface - Climate, wind, solar radiation, and temperature - Sun shading and solar radiation on surfaces - Energy impact on the shape and orientation of buildings.

UNIT- IV

End-use, energy utilization and requirements: Lighting and day lighting - End-use energy requirements - Status of energy use in buildings Estimation of energy use in a building - Heat gain and thermal performance of building envelope - Steady and non-steady heat transfer through the glazed window and the wall - Standards for thermal performance of building envelope -Evaluation of the overall thermal transfer

UNIT- V

Energy management options: Energy audit and energy targeting - Technological options forenergy management.

Suggested Readings:

1. Michael Bauer, Peter Mösle and Michael Schwarz, *"Green Building – Guidebook for Sustainable Architecture"*, Springer, Heidelberg, Germany, 2010.
2. Norbert Lechner, *"Heating, Cooling, Lighting - Sustainable Design Methods for Architects",* Wiley, New York, 2015.
3. Mike Montoya, *"Green Building Fundamentals*", Pearson, USA, 2010.
4. Charles J. Kibert, *"Sustainable Construction - Green Building Design and Delivery*", John Wiley & Sons, New York, 2008.
5. Regina Leffers, *"Sustainable Construction and Design*", Pearson / Prentice Hall, USA, 2009.
6. James Kachadorian, *"The Passive Solar House: Using Solar Design to Heat and Cool Your Home",* Chelsea Green Publishing Co., USA, 1997.

OE 703CS

INFROMATION SECURITY

(Open Elective - II)

Instruction: 3L hours per week *Duration of SEE: 3 hours*

CIE: 30 marks *SEE: 70 marks*

Credits: 3

Course Objectives:

- To learn legal and technical issues in building secure information systems
- To provide an understanding of network security
- To expose the students to security standards and practices

Course Outcomes: Student will be

1. Describe the steps in Security Systems development life cycle(SecSDLC)
2. Understand the common threats and attack to information systems
3. Understand the legal and ethical issues of information technology
4. Identify security needs using risk management and choose the appropriate risk control strategy based on business needs
5. Use the basic knowledge of security frameworks in preparing security blue print for the organization
6. Usage of reactive solutions, network perimeter solution tools such as firewalls, host solutions such as antivirus software and Intrusion Detection techniques and knowledge of ethical hacking tools
7. Use ethical hacking tools to study attack patterns and cryptography and secure communication protocols
8. Understand the technical and non-technical aspects of security project implementation andaccreditation

UNIT – I

Introduction: History, Critical Characteristics of Information, NSTISSC Security Model, Components of an Information System, Securing the Components, Balancing Security and Access,the SDLC, the Security SDLC.

Need for Security: Business Needs, Threats, Attacks, and Secure Software Development

UNIT – II

Legal, Ethical and Professional Issues: Law and ethics in Information Security, Relevant U.S. Laws, International Laws and Legal Bodies, Ethics and Information Security.

Risk Management: Overview, Risk Identification, Risk Assessment, and Risk Control Strategies, Selecting a Risk Control Strategy, Quantitative versus Qualitative Risk Control Practices, Risk Management discussion Points, and Recommended Risk Control Practices.

UNIT – III

Planning for Security: Security policy, Standards and Practices, Security Blue Print, Security Education, Continuity strategies.

Security Technology: Firewalls and VPNs: Physical Design, Firewalls, And Protecting Remote connections.

UNIT – IV

Security Technology: Intrusion Detection, Access Control, and other Security Tools: Intrusion Detection and Prevention Systems-Scanning, and Analysis Tools- Access Control Devices.

Cryptography: Foundations of Cryptology, Cipher methods, Cryptographic Algorithms, Cryptographic Tools, Protocols for Secure Communications, Attacks on Cryptosystems

UNIT – V

Implementing Information Security: Information security project management, Technical topics ofimplementation, Non-Technical Aspects of implementation, Security Certification and Accreditation.

Security and Personnel: Positioning and staffing security function, Employment Policies and Practices, and Internal control Strategies.

Information Security Maintenance: Security management models, Maintenance model, and DigitalForensics.

Suggested Readings:

1. Michael E Whitman and Herbert J Mattord, "*Principles of Information Security*", Cengage Learning, 2011.
2. Thomas R Peltier, Justin Peltier, John Blackley, "*Information Security Fundamentals*",Auerbach Publications, 2010.
3. Detmar W Straub, Seymour Goodman, Richard L Baskerville, "*Information Security,Policy, Processes, and Practices",* PHI, 2008.
4. Mark Merkow and Jim Breithaupt *"Information Security Principle and Practices"*, Pearson Education, 2007

OE 704CS

DATA BASE MANAGEMENT SYSTEMS

(Open Elective - II)

Instruction: 3L hours per week *Duration of SEE: 3 hours*

CIE: 30 marks *SEE: 70 marks*

Credits: 3

Course Objectives:

- To introduce three schema architecture and DBMS functional components.
- To learn formal and commercial query languages of RDBMS.
- To understand the principles of ER modeling and theory of normalization.
- To study different file organization and indexing techniques.
- To familiarize theory of serializablity and implementation of concurrency control, andrecovery.

Course Outcomes: Student will be

1. Understand the mathematical foundations on which RDBMS are built.
2. Model a set of requirements using the Extended Entity Relationship Model (EER), transform an EER model into a relational model, and refine the relational model using theory of Normalization.
3. Develop Database application using SQL and Embedded SQL.
4. Use the knowledge of file organization and indexing to improve database application performance.
5. Understand the working of concurrency control and recovery mechanisms in RDBMS.

UNIT – I

Introduction: Database System Applications, Purpose of Database Systems, View of Values, Nested Sub-queries, Complex Queries, Views, Modification of the Database, Joined Relations Data, Database Languages, Relational Databases, Database Design, Object–based and Semi-structured Databases, Data Storage and Querying, Transaction Management, Data Mining and Analysis, Database Architecture, Database Users and Administrators.

Database Design and the E-R Model: Overview of the Design Process, The Entity-Relationship Model, Constraints, Entity-Relationship Diagrams, Entity – Relationship Design Issues, Weak Entity Sets, Extended E-R Features, Database Design for Banking Enterprise, Reduction to Relational Schemas, Other Aspects of Database Design

UNIT – II

Relational Model: Structure of Relational Databases, Fundamental Relational-Algebra Operations, Additional Relational – Algebra Operations, Extended Relational - Algebra Operations, Null Values, Modification of the Databases.

Structured Query Language: Data Definition, Basic Structure of SQL Queries, Set Operations, Aggregate Functions, Null

UNIT – III

Advanced SQL: SQL Data Types and Schemas, Integrity Constraints, Authorization, Embedded SQL, Dynamic SQL, Functions and Procedural Constructs, Recursive Queries, Advanced SQL Features. Relational Database Design: Features of Good Relational Design, Atomic Domains and First Normal Form, Functional-Dependency Theory, Decomposition using Functional Dependencies.

UNIT – IV

Indexing and Hashing: Basic Concepts, Ordered Indices, B^+-tree Index Files, B-tree Index Files, Multiple-Key Access, Static Hashing, Dynamic Hashing, Comparison of Ordered Indexing and Hashing, Bitmap Indices.

Index Definition in SQL Transactions: Transaction Concepts, Transaction State, Implementation of Atomicity and Durability, Concurrent Executions, Serializability, Recoverability, Implementationof Isolation, Testing for Serializability

UNIT – V

Concurrency Control: Lock-based Protocols, Timestamp-based Protocols, Validation-based Protocols, Multiple Granularity, Multi-version Schemes, Deadlock Handling, Insert and Delete Operations, Weak Levels of Consistency, Concurrency of Index Structures.

Recovery System: Failure Classification, Storage Structure, Recovery and Atomicity, Log-Based Recovery, Recovery with Concurrent Transactions, Buffer Management, Failure with Loss of Nonvolatile Storage, Advanced Recovery Techniques, Remote Backup Systems.

Suggested Readings:

1. Abraham Silberschatz, Henry F Korth, S Sudarshan, "*Database System Concepts"*, McGraw-Hill International Edition, 6th Edition, 2010.
2. Ramakrishnan, Gehrke, "*Database Management Systems"*, McGraw-Hill International Edition, 3rd Edition, 2003.
3. Elmasri, Navathe, Somayajulu, "*Fundamentals of Database Systems"*, Pearson Education,4th Edition, 2004.

OE 705EC

EMBEDDED SYSTEMS

(Open Elective - II)

Instruction: 3L hours per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- To gain knowledge to design embedded systems.
- To understand the processor selection criteria for Embedded System Design.
- To gain the knowledge of ARM Cortex on Zynq for embedded systems.
- To gain the knowledge of tool chain for embedded systems.
- To understand the importance of RTOS in building real time systems

Course Outcomes: Student will be

1. Design an embedded system.
2. Distinguish between RISC and CISC
3. Use the ARM Cortex for design of embedded system
4. Use Embedded Software Development Tools for Designing Embedded System applications
5. Apply their understanding in building real time systems

UNIT-I

Introduction To Embedded Systems: The Embedded Design Life Cycle - Product Specification, Hardware/Software Partitioning, Iteration and Implementation, Detailed Hardware (selection fo processor) and Software Design, Hardware/Software Integration, Product Testing And Release, Maintenance and Upgradation.

UNIT-II

ARM Embedded Systems: The RISC design philosophy, The ARM design philosophy, ARM processor fundamentals, registers, current program status register, pipeline, exceptions, interrupts,and vector table, core extensions, architecture revisions, ARM processor families.

UNIT-III

Embedded processing with ARM CORTEX on Zynq: Fundamentals of FPGA, types of FPGA, case study of Xilinx FPGA, Processing System, programmable logic, programmable logic interfaces, security, Zynq 7000 family members, Zynq versus standard FPGA, Zynq versus standard processor.

UNIT-IV

Embedded Software Development Tools: Host and Target Machines, Cross Compilers, Cross Assemblers, Tool Chains, Linkers/Locators for Embedded Software, Address Resolution, and Locator Maps. Getting Embedded Software into Target System: PROM programmer, ROM emulator, In Circuit- Emulators, Monitors, Testing on Your Host Machine - Instruction Set Simulators, Logic Analyzers.

UNIT-V

Introduction to Real Time Operating Systems: Tasks and task states, tasks and Data, Semaphores and shared data. Operating system services: Message queues, mailboxes and pipes, timer functions, events, memory management, Interrupt routines in an RTOS environment.

Suggested Readings:

1. Arnold S Berger, "*Embedded Systems Design"*, South Asian edition, CMP Books, 2005.
2. Andrew Sloss, Dominic Symes, Chris Wright, *ARM "System Developer's Guide: Designingand Optimizing System Software",* Elsevier, 2004.
3. Louise H Crockett, Ross. A. Elliot et al "*The Zynq Book*", Edition 1, Strathclyde academicmedia, July 2014.
4. David E Simon, "*An Embedded software primer*", Pearson, 2012

With effect from the Academic year 2021-22

OE 706EC

VERILOG HDL

(Open Elective - II)

Instruction: 3L hours per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- To familiarize with various modeling styles: structural, dataflow and behavioral of Verilog HDL.
- To develop combinational and sequential circuits using various modeling styles of Verilog HDL
- To design and develop Verilog HDL models of data path and control units of Central Processing Unit (CPU)
- To learn Synthesis and FPGA design flow.
- To design and develop real time applications: Booth's multiplier, Divider, hardwired control for basic CPU, FIR filter.

Course Outcomes: Student will be

1. Implement and distinguish different Verilog HDL modeling styles
2. Construct and analyze Verilog HDL models of combinational and sequential circuits
3. Design and develop Verilog HDL modeling and test bench for digital systems for the given specifications
4. Outline FPGA design flow and timing analysis

UNIT - I

Introduction to HDL: Overview and Importance of HDLs, Differences between HLL, HDL and ALP. Design methodologies, Modules, Lexical Conventions, Number Specifications, Strings, Identifiers and Keywords Data types, System task and compiler Directives, Port declaration and port connection rules

UNIT - II

Structural and Dataflow modeling: gate-level modeling, delays, hazards, dataflow modeling: Continuous Assignments, Delays, Expressions, Operators and Operands, Operator Types and Design Examples

UNIT - III

Behavioral Modeling: Structured Procedures, Procedural Assignments, Timing Controls, Conditional Statements, multi-way branching, Loops, Sequential and Parallel blocks, Generate blocks. Combinational, sequential logic modules Simulation: Types of Simulation, Event driven Simulation and Cycle Based Simulation; design examples.

UNIT - IV

Synthesis and Verification: Tasks and Functions: Differences between Tasks and Functions, Tasks and Functions. Verilog HDL synthesis, synthesis, Application Specific IC (ASIC) and Field Programmable Gate Array (FPGA) design flow. Verification: Timing analysis and Test bench design. Design examples.

UNIT - V

Real time implementations: Fixed-Point Arithmetic modules: Addition, Multiplication, Division, Arithmetic and Logic Unit (ALU), Timer, Universal Asynchronous Receiver and Transmitter (UART), DSP modules: FIR and IIR filters, CPU design: Data path and control units.

Suggested Reading:

1. Samir Palnitkar, *"Verilog HDL A Guide to Digital Design and Synthesis,"* 2nd Edition, Pearson Education, 2006.
2. Ming-Bo Lin, "*Digital System Designs and Practices: Using Verilog HDL and FPGA,"* Wiley India Edition, 2008.
3. J. Bhasker, *"A Verilog HDL Primer*," 2nd Edition, BS Publications, 2001.

With effect from the Academic year 2021-22

OE 707EC

SATELLITE COMMUNICATION AND APPLICATIONS

(Open Elective - II)

Instruction: 3L hours per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- To familiarize with basic concepts related to satellite Communication.
- To understand Sub-Systems of Satellites and Launches.
- To design the Earth Station antennas.
- To know about the parameters affecting the Satellite System Performance.
- To understand the applications of satellites.

Course Outcomes: Student will be

1. Able to have knowledge about the Satellite communications Principles and Properties.
2. Able to know about the Space craft subsystems and Launch vehicles.
3. Able to design the Satellite Earth station antennas
4. Able to analyze the effects of various parameters on Satellite System performance.
5. Able to understand the applications of Satellite Communication.

UNIT–I

Origin of Satellite communications, A Brief History of Satellite Communication, Basic principlesand properties of satellite communication. Earth segment, Space segment, Interpretation of Kepler's Laws. Orbital Mechanics: The Equation of the Orbit, Describing the Orbit, Locating the Satellite inthe Orbit, Orbital effects in communication system Performance: Doppler shift, Range variation, Eclipse and Sun-Transit Outage.

UNIT– II

Space craft sub systems, Equipment Reliability and Space Qualification: Space Qualification, Reliability, and Redundancy, Satellite launch and launch vehicles and Mechanics of Launching a Synchronous Satellite.

UNIT– III

Earth Stations: Earth Station Design for Low System Noise Temperature, Design of large antennasand small earth station antennas. Low noise amplifiers and High power Amplifiers for Satellite communication.

UNIT– IV

Satellite Link Design: Basic Transmission Theory, System Noise Temperature and G/T ratio: Noise Temperature, calculation of System Noise Temperature, Noise Figure and Noise Temperature, Propagation on Satellite-Earth paths: Attenuation, depolarization, atmospheric absorption, Tropospheric Multipath effects and Land and Sea Multipath, Multipath Effects in System Design,Faraday rotation in the Ionosphere, Ionospheric scintillations, Rain and ice effects.

UNIT– V

Satellite Navigation Applications: Global and Regional Satellite Navigation Systems- Operating Principles, Advantages, Limitations, Current Status and Applications, Remote Sensing Satellites.

Suggested Readings:

1. Wilbur L. Pitchand and Henri G. Suyderhoud, Robert A. Nelson, "*Satellite Communication Systems Engineering",* 2nd edn.3rd Impression, Pearson Education.2008.
2. Timothy Pratt and Charles Nestian. W, "*Satellite Communication"*, John Wiley and Sons, 1988.
3. Tri T. Ha, "*Digital Satellite Communication"*, Tata McGraw- Hill, Special Indian Edition2009.

With effect from the Academic year 2021-22

OE 708EE

OPTIMIZATION TECHNIQUES

(Open Elective - II)

Instruction: 3L hours per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- To understand the need and basic concepts of operations research and classify the optimization problems.
- To study about the linear programming and non-linear programming concepts and their applications
- To understand various constrained and un-constrained optimization techniques and their applications.
- To understand the concepts and implementation of Genetic Algorithms to get the optimum solutions
- To study the concepts of Metaheuristics Optimization techniques

Course Outcomes: Student will be

1. Analyze any problem of optimization in an engineering system and able to formulate a mathematical model to the problem and solving it by the techniques that are presented.
2. Solve problems of L.P. by graphical and Simplex methods.
3. Apply various constrained and un-constrained optimization techniques for the specific problems.
4. Could able to implement the Genetic Algorithms to solve the for optimum solution.
5. Understands the concepts to use the Metaheuristics Optimization techniques

UNIT – I

Introduction: Definitions, Characteristics, Objective function, Classification of optimization problems, Engineering applications and limitations. Single-Variable Optimization, Multivariable Optimization with No Constraints, Multivariable Optimization with Equality Constraints and Multivariable Optimization with Inequality Constraints: Kuhn–Tucker Condition

UNIT – II

Linear Programming: Definitions and Formulation of the LPP, Construction of L.P. Models, Slack and surplus variables, Standard form, Canonical form and matrix form of LP Problems. Artificial Variables, solution by the Big-M method, Duality principle, Dual problems and numerical problems.

UNIT – III

Random Search Methods concepts: Direct Search Methods - Univariate Method, Gradient of a Function, Indirect Search Methods - Gradient of a Function, Steepest Descent (Cauchy) Method, Newton's Method.

UNIT – IV

Binary Genetic Algorithm: Genetic Algorithms Natural Selection on a Computer, Components of a Binary Genetic Algorithm. Selecting the Variables and the Cost Function. Variable

Encoding and Decoding, the Population, Natural Selection, Selection, Mating. Mutations, the Next Generation and Convergence, Components of a Continuous Genetic Algorithm.

UNIT – V

Metaheuristics Optimization: Concepts of Simulated Annealing, Theoretical approaches, Advantages and disadvantages, applications, Ant Colony Algorithms - Introduction, Collective behavior of social insects, Formalization and properties of ant colony optimization.

Suggested Readings

1. Rao, S.S., *"Engineering Optimization: Theory and Practice",* John Wiley & Sons, Inc., 2009
2. Taha, H.A., *"Operations Research, Pearson Education India",* New Delhi, India, 2008.
3. Randy L. Haupt and Sue Ellen Haupt, *"Practical genetic algorithms"* second edition, a John Wiley & sons, inc., publication -2004.
4. Sharma J.K., "*Operation Research: Theory and Applications"* Fifth Edition, Macmillan Publishers, New Delhi, India, 2013.
5. J. Dreo A. Petrowski, P. Siarry E. Taillard, *"Metaheuristics for Hard Optimization"* Springer.

With effect from the Academic year 2021-22

OE 709EE

NON-CONVENTIONAL ENERGY SOURCES

(Open Elective - II)

Instruction: 3L hours per week *Duration of SEE: 3 hours*

CIE: 30 marks *SEE: 70 marks*

Credits: 3

Course Objectives:

- To understand the different types of energy sources
- To Understand the need of non-conventional energy sources and their principles
- To understand the limitations of non-conventional energy sources
- To outline division aspects and utilization of renewable energy sources for diriment application
- To analyze the environmental aspects of renewable energy resources

Course Outcomes: Student will be able to

1. Know the different energy resources and need of renewable energy resources
2. Understand the concepts of working of fuel cell systems along with their applications
3. Describe the use of solar energy and the various components and measuring devices used in the energy production and their applications
4. Appreciate the need of Wind Energy and their classification and various components used in energy generation and working of different electrical wind energy system
5. Understand the concept of OTEC technology, Biomass energy resources and different types of biogas Plants used in India

UNIT- I

Review of Conventional and Non-Conventional energy sources, Need for non-conventional energy sources Types of Non-conventional energy sources, Fuel Cells, Principle of operation with special reference to H2O2 Cell, Classification and Block diagram of fuel cell systems, Ion exchange membrane cell, Molten carbonate cells, Solid oxide electrolyte cells, Regenerative system, Regenerative Fuel Cell, Advantages and disadvantages of Fuel Cells, Polarization, Conversion efficiency and Applications of Fuel Cells.

UNIT-II

Solar energy, Solar radiation and its measurements, Solar Energy collectors, Solar Energy storage systems, Solar Pond, Application of Solar Pond, Applications of solar energy.

UNIT-III

Wind energy, Principles of wind energy conversion systems, Nature of wind, Power in the Wind, Basic components of WECS, Classification of WECS, Site selection considerations, Advantages and disadvantages of WECS, Wind energy collectors, Wind electric generating and control systems, Applications of Wind energy, Environmental aspects.

UNIT-IV

Energy from the Oceans, Ocean Thermal Electric Conversion (OTEC) methods, Principles of tidal power generation, Advantages and limitations of tidal power generation, Ocean waves, Wave energy conversion devices, Advantages and disadvantages of wave energy, Geo-thermal Energy, Types of Geo-thermal Energy Systems, Applications of Geo-thermal Energy.

UNIT-V

Energy from Biomass, Biomass conversion technologies / processes, Photosynthesis, Photosynthetic efficiency, Biogas generation, Selection of site for Biogas plant, Classification of Biogas plants, Details of commonly used Biogas plants in India, Advantages and disadvantages of Biogas generation, Thermal gasification of biomass, Biomass gasifies.

Suggested Readings:

1. Rai G.D, *"Non-Conventional Sources of Energy",* Khandala Publishers, New Delhi, 1999.
2. M. M. El-Wakil, *"Power Plant Technology"*, McGraw Hill, 1984.

With effect from the Academic year 2021-22

OE 710ME

STARTUP ENTREPRENEURSHIP

(Open Elective - II)

Instruction: 3L hours per week *Duration of SEE: 3 hours*

CIE: 30 marks *SEE: 70 marks*

Credits: 3

Course Objectives:

- To motivate students to take up entrepreneurship in future
- To learn nuances of starting an enterprise by creative thinking and shape ideas into reality.
- To understand action driven business plan and learn to prepare project budget.

Course Outcomes: Student will be able to

1. Think creatively and transform ideas into reality.
2. Differentiate market transforming strategy.
3. Create a complete business plan and workout the budget plan.

UNIT – I

*Creativity & Discovery***:** Definition of Creativity, self-test creativity, discovery and delivery skills, The imagination threshold, Building creativity ladder, Collection of wild ideas, Bench marking the ideas, Innovative to borrow or adopt, choosing the best of many ideas, management of tradeoff between discovery and delivery, Sharpening observation skills, reinventing self, Inspire and aspire through success stories

UNIT – II

*From Idea to Startup***:** Introduction to think ahead backward, Validation of ideas using cost and strategy, visualizing the business through value profile, activity mapping, Risks as opportunities, building your own road map

UNIT – III

Innovation career lessons: Growing & Sharing Knowledge, The Role of Failure In Achieving Success, Creating vision, Strategy, Action & Resistance: Differentiated Market Transforming Strategy; Dare to Take Action; Fighting Resistance; All About the startup Ecosystem; Building a Team; Keeping it Simple and Working Hard.

UNIT – IV

Action driven business plan: Creating a completed non-business plan (a series of actions each of which moves your idea toward implementation), including a list of the activities to be undertaken, with degrees of importance (scale of 1 to 3, where 1 is 'most important'). A revision of the original product or service idea, in light of information gathered in the process, beginning to design the business or organization that will successfully implement your creative idea. Preparing an activity map.

UNIT – V

Startup financing cycle: Preparing an initial cash flow statement, showing money flowing out (operations; capital) and flowing in. Estimate your capital needs realistically. Prepare a bootstrapping option (self-financing). Prepare a risk map. Prepare a business plan comprising five sections: The Need; The Product; Unique Features; The Market; Future Developments. Include a Gantt chart (project plan – detailed activities and starting and ending dates); and a project budget.

Suggested Readings:

1. Vasant Desai, *"Dynamics of Entrepreneurial Development and Management"*, Himalaya Publishing House, 1997.
2. Prasanna Chandra, *"Project – Planning, Analysis, Selection, Implementation and Review",* Tata McGraw-Hill Publishing Company Ltd., 1995.
3. B. Badhai, "*Entrepreneurship for Engineers*", Dhanpath Rai & Co., Delhi, 2001.
4. Stephen R. Covey and A. Roger Merrill, "*First Things First",* Simon and Schuster, 2002.
5. Robert D. Hisrich and Michael P.Peters, *"Entrepreneurship*", Tata McGraw Hill Edition, 2002.

With effect from the Academic year 2021-22

OE 711ME

NANO TECHNOLOGY

(Open Elective - II)

Instructions: (3L) hrs per week *Duration of SEE: 3hours*
CIE: 30 Marks *SEE: 70 Marks*
Credits: 3

Course Objectives:

- To familiarize Nano materials and technology.
- To understand Nano structures, fabrication and special Nano materials.

Course Outcomes: Upon successful completion of this course, the student will be able to:

1. To understand that properties of materials are size and shape dependent
2. To learn key concepts in understanding fabrication techniques
3. To critically analyze properties of nanomaterial for future engineering applications
4. To understand various approaches to synthesis of nanostructures

UNIT-I

Introduction: Nanoscale, Properties at Nanoscale, advantages and disadvantages, importance of Nano Technology,
Bottom-up and Top-down approaches, challenges in Nanotechnology.

UNIT-II

Materials of Nano Technology: Introduction-Si-based materials, Ge-based materials, Smart materials, metals, Ferroelectric materials, Polymer materials, GaAs & InP (III-V) group materials, Nano tribology and Materials, Principles and analytical techniques of XRD, SEM, TEM and STM/AFM.

UNIT-III

Nano Structures: Zero dimensional Nano structure (Nano Particles)- Synthesis procedure, characterization techniques, properties and applications of Nano Particles
One dimensional Nano structures (Nano Wires, Nano Tubes)- Various Synthesis procedure, characterization procedure and principles involved, properties and applications of Nano Wires, Types of Nano Tubes, Synthesis procedure, characterization properties and applications of Nano Tubes.

UNIT-IV

*Nano Fabrication***:** Introduction, Basic fabrication techniques (Lithography, thin film deposition, and doping) MEMS fabrication techniques, Nano fabrication techniques (E-beam Nano-imprint fabrication, Epitaxy and strain engineering, Scanned probe techniques).

UNIT-V

Special Nano Materials: Nano Composites: Introduction, Synthesis procedures, various systems (metal-polymer, metal- ceramics and polymer-Ceramics), Characterization procedures, applications.
*Nano Biomaterials***:** Introduction, Biocompatibility, anti-bacterial activity, principles involved, applications.

Suggested Reading:

1. A.K.Bandyopadyay, "*Nano Materials",* New Age Publications, 2007.
2. T. Pradeep, *"Nano: The Essentials: Understanding Nanoscience and Nanotechnolgy"*, Tata McGraw-Hill, 2008.
3. Carl. C. Koch, *"Nano Materials Synthesis, Properties and Applications",* Jaico Publishing House, 2008.
4. Willia Illsey Atkinson, *"NanoTechnology*", Jaico Publishing House, 2009.

With effect from the Academic year 2021-22

PC 752 CE

COMPUTER APPLICATIONS LABORATORY

Instruction: 2 periods per week *Duration of Semester End Examination: 3 hours*
CIE: 25marks *SEE: 50 marks*
Credits: 1

Course Objectives:

- Understand the design steps for preparation algorithm for typical simple structural problems
- Understand the algorithm and steps for typical Geotechnical Engineering problems
- Understand to prepare steps for hydraulics related problems

Course Outcomes:

1. Ability to develop and execute computer code for simple structural elements
2. Ability to develop code for Geotechnical application problems
3. Get skill to prepare computer code for Hydraulic problems for flow measurements

1. Calculation of shear force *I* bending moment at any section for a simply supported beam carrying a u.d.l., shorter than span.
2. Structural design of an RCC beam section using limit state method, given are the grade of concrete, grade or steel, BM and SF.
3. A rectangular cross section is subjected to a non-central force parallel to axis of member. Determine the stresses at any location of the section. Direct and bending stresses.
4. Compute distribution of increment in vertical stress due to applied point load ona (a) Horizontal Plane (b) Vertical plane. Using the computed values, plot the distribution utilizing VC as front-endtool.
5. Compute the values of a pressure bulb and using the values plot pressure bulb utilizing VC as front-end tool.
6. Compute the consolidation settlement duly dividing the strata in to infinitesimally small layers to fulfill the Terzaghi' sassumption.
7. Compute earth pressure on to a retaining wall and check its stability.
8. Compute bearing capacity of a shallow foundation as per IS: 6403-1980
9. Develop a code in C to design a single vertical pile, pile group to suit various ground conditions.
10. Computation of discharge over a rectangular notch using velocity of approach
11. Calculation of normal depth in a trapezoidal channel
12. Calculation of critical depth in a trapezoidal channel
13. Calculation of Φ-index
14. Estimation of specific capacity and maximum pumping rate of a well
15. Analysis of pipe network in water distribution systems
16. Flood routing using Muskigham's method
17. Design of an irrigation channel using Kennedy's theory by 3 approaches
18. Design of trapezoidal notch canal fall

With effect from the Academic year 2021-22

PW 762 CE

MAJOR PROJECT PHASE -I

Instruction: 4 periods per week *Duration of SEE: --*
CIE: 50 marks *SEE: -- marks*
Credits: 2

Course Objectives:

- To enhance practical and professional skills.
- To familiarize tools and techniques of systematic literature survey and prepare documentation
- To expose the students to industry practices and ability to work as team.
- To encourage students to work with innovative and entrepreneurial ideas

Course Outcomes:

1. Demonstrate the ability to synthesize and apply the knowledge and skills acquired in the Academic program to real-world problems
2. Ability to collect the relevant literature and information in an organized manner
3. Evaluate different solutions based on economic and technical feasibility
4. Effectively plan a project and confidently perform all aspects of project management
5. Demonstrate effective technical write up and oral communication skills

The Department can initiate the project allotment procedure at the end of VI semester and finalize it in the first two weeks of VII semester. The department will appoint a project coordinator who will coordinate the following:
Collection of project topics/ descriptions from faculty members (Problems can also be invited from the industries)
Grouping of students (3 to 5 in a group maximum)
Allotment of project guides
The aim of project work is to develop solutions to realistic problems applying the knowledge and skills obtained in different courses, new technologies and current industry practices. This requires students to understand current problems in their domain and methodologies to solve these problems. After completion of these seminars each group has to formalize the project proposal based on their own ideas or as suggested by the project guide.

Seminar schedule will be prepared by the coordinator for all the students from the 5^{th}week to the last week of the semester which should be strictly adhered to.

Each group will be required to:
1. Submit a one-page synopsis before the seminar for display on notice board.
2. Give a 30 minutes presentation followed by 10 minutes discussion.
3. Submit a technical write-up on the talk.

At least two teachers will be associated with the Project Seminar to evaluate students for the award of sessional marks which will be on the basis of performance in all the 3items stated above.
The seminar presentation should include the following components of the project:

- Problem definition and specification
- Literature survey
- Broad knowledge of available techniques to solve a particular problem.
- Planning of the work, preparation of bar (activity) charts
- Presentation- oral and written.

With effect from the Academic year 2021-22

PW 653 CE

SUMMER INTERNSHIP*

Instruction: 6 weeks **CIE: 50 marks**
Credits 2

Course Objectives:

1. To expose the students in understanding the real-life practical problems and technologies.
2. To provide an opportunity to integrate various aspects of learning reference of practical problems.
3. To enhance the confidence of the students by interaction with field professionals

Course Outcomes: Student will be

1. Able to design or develop a simple software suitable to industry
2. Able to complete the task or realize a prespecified target within a limited scope.
3. Able to learn to find alternate viable solutions for a given problem based on criteria.
4. Able to learn new software suitable for Civil Engineering problems.
5. Ability to learn field constraints and also documentation of technical report.

Summer Internship is introduced as part of the curricula to encourage students to work on problems of interest to industries or in a consulting organization. A batch of two or three students will be attached to Industry/ R & D Organization / National Laboratory / Consultants / Project offices/ Executing Agencies /Departments/ Private Builders for a period of SIX weeks. This will be during the summer vacation followed after the completion VI semester course. Faculty member (s) will be acting as an internal guide(s) for the batches to mentor and monitor the progress and also interacts with the Industry guide (s) as per the need.

After the completion of the internship, students need to submit a brief technical report on the project executed and present the work through a seminar talk to be organized by the Department. Award of sessional are based on the performance of the student at the work place and will be judged by internal guide (s) (25 Marks) followed by presentation before the committee constituted by the Department (25 Marks). One faculty member will coordinate the overall activity of Summer Internship.

***Students have to undergo summer internship of 6 Weeks duration at the end of semester VI and the credits will be awarded after evaluation in VII semester.**

With effect from the Academic year 2021-22

SCHEME OF INSTRUCTION FOR B.E. (CIVIL ENGG)
VIII SEMESTER

S.No.	Course Code	Course Title	Scheme of Instruction			Contact hr/week	Scheme of Examination		Credits
			L	T	P		CIE	SEE	
1	OE III	Open Elective - III	2	0	0	2	30	70	2
2	MC 902 AS	Essence of Indian Traditional Knowledge	2	0	0	2	30	70	0
3	PW 851 CE	Major Project Phase -II / Internship	-	-	12	12	50	100	6
		Total	**4**	**-**	**12**	**16**	**110**	**240**	**8**
									157.5

code	**Open Elective Course-III**
OE801BM	Basic Medical Equipment
OE802CS	Data Science Using R
OE803EC	Mobile Communication
OE804EC	Internet of Things and Applications
OE805EC	Global and Regional Satellite Navigation System
OE806EE	Applications of Electrical Energy
OE807 ME	Composite material Applications
OE808 ME	Industrial Administration and Financial Management
OE809CS	Software Engineering
OE810CS	Python Programming
OE811CS	Cyber Security

MOOCS / ONLINE COURSES

OFFERED BY OTHER PREMIER INSTITUTES ARE DISCUSSED IN FACULTY MEETING AND APPROVED LIST OF SUBJECTS WILL BE SENT TO COORDINATOR FOR THOSE STUDENTS WHO ASPIRE FOR HIGHER CREDITS AND FOR THOSE STUDENTS FULL SEMSTER INTERNSHIP PROGRAM.

OE801 BM

BASIC MEDICAL EQUIPMENT

(OPEN ELECTIVE-III)

Instruction: 3 Periods per week *Duration of SEE: 3 hours*
CIE: 30 Marks *SEE: 70 Marks*
Credits: 3

Course objectives:

- To make the students understand the need for several Biomedical Equipments.
- To make the students understand the operating principles of a wide range of Biomedical Equipment.

Course outcomes: Upon completion of the course, the students will be able to:

1. Learn about various physiological parameters, monitoring and recording.
2. Assess the need and operating principle of equipment used in physiotherapy
3. Interpret the working principle and operating procedure and applications of Medical Imaging equipments.
4. Perceive the governing principles and functions of critical care equipments.
5. Learn about the various Therapeutic Equipment used for different applications

UNIT-I

*Medical Monitoring and recording***:** Patient monitoring: System concepts, bedside monitoring systems, central monitors, heart rate and pulse rate measurement. Temperature measurement Blood pressure measurement: Direct and indirect methods. Respiration rate measurement: Impedance pneumograph, Apnoea detectors. Ambulatory monitoring: Arrhythmia monitor,

UNIT-II

Physiotherapy and Electrotherapy Equipment: Diathermy machines: Short wave diathermy, Microwave diathermy and ultrasonic diathermy Electro diagnostic/Therapeutic apparatus: Nerve muscle stimulator, Functional electrical stimulator etc.

UNIT-III

Medical Imaging Equipment:

X-Ray machines: Properties and production of X-Rays, X-ray machine, Image Intensifier. X-ray computed tomography: basic principle and construction of the components. Ultrasonic Imaging: Physics of ultrasonic waves, medical ultrasound, basic pulse echo apparatus. Magnetic Resonance Imaging: Principle, Image reconstruction techniques, Basic NMR components, Biological effects, Merits.

UNIT-IV

Critical care Equipment:

Ventilators: Mechanics of respiration, artificial ventilators, Positive pressure ventilator, Types and classification of ventilators. Drug delivery system: Infusion pumps, basic components, implantable infusion system, closed loop control in infusion pump. Cardiac Defibrillators: Need for defibrillators, DC defibrillator, Implantable defibrillators, Defibrillator analyzer.

UNIT-V

Therapeutic Equipment:

Cardiac pacemakers: Need for cardiac pacemakers, External and implantable pacemakers, types. Dialysis Machine: Function of kidney, artificial kidney, Dialyzers, Membranes, Hemodialysis machine. Lithotripters: The stone diseases problem, Modern Lithotripter systems, extra corporeal shockwave therapy.

Suggested Readings:

1. R.S.Khandpur, Hand Book of Biomedical Instrumentation, Tata McGrawHill, Second Edition, 2014.
2. John G.Webster, Medical Instrumentation Application and design, Wiley India Edition, 2009.

OE 802CS

DATA SCIENCE USING R

(Open Elective - III)

Instruction: (3L) hours per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- To learn basics of R Programming environment: R language, R-studio and R packages
- To learn various statistical concepts like linear and logistic regression, cluster analysis, time series forecasting
- To learn Decision tree induction, association rule mining and text mining

Course Outcomes: Student will be able to

1. UsevariousdatastructuresandpackagesinRfordatavisualizationandsummarization
2. Uselinear,non-linearregressionmodels,andclassificationtechniquesfordataanalysis
3. Use clustering methods including K-means and CURE algorithm

UNIT-I

Introduction to R: Introduction, Downloading and Installing R, IDE and Text Editors, Handling Packages in R.

*Getting Started with R***:** Introduction, Working with Directory, Data Types in R , Few Commands for Data Exploration.

*Loading and Handling Data In R***:** Introduction, Challenges of Analytical Data Processing, Expression, Variables, Functions, Missing Values Treatment In R, Using 'As' Operator To Change The Structure Of The Data, Victors, Matrices, Factors, List, Few Common Analytical Tasks, Aggregation And Group Processing Of A Variable, Simple Analysis Using R, Methods For Reading Data, Comparison Of R GUI's For Data Input, Using R With Databases And Business Intelligence Systems.

UNIT-II

Exploring Data In R: Introduction, Data Frames, R Functions for Understanding Data in Data Frames, Load Data Frames, Exploring Data, Data Summary, Finding the Missing Values, Invalid Values and Outliers, Descriptive Statistics, Spotting Problems In Data with Visualization.

UNIT-III

Linear Regression Using R: Introduction, Model Fitting, Linear Regression, Assumptions of Linear Regression, Validating Linear Assumption.

Logistic Regression: Introduction, What Is Regression? Introduction to Generalized Linear Model, Logistic Regression, Binary Logistic Regression, Diagnosing Logistic Regression, Multinomial Logistic Regression Model.

UNIT-IV

Decision Tree: Introduction, What Is a Decision Tree? Decision Tree Representation In R, Appropriate Problems For Decision Tree Learning, Basic Decision Tree Learning Algorithm, Measuring Features, Hypothesis Space Search In Decision Tree Learning, Inductive Bias In Decision Tree Learning, Why Prefer Short Hypotheses, Issues In Decision Tree Learning.

*Time Series in R***:** Introduction, What Is Time Series Data, Reading Time Series Data, Decomposing Time Series Data, Forecasts Using Exponential Smoothing, ARIMA Models.

UNIT-V

Clustering: Introduction, What Is Clustering, Basic Concepts in Clustering, Hierarchical Clustering, K-Means Algorithm, CURE Algorithm, Clustering in Non-Euclidean Space, Clustering for Streams and Parallelism.

Association Rules: Introduction, Frequent Item set, Data Structure Overview, Mining Algorithm Interfaces, Auxiliary Functions, Sampling from Transaction, Generating Synthetic Transaction Data, Additional Measures of Interestingness, Distance Based Clustering Transaction and Association.

*Text Mining***:** Introduction, Definition of Text Mining, A Few Challenges in Text Mining, Text Mining Verses Data Mining, Text Mining In R, General Architectures of Text Mining Systems, Pre-Processing of Documents In R, Core Text Mining Operations, Using Background Knowledge for Text Mining, Text Mining Query Languages.

Mining Frequent Patterns, Associations and Correlations: Basic Concepts and Methods. Frequent Item set, Closed Item set And Association Rules.

Frequent Item set: Mining Methods, Pattern Evaluation Methods, and Sentiment Analysis

Suggested Readings:

1. Seema Acharya, "*Data Analytics using R",* Mc Graw Hill education.
2. Nina Zumel and John Mount, "*Practical Data Science with R"*, Manning Shelter Island.
3. Crawley, MichaelJ., " *The R book",* John Wiley & Sons, Ltd

OE 803EC

MOBILE COMMUNICATION

(Open Elective - III)

Instruction: (3L) hours per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- Understand basics of Cellular systems, their generations and Characteristics of Mobile Communications.
- Understand the Frequency reuse mechanism for Mobile operations and Co-Channel interference concepts
- Understand the Mobile signal Coverage in different terrains and Lee models
- Understand the working of Antennas at Cell-site and at Mobile units.
- Understand the various Handoff mechanisms and Concept of Dropped calls

Course Outcomes: Student will be

1. Able to analyze the various operational features of Mobile Communication Systems
2. Able to deal with the Mobile communication system designs of Frequency re-use and Interference Factors
3. Able to carry out the Design aspects of Mobile signal coverage over different terrains
4. Able to analyze the different Cell-site and Mobile antennas for different applications
5. Able to characterize the Handoffs mechanisms.

UNIT – I

Introduction to Cellular Mobile Communications:

History of Mobile cellular: AMPS system (First-generation systems), Second-generation System, 3G Systems, 4G Systems, 5G Systems, Other Cellular-like Systems, Spectrum allocation, Spectrum Efficiency Considerations.

Basic Cellular systems, Circuit-Switched and Packet-Switched Systems, Performance criteria, Voice quality, Data quality, Picture quality, Service quality and special features.

Uniqueness of Mobile Radio Environment, Description of Mobile Radio Transmission Medium, Model of Transmission Medium, Mobile Fading characteristics, The Radius of Active Scatter region, Delay spread and Coherence Bandwidth, Noise level in Cellular Frequency band

UNIT – II

Frequency Reuse Concept and Cellular system Components:

Concept of Frequency reuse channels, Frequency reuse schemes, Frequency reuse distance, Number of Customers in the System, Co-Channel Interference Reduction Factor, Desired C/I from a Normal case in an Omni-directional antenna System, Handoff mechanism, Cell splitting, Consideration of the Components of Cellular Systems, Antennas, Switching equipment and Data Links.

UNIT – III

Cell Coverage:

General Introduction, Ground Incident angle and Ground Elevation angle, Ground Reflection angle and Reflection point, Obtaining the Mobile Point-to-Point Model (Lee Model), A standard condition, Obtain Area-to-Area Prediction model, The Phase difference between a direct path and ground-reflected path, A general formula for Mobile Radio Propagation

Propagation over water or Flat open area, Between Fixed stations, Land-to-Mobile transmission over water, Foliage Loss, Propagation in Near-In distance, Long distance propagation, Obtain Path loss from a Point-to-Point Prediction Model in Non-obstuctive condition and obstructive condition, Form of a Point-to-Point Model, General Formula and its Merit

UNIT – IV

Cell-Site and Mobile Antennas:

Antennas at Cell-site, Omnidirectional antennas, Directional antennas, Location antennas, Set-up Channel antennas, Space Diversity Antennas at cell site, Umbrella-Pattern Antennas, Interference reduction antennas, Unique Situations of Cell-Site antennas, Smart antennas, types and applications

Mobile Antennas, Roof-mounted antenna, Glass-Mounted antenna, High-gain antenna, horizontally and vertically oriented Space-Diversity Antennas.

UNIT – V

Handoff and Dropped Calls:

Value of Implementing Handoffs, Types of Handoff, Initiation of Hard Handoff, Delaying a Handoff, Forced Handoffs. Queuing of handoffs, Power difference Handoffs, MAHO and Soft Handoff, Cell-site Handoff only, Intersystem Handoff

Introduction to Dropped Call Rate and Formula of Dropped Call Rate

Suggested Readings:

1. William C.Y.Lee, *"Wireless and Cellular Telecommunications*", 3rd International edition, McGraw Hill, 2006
2. Theodere S. Rappaport, *"Wireless Communications, Principles and Practice*", 2nd edition, Prentice Hall, 2003.
3. Gordon L. Stuber. "*Principles of Mobile Communications",* 3rd edition, Springer Publications, 2011.

OE 804EC

INTERNET OF THINGS AND APPLICATIONS

(Open Elective - III)

Instruction: (3L) hours per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- To introduce the concepts of automation in daily life.
- To familiarize the concepts of all IoT based communication systems.
- To understand the importance of cloud technologies in the field of IoT.
- To get familiar with standard embedded boards like Raspberry Pi.
- To study a real time system with a view of an application program interface (API).

Course Outcomes: Student will be

1. Able to design IoT based solutions for given problem statements.
2. Able to develop programs for Raspberry Pi.
3. Able to demonstrate the functionality of cloud communication.
4. Able to analyze the technologies used in IoT.
5. Able to incorporate multiple sensors to develop an IoT based system.

UNIT- I

Introduction to Internet of Things

Definition and Characteristics of IoT, Physical Design of IoT: Things in IoT,IoT protocols, Logical Design of IoT: IoT functional Blocks, Communication Models, APIs, IoT enabling TEchnologies: Wireless Sensor Networks, Cloud Computing, Big Data Analytics IoT Applications: Smart Home, Smart Cities, Smart Environment, Smart Energy, Smart Retail and Logistics, Smart Agriculture and Industry, Smart Industry and smart Health (Ref1)

UNIT- II

Internet Principles and communication technology

Internet Communications: An Overview – IP, TCP, IP protocol Suite, UDP. IP addresses – DNS, Static and Dynamic IP addresses, MAC Addresses, TCP and UDP Ports, Application Layer Protocols – HTTP, HTTPS, Cost Vs Ease of Production, Prototypes and Production, Open Source
Vs Closed Source. Prototyping Embedded Devices – Sensors, Actuators, Microcontrollers, SoC, Choosing a platform, Prototyping Hardware platforms – Arduino, Raspberry Pi. Prototyping the physical design – Laser Cutting, 3D printing, CNC Milling.

UNIT- III

API Development and Embedded programming

Getting started with API, Writing a new API, Real time Reactions, Other Protocols, Techniques
for writing embedded code: Memory management, Performance and Battery Life, Libraries, Debugging. Developing Internet of Things: IoT design Methodology, Case study on IoT System for weather Monitoring.

UNIT -IV

IoT Systems - Logical Design using Python

Introduction to Python, Data Types and Structures, Control Flow, Functions, Modules, Packages, File Hnadling, Date/Time Operations., Classes, and Python packages for IoT, IoT Physical Devices and Endpoints: Raspberry Pi, Interfaces of Pi, Programming pi with Python - Controlling LED and LDR using Pi with python programming.

UNIT- V

Cloud computing and Data analytics and IoT Product Manufacturing

Introduction to Cloud storage models and Communication APIs, Amazon webservices for IoT, Skynet IoT Messaging Platform. Introduction to Data Analytics for IoT (Ref 1). Case studies illustrating IoT Design – Smart Lighting, Weather Monitoring, Smart Irrigation.(Ref 1) Business model for IoT product manufacturing, IoT Startups, Mass manufacturing, Ethical issues in IoT.

Suggested Readings:

1. Vijay Madisetti ,ArshdeepBahga, "*Internet of Things (A Hands-on-Approach)",* VPT Publisher, 1st Edition, 2014
2. Adrian McEwen (Author), Hakim Cassimally", *"Designing the Internet of Things",* Wiley India Publishers
3. Kenneth A Lambert and B.L. Juneja*, "Fundamentals of Python*", Cenage Learning

OE 805EC

GLOBAL AND REGIONAL SATELLITE NAVIGATION SYSTEM

(Open Elective - III)

Instruction: (3L) hours per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- To explain the basic principle of GPS and its operation.
- To make the students to understand signal structure.
- To make the students understand the GPS errors.
- Highlight the importance of integrating GPS with other systems.
- To make the students understand about various GRNSS.

Course Outcomes: Student will be

1. Able to understand the principle and operation of GPS.
2. Able to understand the GPS Signal structure and services.
3. Able to understand about various errors.
4. Able to use of GPS in various fields such as navigation, GIS etc.
5. Able to understand principle of Operation of various GRNSS.

UNIT- I

Introduction to Satellites, their properties, Orbits and Launch vehicles, Kepler's Laws, GPS fundamentals: Principle of Trilaiteration, Transit, GPS Operating Principle, And Architecture: Space, Control and User Segments and its Frequencies.

UNIT- II

GPS Signal structure: C/A and P-Codes, SPS and PPS services, GPS Coordinate Systems: Significance, Types of GPS receivers, Selective Availability, Spoofing and Anti-spoofing.

UNIT- III

GPS Errors: Ionospheric error, Tropospheric error, Ephemeris error, Clock errors, Satellite and receiver instrumental biases, Multipath; Dilution of Precision (DOP).

UNIT- IV

GPS Modernization: Future GPS satellites, New signals and their benefits, New Control Segment, Principle of operation of DGPS, architecture and limitations, GPS Applications: Surveying Mapping Marine, air and land Navigation, Military and Space Application. GPS Integration with Geographic Information System (GIS), Inertial Navigation System (INS), Pseudolite and Cellular.

UNIT- V

Other GRNSS: GLONASS, GALILEO, QZNSS, CNSS and IRNSS System: Principle of Operation, Features and their Current Status.

Suggested Readings:

1. Ahmed El-Rabbany, "*Introduction to GPS"*, Artech House Publishers, 2/e, Boston 2006.
2. Elliot D Kaplan and Christopher J Hegarty," *Understanding GPS principles and applications*", Artech House Publishers, 2/e Boston & London 2005.
3. B.Hofmann-Wellenhof, H.Lichtenegger, and J.Collins, "*GPS Theory and Practice,"* Springer Verlog, 5/e, 2008.

OE806EE

APPLICATIONS OF ELECTRICAL ENERGY

(Open Elective-III)

Instruction: 3 Periods per week *Duration of SEE: 3 hours*
CIE: 30 Marks *SEE: 70 Marks*
Credits: 3

Course Objectives:

- To introduce the students and understand Utilization of electrical energy for various applications like industrial heating.
- To understand various techniques of electric welding and types of batteries.
- To understand the concept of illumination, and know the applications of various lamps to factory lighting, street lighting etc.
- To understand the concept of electric traction including speed – time curves of different traction services.
- To understand systems of train lighting.

Course Outcomes: After completion of this course, the students shall be able to:

1. Identify a suitable heating scheme for a given application.
2. Identify proper welding technique and various characteristics of batteries.
3. Classify types of electric light sources based on nature and operation and their objectives, performance and reliability.
4. Determine the speed-time characteristics of various traction services and also estimate the energy consumption levels at various modes of operation.
5. Select proper train lighting scheme.

UNIT-I

Industrial Heating: Advantages and methods of electric heating. Description, operation and performance of resistance ovens, Design of heating element. High frequency heating, Induction Heating, Induction furnaces, Core type, Coreless furnaces, Dielectric heating. Electric Arc furnaces, Direct Arc furnace, Indirect Arc furnaces.

UNIT- II

*Electric welding***:** Classification of Electric welding, welding transformer and its rating, various types of Electric arc welding and electric resistance welding.

Batteries: Lead acid batteries, SMF batteries, Construction and maintenance, Charging and rating of batteries.

UNIT- III

Illumination: Introduction, nature and production of light, Sensitivity of the eye, Units of light. The inverse square law and cosine law, Solid angle, Lighting calculations, Determination of M.S.C.P, Rousseau's construction, Discharge lamps, Sodium vapour lamps, Mercury vapour lamps, Fluorescent lamp, Starting and power factor corrections, Stroboscopic effects, Neon signs, Application to factory lighting, Street lighting and Flood lighting.

UNIT- IV

*Electric Traction***:** System of Electric Traction, Transmission of drive, Systems of track electrification, Traction mechanics, Speed time curves, Tractive effort, Power of Traction motor, Specific energy consumption, Mechanics of train movement, Coefficient of adhesion.

UNIT – V

Train Lighting: Systems of train lighting, Special requirements of train lighting, Methods of obtaining unidirectional polarity, Methods of obtaining constant output, Single battery system, Double battery parallel block system, Principal equipment of double battery system, Coach wiring, Dynamo.

Suggested Reading:

1. Partab H, Art and Science of Utilization of Electric Power, Dhanpat Rai & Sons, 1997.
2. K.B. Raina & S.K. Bhattacharya, Electrical Design, Estimating 1. and Costing, Wiley Eastern Ltd., 1991.
3. Partab H, Modern Electric Traction, Dhanpat Rai & Sons, 2000.
4. B.L.Theraja, A Text Book of Electrical Technology, S.Chand& Company Ltd, Vol-I.

OE 807ME

COMPOSITE MATERIAL APPLICATIONS

(Open Elective - III)

Instruction: (3L) hours per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- To know the properties of fiber and matrix materials used in composites, as well as somecommon manufacturing techniques.
- To know the various moulding process and architecture of composite laminates
- To know how to estimate the laminate properties from lamina properties.
- To understand the strength of an orthotropic lamina and measurement of basic compositeproperties.

Course Outcomes: Student will be able to

1. Understand the distinction of composites, its advantages, classification and applications
2. Predict the properties of composite lamina and laminate
3. Understand the testing of composites and design the structure using the appropriatedesign criteria.

UNIT- I

Introduction to composite materials, general characteristics, Fibres, Matrix materials, interfaces, polymer matrix composites, metal matrix composites, ceramic matrix composites, carbon fibre composites.

UNIT- II

Molding Processes: hand layup, vacuum molding, compression molding, pultrusion molding, centrifugal molding, filament winding, prepegs and molding compounds and architecture of composite materials: laminates, sandwich composites and other architectures.

UNIT- III

Micromechanics of Composites: Mechanical properties: Production of Elastic constant, micromechanical approach, Halpin-Tsal equations, Transverse stresses. Thermal properties: Hygrothermal stresses, mechanics of load transfer from matrix to fibre.

UNIT- IV

Macromechanics of Composites: Elastic constants of a lamina, relations between engineering constants and reduced stiffness and compliances, variation of lamina properties with orientation, analysis of laminated composites, stresses and strains with orientation.

UNIT- V

Strength of an orthotropic lamina: Maximum stress theory, maximum strain criteria, maximum work (Tsai-Hill) criterion, quadratic interaction criteria. Designing with composite materials. Measurement of constituent material properties: Fibre tests, Matrix tests. Measurement of basic composite properties: Tensile test, compressive test, a plane shear test, interlaminar shear test, flexure test.

Suggested Readings:

1. Jones, R.M., *"Mechanics of Composite Materials"*, McGraw Hill Co., 1967.
2. Ronald F. Gibson, "*Principles of Composite Materials Mechanics*", McGraw-Hill, Inc.,1994.
3. Krishan, K. Chewla, "*Composite Material*", Springer - verlag, 1987.
4. Carl. T. Herakovich, *"Mechanics of Fibrous Composites*", John Wiley Sons Inc., 1998.

OE808ME

INDUSTRIAL ADMINISTRATION AND FINANCIAL MANAGEMENT

(Open Elective-III)

Instruction: (3L) hours per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- To understand various types of organizational structures, manufacturing processes and importance of plant layout and the role of scheduling function in optimizing the utilization of resources
- To understand the importance of quality, inventory control and concepts like MRP I and MRP II
- To understand the nature of financial management and concepts like breakeven analysis, depreciation and replacement analysis

Course Outcomes: At the end of this course student is expected reach the following outcomes.

1. Understand the different phases of product life cycle, types of manufacturing systems, plant layout
2. optimization problems
3. Role of scheduling function in better utilization of resources
4. Fundamental concepts of quality control, process control, material control and appreciate the importance of MRP-I and MRP –II.
5. Know the different terminology used in financial management and apply different techniques of capital budgeting
6. Analyse and various types of costs involved in running an industrial organization

UNIT-I

Types of organizations, organizational structures. Designing Products, Services and Processes:
New product design and development. Product life cycle: phasing multiple products.
Manufacturing process Technology: Product, job shop, batch, assembly line and continuous process technology; flexible manufacturing systems. Design of Services, service process technology operations capacity; capacity planning decisions, measuring capacity; estimating future capacity needs.

UNIT-II

Locating production and services facilities, effects of location and costs and revenues, factor rating, simple median model (linear programming) Layout planning; process layout; product layout — Assembly lines; line balancing manufacturing cellular layout. Scheduling systems andaggregate planning for production and services; loading assignment algorithm; priority sequencing and other criteria.

UNIT-III

Quality planning and Control: basic concepts, definitions and history of quality control. Quality function and concept of quality cycle. Quality policy and objectives. Economics of quality and measurement of the cost of quality. Quality considerations in design.

Process control: machine and process capability analysis. Use of control charts and process engineering techniques for implementing the quality plan. Acceptance sampling: single, double and multiple sampling, operating characteristic Curve - calculation of producers risk and consumers risk.

UNIT-IV

Inventory control: deterministic and stochastic inventory models; variable demand; lead time, specific service level, perishable products and service.

Inventory control in application; concepts for the practioners; saving money in inventory systems; ABC classifications. Inventory control procedures; Quantity - reorders versus periodic inventory systems; material requirement planning (MRP); MRP as a scheduling and ordering system; MRP system components; MRP computational procedure; Detailed capacity planning;

MRP - limitation and advantages; Manufacturing Resources Planning (MRP-II).

UNIT-V

Elements of cost, overheads, breakeven analysis, depreciation, replacement analysis. Nature of financial management-time value of money, techniques of capital budgeting and method, cost of capital, financial leverage.

Suggested Reading

1. Buifa and Sarin, "Production and operations management" - Wiley Publications.
2. I.M. Pandey, "Elements of Financial Management" Vikas Publications, New Delhi, 1994.
3. James C. Van Home & John, M. Wachowicz, Jr., "Fundamentals of Financial Management", Pearson Education Asia, 11 Th ed. 2001.

OE809CS

SOFTWARE ENGINEERING

(Open Elective - III)

Instruction: 3L hrs per week *Duration of SEE : 3 hours*
CIE : 30 Marks *SEE : 70 Marks*
Credits:3

Course Objectives:

- To introduce the basic concepts of software development- processes from defining a product to shipping and maintaining that product
- To impart knowledge on various phases , methodologies and practices of software development
- To understand the importance of testing in software development and study various testing
  strategies and software quality metrics

Course Outcomes:

Student will be able to

1. Acquire working knowledge of alternative approaches and techniques for each phase of software development
2. Acquire skills necessary for independently developing a complete software project
3. Understand the practical challenges associated with the development of a significant software system

UNIT-I

Introduction to Software Engineering:
*A generic view of Process***:** Software Engineering, Process Framework, CMM Process Patterns, Process Assessment.
Process Models: Prescriptive Models, Waterfall Model, Incremental Process Models, Evolutionary Process Models, Specialized Process Models, The Unified Models, Personal and Team Process Models, Process Technology, Product and Process.
An Agile view of Process: Introduction to Agility and Agile Process, Agile Process Models.

UNIT-II

Software Engineering Principles: SE Principles, Communication Principles, Planning Principles, Modeling Principles, Construction Principles, Deployment.
System Engineering: Computer-based Systems, The System Engineering Hierarchy, Business Process Engineering, Product Engineering, System Modeling.
Requirements Engineering: A Bridge to Design and Construction, Requirements Engineering Tasks, Initiating Requirements Engineering Process, Eliciting Requirements, Developing Use-Cases, Building the Analysis Model, Negotiating Requirements, Validating Requirements.

UNIT-III

Building the Analysis Model: Requirements Analysis Modeling Approaches, Data Modeling Concepts, Object-Oriented Analysis, Scenario-based Modeling, Flow-oriented Modeling, Class-based Modeling, Creating a Behavioral Model.
Design Engineering: Design within the context of SE, Design Process and Design Quality, Design Concepts, The Design Model, Pattern-based Software Design

UNIT-IV

Creating an Architectural Design: Software Architecture, Data Design, Architectural Styles and Patterns, Architectural Design, Assessing Alternative Architectural Designs, Mapping Data Flow into a Software Architecture.

Modeling Component-Level Design: Definition of Component, Designing Class-based Components, Conducting Component-level Design, Object Constraint Language, Designing Conventional Components.

Performing User Interface Design: The Golden Rules, User Interface Analysis and Design, Interface Analysis, Interface Design Steps, Design Evaluation.

UNIT-V

Software Quality Assurance: Basic Elements, Tasks, Goals and Metrics, Formal Approaches, Statistical Software Quality Assurance, Software Reliability, ISO 9000 Quality Standards, SQA Plan.

Testing Strategies: A Strategic Approach to Software Testing, Strategic Issues, Test Strategies for O-O Software, Validation Testing, System Testing, The Art of Debugging.

Testing Tactics: Software Testing Fundamentals, Black-box and White-box Testing, Basis Path Testing, Control Structure Testing, O-O Testing Methods, Testing Methods applicable on the Class Level, Inter Class Test Case Design, Testing for Specialized Environments, Architectures and Applications, Testing Patterns.

Product Metrics: Software Quality, A Framework for Product Metrics, Metrics for the Analysis Model, Metrics for the Design Model, Metrics for Source Code, Metrics for Testing, Metrics for Maintenance.

Suggested Readings:

1. Roger S.Pressman," *Software Enigneering: A Practitioner's Approach*", 7th Edition, McGraw Hill, 2009.
2. Ali Behforooz and Frederick J.Hudson, "*Software Engineering Fundamentals*", Oxford University Press, 1996.
3. Pankaj Jalote , "*An Integrated Approach to Software Engineering*", 3rd Edition, Narosa Publishing House, 2008.

OE810CS

PYTHON PROGRAMMING

(Open Elective - III)

Instruction: 3L hrs per week *Duration of SEE : 3 hours*
CIE : 30 Marks *SEE : 70 Marks*
Credits:3

Course Objectives:
The main objective is to teach Computational thinking using Python.

- To know the basics of Programming
- To convert an algorithm into a Python program
- To construct Python programs with control structures.
- To structure a Python Program as a set of functions
- To use Python data structures-lists, tuples, dictionaries.
- To do input/output with files in Python.
- To construct Python programs as a set of objects.

Course Outcomes:
On completion of the course, students will be able to:

1. Develop algorithmic solutions to simple computational problems.
2. Develop and execute simple Python programs.
3. Develop simple Python programs for solving problems.
4. Structure a Python program into functions.
5. Represent compound data using Python lists, tuples, dictionaries.
6. Read and write data from/to files in Python Programs

UNIT-I
*Introduction to Computing and Problem Solving***:** Fundamentals of Computing – Computing Devices – Identification of Computational Problems – Pseudo Code and Flowcharts – Instructions – Algorithms – Building Blocks of Algorithms.
Introduction to Python Programming: Python Interpreter and Interactive Mode– Variables and Identifiers – Arithmetic Operators – Values and Types – Statements, Reading Input, Print Output, Type Conversions, The type() Function and Is Operator, Dynamic and Strongly Typed Language.
Control Flow Statements: The if, The if…else,The if…elif…else Decision Control Statements, Nested if Statement, The while Loop, The for Loop, The continue and break Statements.

UNIT-II
Functions: Built-In Functions, Commonly Used Modules, Function Definition and Calling the Function, The return Statement and void Function, Scope and Lifetime of Variables, Default Parameters, Keyword Arguments, Command Line Arguments.
Strings: Creating and Storing Strings, Basic String Operations, Accessing Characters in String by Index Number, String Slicing and Joining, String Methods, Formatting Strings.
Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: selection sort, insertion sort, mergesort, histogram.

UNIT-III

Files and exception: text files, reading and writing files, format operator; command line arguments,errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file.

Strings: Basic String Operations, String Slicing, Testing, Searching, and Manipulating Strings

Dictionaries and Sets: Dictionaries, Sets, Serializing Objects.

UNIT-IV

Object-Oriented Programming: Classes and Objects, Creating Classes in Python, Creating Objects in Python, The Constructor Method, Classes with Multiple Objects, Class Attributes versus Data Attributes, Encapsulation, Inheritance The Polymorphism.

Functional Programming: Lambda. Iterators, Generators, List Comprehensions.

UNIT-V

GUI Programming: Graphical User Interfaces, Using the tkinter Module, Display text with Label Widgets, Organizing Widgets with Frames, Button Widgets and Info Dialog Boxes, Getting Input with Entry Widget, Using Labels as Output Fields, Radio Buttons, Check Buttons.

Suggested Readings:

1. Richard L. Halterman, " *Learning To Program With Python*", Copyright © 2011.
2. Dr. Charles R , "*Python for Everybody, Exploring Data Using Python 3*", Severance. 2016.
3. Gowrishankar S., Veena A, "*Introduction to Python Programming*", CRC Press, Taylor & Francis Group, 2019.
4. Allen B. Downey, ``*Think Python: How to Think Like a Computer Scientist*'', 2nd edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016 (http://greenteapress.com/wp/think- python/)

OE811CS

CYBER SECURITY

(Open Elective - III)

Instruction: 3L hrs per week *Duration of SEE : 3 hours*
CIE : 30 Marks *SEE : 70 Marks*
Credits:3

Course Objectives:

- Understand the threats in networks and security concepts.
- Apply authentication applications in different networks.
- Understand security services for email.
- Awareness of firewall and it applications.

Course Outcomes:

After Completion of the course, Student will be able to:

1. Understand the various network threats
2. Analyse the forensic tools for evidence collection
3. Apply the firewalls for threat analysis

UNIT-I

Ethical hacking, Attack Vectors, Cyberspace and Criminal Behaviour, Clarification of Terms, Traditional Problems associated with Computer Crimes, Realms of Cyber world, brief history of the internet, contaminants and destruction of data, unauthorized access, computer intrusions, white-collar crimes, viruses and malicious code, virus attacks, pornography, software piracy, mail bombs, exploitation, stalking and obscenity in internet, Cyber psychology, Social Engineering.

UNIT-II

Introduction to Digital forensics, Forensic software and handling, forensic hardware and handling, analysis and advanced tools, forensic technology and practices, Biometrics: face, iris and fingerprint recognition, Audio-video evidence collection, Preservation and Forensic Analysis.

UNIT-III

Investigation Tools, e-discovery, EDRM Models, digital evidence collection and preservation, email investigation, email tracking, IP tracking, email recovery, searc and seizure of computer systems, password cracking

UNIT-IV

Forensic Analysis of OS artifact, Internet Artifacts, File System Artifacts, Registry Artifacts, Application Artifacts, Report Writing, Mobile Forensic- identification, collection and preservation of mobile evidences, social media analysis, data retrival, Email analysis from mobile phones.

UNIT-V

Ethics, Policies and IT Act

Basics of Law and Technology, Introduction to Indian Laws, Scope and Jurisprudence, Digital Signatures, E Commerce-an Introduction, possible crime scenarios, law coverage, data interchange, mobile communication development, smart card and expert systems

Indian Laws, Information Technology Act 2000, Indian Evidence Act, India Technology Amendment Act 2008, Indian Penal Code , Computer Security Act 1987, National Information Infrastructure Protection Act 1996, Fraud Act 1997, Children Online Protection Act 1998, Computer Fraud and Abuse Act 2001, Intellectual Property, IP Theft, Copyright, Trademark, Privacy and Censorship, Introduction to Cyber Ethics, rights over intellectual property, Corporate IT Policy Formulations, Compliance Auditing.

Suggested Readings:

1. Charles P. Fleeger, "*Security in Computing*", Prentice Hall, New Delhi, 2009.
2. BehrouzA.Forouzan, "*Cryptography & Network Security*", Tata McGraw Hill, India, New Delhi, 2009.
3. William Stallings, "*Cryptography and Network Security*", Prentice Hall, New Delhi, 2006.
4. Chalie Kaufman, Radia Perlman, Mike Speciner, "*Network Security: Private Communication in a Public Network*", Pearson Education, New Delhi, 2004.
5. Neal Krawetz, "*Introduction to Network Security*", Thomson Learning, Boston, 2007.
6. Bruce Schneier, "*Applied Cryptography*", John Wiley & Sons, New York, 2004.

MC 902AS

ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE

Instruction: 2 periods per week Duration of SEE: 3 hours

CIE: 30 Marks SEE: 70 Marks

Credits: Nil

Course Objectives:

- The course aims at imparting basic principles of thought process, reasoning and inference. Sustainability is at the core of Indian Traditional Knowledge Systems connecting society and nature.
- Holistic life style of Yogic-science and wisdom capsules in Sanskrit literature are also important in modern society with rapid technological advancements and societal disruptions.
- The course focuses on introduction to Indian Knowledge System, Indian perspective of modern scientific world-view and basic principles of Yoga and holistic healthcare system.

Course Outcomes: Student will be able to

1. Ability to understand, connect up and explain basics of Indian Traditional knowledge modern scientific perspective.
2. To explain holistic life style of yoga science
3. Understand basic structure of Indian knowledge system

Course Content

Basic Structure of Indian Knowledge System (i) वेद, (ii) उपवेद (आयुर्वेद, धनुर्वेद, गन्धर्वेद, स्थापत्य आदि) (iii) वेदांग (शिक्षा, कल्प, निरुत, व्याकरण, ज्योतिष छंद), (iv) उपाइग (धर्म शास्त्र, मीमांसा, पुराण, तर्कशास्त्र)

- Modern Science and Indian Knowledge System
- Yoga and Holistic Health care
- Case Studies.

Suggested Text/Reference Books

1. V. Sivaramakrishna (Ed.), Cultural Heritage of India-Course Material, Bharatiya Vidya Bhavan, Mumbai, 5th Edition, 2014
2. Swami Jitatmanand, Modern Physics and Vedant, BharatiyaVidya Bhavan
3. Fritzof Capra, Tao of Physics
4. Fritzof Capra, The wave of Life
5. V N Jha (Eng. Trans,), Tarkasangraha of Annam Bhatta, Inernational Chinmay Foundation, Velliarnad, Amaku,am
6. Yoga Sutra of Patanjali, Ramakrishna Mission, Kolkatta
7. GN Jha(Eng. Trans.) Ed. R N Jha, Yoga-darshanam with VyasaBhashya, Vidyanidhi Prakasham, Delhi, 2016
8. RN Jha, Science of Consciousness Psychotherapy and Yoga Practices, Vidyanidhi Prakasham, Delhi, 2016
9. P R Sharma (English translation), Shodashang Hridayam

PW 851CE

MAJOR PROJECT PHASE -II

Instruction: 12 periods per week
CIE: 50 marks *SEE:100 marks*
Credits: 6

Course Objectives:

- To enhance practical and professional skills.
- To gain application knowledge to solve real world problem
- To expose the students to industrial related problems and practices and ability to work as team.
- To encourage students to work with innovative and entrepreneurial ideas

Course Outcomes:

1. Demonstrate the ability to synthesize and apply the knowledge and skills acquired in the academic program to solve real-world problems
2. Ability to learn new tools and methods to solve practical problems
3. Evaluate different solutions based on economic and technical feasibility
4. Ability to provide a practical / innovative solution with the technical knowledge gained
5. Ability to prepare a technical report and findings from the project work carried out.

The aim of project work –II is to implement and evaluate the proposal made as part of project work Phase - I. Students can also be encouraged to do full time internship as part of project work-II based on the common guidelines for all the Departments if they get selected. The students placed in internships need to write the new proposal in consultation with industry coordinator and project guide within two weeks from the commencement of instruction. The Department will appoint a project coordinator who will coordinate the following: Re-grouping of students - deletion of inters hip candidates from groups made as part of project work phase -I andRe-Allotment of internship students to project guides Project monitoring at regular intervalsAll re-grouping/re-allotment has to be completed by the 1nd week of VIII semester so that students get sufficient time for completion of the project. All projects (internship and Departmental) will be monitored at least twice in a semester through student presentation for the award of sessional marks. Sessional marks are awarded by a monitoring committee comprising of faculty members as well as by the supervisor. The first review of projects for 25 marks can be conducted after completion of five weeks. The second review for another 25 marks can be conducted after 12 weeks of instruction. Common norms will be established for the final documentation of the project report by the respective departments. The students are required to submit draft copies of their project report within one week after completion of instruction.

Note: Three periods of contact load will be assigned to each project guide.

The final end semester examination will be in the form of viva-voce examination and comprising of the following.

The students' groups should submit before the schedules date of external viva-voce examination a detailed project report duly approved by their Project work Phase – II guide(s) in the Department to organise the Project work Phase II viva-voce examination.

The Chair-Person BOS (A) will nominate internal examiners and external examiner panel to the examination cell, UCE(A), O.U.

The internal examiner will be coordinating the conduct of examination with external examiner as per the schedule and as per the batches. The Project work Phase – II guide also to be available during the presentation of project of their batch and the final marks awarded by external examiner and internal examiner will be sent to examination cell in sealed cover after the viva-voce examinations is completed. The distribution of 100 marks to be carried out by the External Examiner with consultation of Head of Department. The pattern of examination is PPT presentation by the all the students of the entire group by PPT presentation generally limited to 30 minutes per batch including viva-voce questions. The marks will be awarded by the external examiner based on the Project work Phase – II report, presentation and viva-voce performance of students by the external examiner.