



DEPARTMENT OF CIVIL ENGINEERING

Scheme of Instruction

and

Syllabus of

M.E. (CIVIL ENGINEERING)

Specialization:

GEO-TECHNICAL ENGINEERING

Full Time & PTPG

AICTE Model Curriculum

2021-22



UNIVERSITY COLLEGE OF ENGINEERING

(Autonomous)

Osmania University

Hyderabad – 500 007, TS, INDIA

INSTITUTE

Vision

The Vision of the institute is to generate and disseminate knowledge through harmonious blending of science, engineering and technology. To serve the society by developing a modern technology in students' heightened intellectual, cultural, ethical and humane sensitivities, fostering a scientific temper and promoting professional and technological expertise.

Mission

- To achieve excellence in Teaching and Research
- To generate , disseminate and preserve knowledge
- To enable empowerment through knowledge and information
- Advancement of knowledge in Engineering, Science and Technology
- Promote learning in free thinking and innovative environment
- Cultivate skills, attitudes to promote knowledge creation
- Rendering socially relevant technical services to the community
- To impart new skills of technology development
- To inculcate entrepreneurial talents and technology appreciation programmes
- Technology transfer and incubation

DEPARTMENT

Vision

To be as a leading academic department on pace with global standards and contribute to the development of economic, technically viable and useful to societal problems and challenges of civil engineering profession and also contribute to the regional and country's developmental activities.

Mission

- To train the human resources with knowledge base in the field of Civil Engineering so that they can face the challenges of civil and infrastructural engineering problems to provide viable solutions.
- To integrate their understanding and attainable knowledge on the specializations for effective functioning in their profession and useful to the welfare and safety of mankind.
- To enhance the technical knowledge and research aptitude in the domains of various Civil Engineering specializations to serve the society in highly professional manner.
- Produce highly competent and capable professionals and motivated young academicians to provide solutions to real life problems of Engineering and Technology and has apt for continuous learning and dedication towards societal issues.

Programme Educational Objectives (PEO):

PEO-1: Impart theoretical concepts and fundamentals including appraisal of the principles involved, assumptions made, limitations and validity of the theories

PEO-2: Provide adequate scope to understand the mechanisms through laboratory experimentation.

PEO-3: Inculcate application of theoretical concepts to solve field challenges through illustration of Case Studies and Field visits.

PEO-4: Develop skill to transform the in-situ behavior in to a physical / analytical model, to analyze and to find solutions leading to a meaningful research outcome.

PEO-5: Prepare to deal with the professional challenges, demonstrate leadership, exhibit ethics contribute to the sustainable development of the society and to excel at global standards.

Programme Outcomes (PO):

- PO-1: Acquisition of Strong theoretical base which enhance analytical capabilities
- PO-2: Greater capability for laboratory experimentation and field evaluation of geotechnical behavior of soils / Rocks
- PO-3 Ability to apply engineering knowledge, analyse, design and develop solution to complex geotechnical engineering problems
- PO-4 Competence to take up research in a systematic and organized manner to obtain meaningful Outcome
- PO-5 Development of comprehension, presentation / communication skills, adoption to modern tools and inclination for continued learning
- PO-6 Preparation of Professionals who can understand field challenges in geotechnical engineering and provide an ideal/ethical solution towards sustainable development of society

MAPPING OF PEO'S WITH PO'S

PROGRAMME EDUCATIONAL OBJECTIVES	MAPPING WITH POs					
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
PEO-1	3	--	--	--	--	2
PEO-2	--	3	--	2	---	2
PEO-3	2	2	3	1	---	2
PEO-4	----	----	2	3	2	2
PEO-5	2	2	2	2	2	3

Rubrix

- 1 : Weakly mapped**
- 2 : Moderately mapped**
- 3 : Strongly mapped**

SCHEME OF INSTRUCTION
M.E CIVIL (Geo-Technical Engineering)

Type of course	Course Code	Course Name	Contact hours per week			Scheme of Examination		Credits
			L	T	P	CIE	SEE	
SEMESTER-I								
Core-I	CE301	Advanced Soil Mechanics	3			30	70	3
Core-II	CE302	Advanced Foundation Engineering	3			30	70	3
Program Elective-I	CE311	Sub-surface Investigations and Instrumentation	3			30	70	3
	CE312	Soil Structure Interaction						
	MI116	Tunneling and underground space Technology						
Program Elective-II	CE314	Advanced Engineering Geology	3			30	70	3
	CE315	Environmental Geo-technology						
	CE117	Green Building Technology						
Audit-I	AC131	Disaster Mitigation & Management	3			30	70	0
	AC031	English for Academic and Research Paper Writing						
	AC033	Sanskrit for Technical Knowledge						
	AC034	Value Education						
Lab-I	CE351	GTE Laboratory – I			3	50	-	1.5
Sem	CE361	Seminar			3	50	-	1.5
MC	CE100	Research Methodology in Civil Engg.	3	-		30	70	3
TOTAL			16	2	8	280	420	18
SEMESTER-II								
Core-III	CE303	Dynamics of Soils and Foundations	3			30	70	3
Core-IV	CE304	Ground Improvement Techniques	3			30	70	3
Program Elective-III	CE316	Engineering Rock Mechanics	3			30	70	3
	CE317	Offshore Geotechnical Engineering						
	CE319	Earth Retaining Structures						
	CE418	Rural Roads						
Program Elective-IV	CE318	Expansive Soil Engineering	3			30	70	3
	CE103	Finite Element Analysis						
	CE121	Advanced Concrete Technology						
	CE614	Neural Fuzzy & Expert Systems						
Audit-II	AC036	Personality Development through Life Enhancement Skills	2	1		30	70	0
	AC035	Stress Management by Yoga						
	AC037	Constitution of India						
	AC038	Pedagogy Studies						
MC	CE371	Mini Project			6	50		3
Lab-II	CE352	GTE Laboratory – II (including Advanced Computational Lab.)			3	50	-	1.5
Lab-III	CE353	Rock Mechanics Laboratory			3	50	-	1.5
TOTAL			14	1	12	300	350	18
SEMESTER-III								

Program Elective-V	CE320	Designing with Geosynthetics	3		30	70	3	
	CE321	Geotechnical Earthquake Engineering						
	CE411	Statistical Techniques						
	CE422	Pavement Evaluation, Maintenance & Management						
Open Elective	OE 941	Business Analytics	3		30	70	3	
	OE 942	Industrial Safety						
	OE 943	Operational Research						
	OE 944	Cost Management of Engineering Projects						
	OE 945	Composite Materials						
	OE 946	Waste to Energy						
	OE 947	Internet of Things						
	OE 948	Cyber Security						
	CE381	Major Project Phase-I	6		20	100	10	
TOTAL			12		20	160	140	16
SEMESTER-IV								
	CE382	Major Project Phase-II			32		200	16
GRAND TOTAL							68	

CE301

ADVANCED SOIL MECHANICS

Instruction: 3 periods per week

Duration of SEE: 3 hours

CIE: 30 marks

SEE: 70 marks

Credits: 3

Course Objectives:

- *To understand the Seepage analysis and related applications*
- *To learn the mechanisms contributing to shear strength of soils, factors affecting and procedures for determination of shear parameters in laboratory*
- *To gain knowledge in the settlement analysis, earth pressure computation.*
- *To understand the soil mechanics associated with analysis, design and construction of Embankments and Earthen Dams*

Course Outcomes:

1. *Understanding the mechanics of Seepage and competence to take up seepage analysis.*
2. *Ability to perform laboratory tests and to find the shear strength parameters of the soil simulating the different field conditions.*
3. *Competence in performing the settlement analysis*
4. *Ability to compute earth pressure and perform stability analysis of earth retaining systems*
5. *Core competence in analysis & design of Embankments and Earthen Dams*

UNIT-I

Soil water hydraulics: Seepage - mathematical Analysis-finite element formulation of steady state and transient flow of water through soils- Quick Condition – analysis – measures to mitigate – case studies. Flow nets - construction of flow nets below and through the body of the earthen dams.

UNIT-II

Shear strength of soils: Review of conventional laboratory tests for determination of shear strength parameters - Factors affecting shear strength of soils – pore pressure in soils- pore pressure measurement in triaxial compression test and field measurements- total and effective shear stress parameters- stress path – Hvorslave shear parameters – shear strength, thixotropy and liquefaction of soils.

UNIT-III

Consolidation of Clayey Soils : one, two and three dimensional consolidation theories – primary, secondary consolidation process-finite difference formulations of consolidation equations – radial consolidation – sand drains and other techniques to accelerate consolidation process- estimation of settlements.

UNIT-IV

Earth Pressure : Review of Limit equilibrium (Rankine, Coulomb) Earth pressure theories - Computation of earth pressure using theory of plasticity for cohesive and cohesionless soils- soil tension effects- rupture zones- reliability of solutions- Earth pressure computations- soil properties to be used- graphical and computer aided solutions.

UNIT-V

Earthen dams and highway embankments- type of embankments, factors influencing design of embankments- control of pore pressure, slope stability analysis of embankments – critical study of failures- embankments settlements – Earthen Dams : Types - seepage analysis- seepage control methods- filters and their use- impervious zones- cut off walls- slope protection methods.

Suggested reading:

1. Scott, R.F., *Principles of Soil Mechanics*, Eastern Willey Publications.
2. Lambe, T.W. and Whitman, R.V., *Soil Mechanics*, John Wiley and Sons, 1969.
3. Alam Singh, *Soil Engineering in Theory and Practice*, Asia Publishing House, 1981.
4. Sherard, J.E., *Earth and Rock Filled Dams*, John Wiley and Sons.

CE 302

ADVANCED FOUNDATION ENGINEERING

Instruction: 3 periods per week

CIE: 30 marks

Credits: 3

Duration of SEE: 3 hours

SEE: 70 marks

Course Objectives:

- *To understand the estimation of allowable bearing capacity of shallow foundations using theories and field tests.*
- *To learn the necessity of deep foundations, types and their suitability, evaluation of their capacity.*
- *To learn the mechanics governing the stability of deep excavations*
- *To learn different methods of geotechnical investigations required for selection and design of shallow foundations.*

Course Outcomes:

1. *Comprehensive understanding about bearing capacity of shallow foundations (Isolated & Spread footings) and the analysis and design associated with it*
2. *Competence in the analysis and geotechnical design of Pile foundations.*
3. *Ability to perform geotechnical design of Pier foundations.*
4. *Understanding of the design and construction of Caissons.*
5. *Knowledge of foundation construction related aspects such as deep excavations, Sheet pile walls, cofferdams*

UNIT-I

General : Functions and necessity of Foundation – Types and suitability – Necessity of Geotechnical Investigations in the geotechnical design of foundations-Review of foundation design principles.

Shallow Foundations : Bearing capacity of Shallow foundations on Soils - review of existing methods- additional considerations for development of bearing capacity of equations (Terzaghi, Meyerhoff, Vesic, Brinch Hansen etc.) - effect of water table, layered soils, foundation on slopes, uplift pressure- consideration from field test (PLT, SPT, CPT etc.). Settlement analysis and estimation of allowable bearing capacity. Bearing capacity of Shallow foundations on rocks - safety factors in foundation design.

UNIT- II

Pile Foundations : Types of piles- necessity and use of pile foundation - review of principles of design by conventional and finite element methods determination of pile capacities for vertical and horizontal loads - single pile and group of pile - for loads - tension piles - batter piles and anchor piles - settlement of pile foundations - negative skin friction, design of pile caps - polygon of forces - pile load tests.

UNIT – III

Pier foundations - types - their necessity - construction methods - determination of ultimate load capacity for vertical and lateral loads- settlement - pier inspection methods.

UNIT- IV

Well foundations (Caissons) types of caissons - their necessity- principles of design – review of IS and IRC codes- determination of grip length in cohesive and cohesionless soils - settlements - scour depths - thickness of straining - case studies.

UNIT- V

Walls for deep excavations of foundations : Necessity for deep excavation (>6m deep) various methods and techniques adopted- braced type wall supports- estimation of soil pressures – ground loss around excavations- instability due to heave and piping of bottom of excavations and other causes of instability.

Sheet pile walls - necessity of using the piles - types of piles - principles of design consideration of sheet piles and their components - cantilevered, anchored, - review of conventional design methods and finite elements methods.

Coffer dams - different types and their utility- principles of design and construction of methods - review of conventional methods.

Suggested Reading:

1. "Foundation and analysis" by Joseph Bowels, Mc Graw Hills.
2. "Foundations Engineering Hand Book" by H.Y.Fang , CBS Pub, 1997
3. "Foundation Design and construction" by Tomlinson M.J. Longman and technical scientific.

CE 311

SUB-SURFACE INVESTIGATIONS AND INSTRUMENTATION

Instruction: 3 periods per week

CIE: 30 marks

Credits: 3

Duration of SEE: 3 hours

SEE: 70 marks

Course Objectives:

- *To understand the objectives, necessity and scope of sub-soil exploration methods*
- *To learn the field and laboratory components of a geotechnical investigation*
- *To gain competence in interpretation of the investigation data*
- *To learn the methods of reporting including the recommendations*

Course Outcomes:

1. *Ability to understand the requirement of geotechnical investigations, select suitable method of investigation and planning*
2. *Competence in the investigation methods including collection of samples*
3. *Acquire knowledge to perform different field tests, to take observations, to analyse and interpret the results.*
4. *Competence to prepare Geotechnical Investigation report to suit the requirements of a project including necessary recommendations*
5. *Acquire knowledge about different instruments used in GTE practice*

UNIT – I

General considerations – Delineation of objectives of site investigation, reconnaissance, preliminary and detail investigations - methods and types of investigations – spacing of bore holes – geophysical methods – planning of exploration methods.

UNIT – II

Methods of direct investigations, review of existing methods including for marine conditions, drilling in soils and rock, description of soils and rock during exploration, methods of sampling and preservations - ground water observations.

UNIT – III

Insitu tests(field) : static and dynamic tests – SPT, CPT, Dutch cone, vane shear, PMT, DMT, BST, permeability, KO, Plate load test, deformation modulus, tests on rocks RQD, chemical tests on water - recording of the tests and their interpretation – determination of dynamic properties of soils and rock for machine foundation designs – C_u , shear G , natural frequency, resonance, amplitude and damping ,etc.

UNIT – IV

Preparation of geotechnical investigation reports – geotechnical documentation – preparation of geotechnical features – generalized characteristics properties of soils – statistics methods, graphical

correlations and factor of safety values. Final recommendation to evaluate the bearing capacities and settlement characteristics of soils and for use of proper selection of type of foundations.

UNIT – V

Geotechnical Instrumentation – Necessity and use – Displacement measuring Devices – Pore pressure measuring devices – Earth pressure measuring devices – Vibration measuring devices – Advances in instrumentation.

Suggested Reading:

1. J.E. Bowles – Foundation Design & Analysis. McGraw-Hill Edition 1995.
2. Roy E.Hunt – Geotechnical Investigation Methods – A field guide to Geotechnical Engineers, Taylor & Francis, CRC Publications.
3. Lourie, W. - Fundamentals of Geophysics, Cambridge University press, 1997.
- 4 . “Foundation Instrumentations” by Hanna T.W., Transtech Pub., Switzerland.

CE 312

SOIL-STRUCTURE INTERACTION

Instruction: 3 periods per week

Duration of SEE: 3 hours

CIE: 30 marks

SEE: 70 marks

Credits: 3

Course Objectives

- To understand the engineering behavior of the structure, soil and their interaction
- To learn the methods to model the soil behavior associated with Isolated, Combined, Raft and pile foundations.
- To study the effect of structure on the soil-structure interaction

Course Outcomes

- 1 Gain knowledge about the engineering behavior of the soil-structure interaction.
- 2 Competence to model the soil behavior associated with shallow isolated / combined footing.
- 3 Ability to model the soil-structure interaction associated with a raft foundation. .
- 4 Competence to model the interaction of a pile foundation with the soil
- 5 Understanding about the effect of Structure on the soil behavior.

UNIT-I

Soil-Foundation Interaction: Introduction to soil-foundation interaction problems, Soil behaviour, Foundation behaviour, Interface behaviour, Scope of soil foundation interaction analysis, soil response models, Winkler, Elastic continuum, Two parameter elastic models, Elasto-plastic behaviour, Time dependent behaviour.

UNIT-II

Beam on Elastic Foundation- Soil Models: Infinite beam, Two-parameters models, Isotropic elastic half space model, Analysis of beams of finite length, combined footings.

UNIT-III

Plates on Elastic Continuum: Thin and thick rafts, Analysis of finite plates, Numerical analysis of finite plates.

UNIT-IV

Analysis of Axially and Laterally Loaded Piles and Pile Groups: Elastic analysis of single pile, Theoretical solutions for settlement and load distributions, Analysis of pile group, Interaction analysis, Load distribution in groups with rigid cap, Load deflection prediction for laterally loaded piles, Subgrade reaction and elastic analysis, Interaction analysis, Pile-raft system.

UNIT-V

Ground-Foundation-Structure Interaction: Effect of structure on ground-foundation interaction, Static and dynamic loads.

REFERENCES

1. Rolando P. Orense, Nawawi Chouw & Michael J. Pender - Soil-Foundation-Structure Interaction, CRC Press, 2010 Taylor & Francis Group, London, UK.
2. Soil Structure Interaction – The real behaviour of structures, the institution of structural engineers, London, March 1989.
3. Selvadurai, A. P. S. - Elastic Analysis of Soil-Foundation Interaction, 1979.
4. Poulos, H. G., and Davis, E. H. - Pile Foundation Analysis and Design, 1980
6. Bowles, J. E. - Foundation Analysis & Design 5th Edition McGraw-Hill Companies, Inc.(1996).
7. Das, B. M. - Principles of Foundation Engineering 5th Edition Nelson Engineering

MI 116

TUNNELLING AND UNDERGROUND SPACE TECHNOLOGY (PROGRAM ELECTIVE - I)

Instruction: 3 periods per week

Duration of SEE: 3 hours

CIE: 30 marks

SEE: 70 marks

Credits: 3

Course Objectives:

- *To study various design methods of tunnels, underground spaces and their supports*
- *To study various methods of driving tunnels, underground spaces and their surveying related*
- *To study about various machinery used in driving tunnels and underground spaces.*

Course Outcomes:

1. *The students will acquire knowledge relating to design of underground tunnels and spaces including their supports*
2. *Competence in selection of suitable method of driving tunnels and underground spaces.*
3. *Gain knowledge of machinery used in underground tunnelling and spaces.*

UNIT I

INTRODUCTION

Congestion in cities and its impact on development of social infrastructure for transport, water and power supply, separation of pedestrian and motorized vehicles and its movements, storage of materials, defence facilities including civil shelters. Parameters influencing location, shape and size; geological aspects; planning and site investigations. Natural caves, archaeological caves and their construction; Scope and application, historical developments, art of tunnelling, tunnel engineering, Tunnels for various purposes like road, rail, hydropower tunnels and caverns, Underground storage for LPG and crude oil, Nuclear waste disposal, Metro tunnels, future tunnelling considerations. Planning and design, Assessment of behaviour of tunnelling media, deformation modulus and rock pressure assessment; determination of appropriate size and shape; Design of openings in rocks with the help of field data; Instrumentation and monitoring; Numerical modelling to assess the stability.

UNIT II

TUNNELLING METHODS

Types and purpose of tunnels; factors affecting choice of excavation techniques; soil and rock sampling and testing, Methods - soft ground tunnelling, hard rock tunnelling, shallow tunnelling, deep tunnelling; Shallow tunnels – cut and cover, cover and cut, pipe jacking, jacked box excavation techniques, methods of muck disposal, supporting, problems encountered and remedial measures.

UNIT III

TUNNELLING BY DRILLING AND BLASTING

Unit operations in conventional tunnelling; Drilling - drilling principles, drilling equipment, drilling tools, drill selection, specific drilling, rock drillability factors; Blasting - explosives, initiators, blasting mechanics, blast holes nomenclature; types of cuts - fan, wedge and others; blast design, tunnel blast performance - powder factor, parameters influencing, models for prediction; mucking and transportation equipment selection.

UNIT IV

TUNNELLING BY ROADHEADERS, IMPACT HAMMERS AND TUNNEL BORING MACHIN

Cutting principles, method of excavation, selection, performance, limitations and problems. Boring principles, method of excavation, selection, performance, limitations and problems; Road headers, Impact Hammers, Tunnel Boring Machines and applications.

UNIT V

TUNNEL SURVEYING, SUPPORTS AND SERVICES

Surveying in Tunnels: Topographic and geological survey, Methods of surveying and different instruments used for surveying in tunnels, Supports in Tunnels: Principal types of supports, their design and applicability. Steel supports, rock bolts, shotcrete, wire mesh, chain link fabric and fibre reinforced shotcrete and other ground consolidation/grouting techniques. Ground Treatment in Tunnelling: Adverse ground conditions and its effect on tunnelling; introduction to ground control. Supports in Metro tunnels, Tunnel Services and Hazards: Ventilation, drainage and pumping. Explosion, flooding, chimney formation, squeezing ground.

Text Books:

1. Hudson, J.A., Rock Engineering Systems Theory and Practice, Ellis Horwood, England.
2. Clark G.B., (1987), Principles of Rock Fragmentation, John Wiley and Sons, New York.

References:

1. Lohanson, John and Mathiesen, C.F., Modern trends in Tunnelling and Blast Design, AA Balkima, 154 P, 2000.
2. Bickel J.O., Kuesel T.R. and King E.H., Tunnel Engineering Hand Book, Chapman & Hill Inc., New York and CBS Publishers, New Delhi 2nd addition.

CE 314

ADVANCED ENGINEERING GEOLOGY (PROGRAM ELECTIVE - II)

Instruction: 3 periods per week

Duration of SEE: 3 hours

CIE: 30 marks

SEE: 70 marks

Credits: 3

Course Objectives:

- *To understand the formation of Soils / Rock and its influence on their Engineering behavior.*
- *To learn Classification and characterization using advanced techniques such as Geophysical methods, RS, GIS etc.*
- *To gain comprehensive understanding about geological factors influencing the ground water hydraulics*

Course Outcomes:

1. *Ability to characterize the soil and rock based on their formation*
2. *Knowledge of RS & GIS in Engineering Geology*
3. *Competence in application of Geophysical methods for investigation of soils and rock*
4. *Understanding the Geological aspects on Ground water*
5. *Competence for accounting the geological aspects in the selection, investigation of ground for major civil engineering structures.*

UNIT – I

Geology of soils: evolution, classification, characteristics, features, mechanical behavior and engineering uses of soils. Important clay minerals and their importance in soils.

Engineering geomorphology: evolution of different land forms ,(erosional and depositional) characteristic features and their suitability or response to various engineering works.

UNIT – II

Photogeology & remote sensing: Different types of aerial photographs, stereography, principles and uses of aerial photographs in the engineering practice. Infra red line scan(IRLS)and side looking airborne radar (SLAR) thermal properties of geological materials, sensors. Interpretation of landsat images and use of satellite images in civil engineering practice

UNIT – III

Engineering geophysics: principles, theory, instruments, field methods, data collection and data interpretation of electrical and seismic refraction methods. application in engineering practice.

UNIT – IV

Ground water: artificial recharge of ground water, fluctuations in ground water levels due to various causes and management of ground water.

Environmental geology: effects of withdrawal of excessive ground water, disposal of solid and liquid wastes, environmental impact of water impoundment.

UNIT – V

Case histories: Engineering geology of most important dams and funnels of India.

References

1. Attewell and Farmer, *Principles of Geology*, Chapman and Publications, 1976.
2. Bell, F.G., *Fundamentals of Engineering Geology*, Butterworth Publications, 1983.
3. Bell, F.G., *Engineering Geology and Geotechnics*, Butterworth Publications, 1980.

CE 315

ENVIRONMENTAL GEOTECHNOLOGY (PROGRAM ELECTIVE - II)

Instruction: 3 periods per week

Duration of SEE: 3 hours

CIE: 30 marks

SEE: 70 marks

Credits: 3

Course Objectives:

- *To understand the necessity and scope of safe waste disposal systems*
- *To gain comprehensive understanding about the planning and design of waste disposal systems*
- *To learn the analysis and design of applications of Geosynthetics in Geo-environmental applications.*

Course Outcomes:

1. *Understanding about characterization of different types of wastes*
2. *Comprehensive Understanding about the Waste Disposal Facilities and Barrier Systems*
3. *Knowledge of modification and re-use of waste materials*
4. *Understanding about the soil erosion mechanics and measures to control*
5. *Ability to analyse and design the Geo-environmental application of geosynthetics*

UNIT – I

Wastes: source, production and classification of wastes, soil pollution processes, waste characterization.

UNIT – II

Waste disposal facilities such as landfills and impoundments, slurry walls, landfill planning and design.

Barrier systems – basic concepts, design and construction, stability, compatibility and performance contaminant transformation and transport in subsurface.

UNIT – III

Monitoring surface contamination, stabilization, and modification of wastes.

Reuse of waste materials, contaminated site remediation. Case studies in waste handling.

UNIT – IV

Soil erosion and conservations – causes of soil erosions, factors contributing to erosion – climatic factors, topographical factors, vegetation factors. Erosion control – cropping systems, gullies, check dams, contouring, wind striping, ridging, bank protection.

UNIT – V

Application of Geosynthetics : Introduction – Classification & Functions of Geosynthetics –Over view of Geotextiles, Geogrids, Geonets, Geomembranes and Geocomposites.

Geosynthetics in Geo-environmental Engineering : Capping & Lining – Design requirements – Case studies.

Suggested Reading:

1. Daniel, D. E. Geotechnical practice for waste disposal, Chapman and Hall, London 1993
2. Rowe, R. K., Quigley, R. M. and Booker, Clay barrier systems for waste disposal facilities, J.R., E & FN Spon, London, 1995
3. Reddi, L. N., and Inyang, H. F. Geoenvironmental Engineering – principles and applications, Marcel Dekker, 2000
4. Bagchi, A. Design, construction and monitoring of landfills, John Wiley & Sons, New York 1994
5. Sharma, H. D. and Lewis, S. P., Waste containment systems, Waste stabilization and landfills: Design and evaluation John Wiley & Sons, New York 1994
6. Koener, R.M. (2012), “*Designing with Geosynthetics, Vol.1 & 2*”, Xlibris Corporation LLC.

CE117

**GREEN BUILDING TECHNOLOGY
(PROGRAM ELECTIVE - II)**

Instruction: 3 periods per week

CIE: 30 marks

Credits: 3

Duration of SEE: 3 hours

SEE: 70 marks

Course Objectives:

- *Exposure to the green building technologies and their significance.*
- *Understand the judicious 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:

After completing this course, the student will

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 - Auditory requirement.

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 for energy management.

Suggested Readings:

1. Bryant Edwards (2005): Natural Hazards, Cambridge University Press, U.K.
2. Carter, W. Nick, 1991: Disaster Management, Asian Development Bank, Manila.
3. Sahni, Pardeep et.al. (eds.) 2002, Disaster Mitigation Experiences and Reflections,
4. Prentice Hall of India, New Delhi.
5. Bryant Edwards (2005): Natural Hazards, Cambridge University Press, U.K.

AC131

**DISASTER MITIGATION & MANAGEMENT
(AUDIT COURSE - I)**

Instruction: 3 periods per week

Duration of SEE: 3 hours

CIE: 30 marks

SEE: 70 marks

Credits: 0

Course Objectives:

- *Introduction of various types of disasters and its effect on structures.*
- *Educate different types of repair, strengthening, rehabilitation and retrofitting techniques.*
- *Awareness about flood characteristics and flood forecasting systems*

Course Outcomes:

1. *Understand the fundamentals of disaster and different types of disasters*
2. *Assessment of flood characteristics and methods of forecasting*
3. *Appropriate mitigation and rehabilitation of structures due to disasters.*
4. *Adaptation of Regulations to control disasters for vulnerable structures*
5. *Ability to understand to disaster preparedness and rehabilitation of Civil Engineering structures*

UNIT – I: Disaster: Classifications - Causes - Impacts including social, economic, political, environmental, health, psychosocial, etc. Hazard, Vulnerability, Resilience, Risks.-Disaster-Different types of cold wave-heat wave- droughts- floods-Effect of climate change on Processes.

Natural and Manmade disasters- *Impact of drought, review of past disasters and drought in India, its classification and characteristics. Classification of drought, causes*

UNIT – II:

Flood characteristics and forecasting: Measureable features of a flood (Elevation, discharge, volume, and duration), flood forecasting (unit hydrograph method, meteorological and snow data, and snow field air temperatures), operation of flood forecasting systems

UNIT III

Flood Mitigation and Rehabilitation: Flood mitigation reservoirs(purpose, location, size and operation) levees and flood walls (location, maintenance and flood fighting), flood ways, channel improvements, evacuation and flood proofing, land management, flood plain management, estimating benefits of flood mitigation

UNIT – IV

Disaster Risk and Mitigation Strategies: - Introduction of Risk, Problems on computation of risk, significance of and objectives of mitigation, types and strategies guidelines for mitigation of natural disasters like floods, earthquake, fire hazards, mitigation plans based on causes and effects.

UNIT – V

Disaster preparedness and Management: Steps in disaster preparedness-strengthening of community based disaster preparedness- Developing Action plan- Repair of materials, Common types of repairs – Repairs of underwater structures- Gutting- shortcrete-techniques in Civil

Engineering- Repair in concrete structures –Repair of structures distressed due to corrosion, fire, Leakage, earthquake, Retrofitting techniques.

References:

1. Ven Te Chow (1964), 'Hand Book of Applied Hydrology', McGraw-Hill Publishers, New York.
2. Barry A. Richardson (1991) "*Defects and Deterioration in Buildings*", E &FN Spon Press, London, 1991
3. Varshney, R. S. (1979), 'Engineering Hydrology', Nem Chand Publishers, Roorkee.
4. J. H. Bungey (1989) "*Testing of Concrete in Structures*", Chapman and Hall, New Delhi
5. A.R. Santakumar (2006) "*Concrete Technology*", Oxford University Press, New Delhi.
6. Gupta Anil K, and Sreeja S. Nair. (2011). *Environmental Knowledge for Disaster Risk Management*, NIDM, New Delhi.
6. Disaster Management Hazard and Risk awareness A comprehensive Approach by NVS Raju by BS Publishers, Hyderabad.

AC 031

**ENGLISH FOR ACADEMIC AND RESEARCH WRITING
(AUDIT COURSE - I)**

Instruction: 3 periods per week

Duration of SEE: 3 hours

CIE: 30 marks

SEE: 70 marks

Credits: 0

Course Objectives:

- *features of Academic writing; different kinds of Academic writing*
- *some academic writing skills; the research process; the structure of a research document*

Course Outcomes:

1. *Academic writing features; Academic writing kinds; Important academic writing skills*
2. *The process of research; general research document structure*

Unit I: Features of Academic Writing

Language: Clear, Correct, Concise, Inclusive; **Tone:** Formal, Objective, Cautious;

Style: Appropriate, Accurate, Organized; **Ethics:** Honesty, Integrity, Responsibility, Accountability

Unit II: Kinds of Academic Writing

Essays, Reports, Reviews, Abstracts, Proposals

Unit III: Academic Writing Skills

Paraphrasing; Summarizing; Quoting; Rewriting; Expansion

Unit IV: Research Process

Selection of Topic, Formulation of Hypothesis, Collection of Data, Analysis of Data, Interpretation of Data, Presentation of Data

Unit V: Structure of a Research Document

Title, Abstract, Introduction, Literature Survey, Methodology, Discussion, Findings/Results, Conclusion, Documenting Sources (IEEE style)

Suggested Reading:

1. Bailey, S. (2014). *Academic writing: A handbook for international students*. Routledge.
2. Gillett, A., Hammond, A., & Martala, M. (2009). *Inside track: Successful academic writing*. Essex: Pearson Education Limited.
3. Griffin, G. (2006). *Research methods for English studies*. Edinburgh: Edinburgh University Press.
4. Silyn-Roberts, Heather. (2013). *Writing for Science and Engineering: Papers, Presentations and Reports* (2nd ed.). Elsevier.
5. Lipson, Charles (2011). *Cite right: A quick guide to citation styles; MLA, APA, Chicago, the sciences, professions, and more* (2nd ed.). Chicago[u.a.]: University of Chicago Press.

AC 033

SANSKRIT FOR TECHNICAL KNOWLEDGE

Instruction: 3 periods per week

Duration of SEE: 3 hours

CIE: 30 marks

SEE: 70 marks

Credits: 0

Objectives:

- To get a working knowledge in illustrious Sanskrit, the scientific language in the world
- Learning of Sanskrit to improve brain functioning
- Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power
- The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature

Outcomes:

1. Understanding basic Sanskrit language
2. Ancient Sanskrit literature about science & technology can be understood
3. Being a logical language will help to develop logic in students

UNIT-I:

- Alphabets in Sanskrit.
- Past/Present/Future Tense.
- Simple Sentences.

UNIT-II:

- Order
- Introduction of roots
- Technical information about Sanskrit Literature

UNIT-III:

- Technical concepts of Engineering-Electrical,
- Mechanical,
- Architecture,
- Mathematics

References:

1. "Abhyaspustakam" – Dr. Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-VempatiKutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi.

AC034

VALUE EDUCATION

Instruction: 3 periods per week

CIE: 30 marks

Credits: 0

Duration of SEE: 3 hours

SEE: 70 marks

Course Objectives :

- Understand value of education and self- development
- Imbibe good values in students
- Let the should know about the importance of character

Course outcomes :

1. Knowledge of self-development
2. Learn the importance of Human values
3. Developing the overall personality

UNIT I:

- Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism.
- Moral and non- moral valuation. Standards and principles.
- Value judgements.

UNIT II:

- Importance of cultivation of values.
- Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness.
- Honesty, Humanity. Power of faith, National Unity.
- Patriotism. Love for nature, Discipline.

UNIT III:

- Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline.
- Punctuality, Love and Kindness.
- Avoid fault Thinking.
- Free from anger, Dignity of labour.
- Universal brotherhood and religious tolerance.
- True friendship.
- Happiness Vs suffering, love for truth.
- Aware of self-destructive habits.
- Association and Cooperation.
- Doing best for saving nature

UNIT IV:

- Character and Competence –Holy books vs Blind faith.
- Self-management and Good health.
- Science of reincarnation.
- Equality, Nonviolence, Humility, Role of Women.

- All religions and same message.
- Mind your Mind, Self-control.
- Honesty, Studying effectively

References :

1. Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi

CE 351

GEOTECHNICAL ENGINEERING LAB-I

Instruction: 3 periods per week

Duration of SEE:-- hours

CIE: 50 marks

SEE: -- marks

Credits: 1.5

Course Objectives:

- *Expose the students to different types of soils*
- *Experience the concepts of soil mass, soil solids, and soil structure.*
- *Understand the laboratory test procedures and appreciate the suitability of each test.*
- *Make the students to relate theoretical concepts in doing lab tests.*

Course Outcomes:

1. *Competence in performing the laboratory experiments for determination of Index properties and for classification of soils*
2. *Ability to determine the compaction characteristics in the laboratory as well as in the field as part of field compaction quality control*
3. *Hands on experience in finding the shear strength parameters of soils*
4. *Ability to find out the subgrade characteristics and hence ability to design the pavements*
5. *Competence in determination of permeability characteristics of soils*

1. Critical Evaluation of Specific Gravity

- a. Comparison of specific gravity determined by using density bottle and Pycnometer
- b. Evaluation of Specific gravity of Clays by density bottle using distilled water and Kerosene
- c. Correction of Specific gravity for temperature

2. Comparison of Water content determined by Pycnometer with Oven drying method

3. Particle Size Analysis

- a. Comparison of Dry and Wet sieve analysis
- b. Hydrometer analysis
- c. Gradation of soils

4. Consistency of Clays

- a. Determination of Liquid and Plastic Limit
- b. Critical comparison of Liquid Limit determined using Standard Casagrande's apparatus with Cone Penetration method
- c. Determination of Shrinkage Limit
- d. Determination of DFSI

5. Classification of soils using IS:1498-1970

6. Compaction Characteristics

- a. Evaluation of effect of compaction effort on compaction characteristics by performing IS Light and Heavy compaction tests
- b. Calibration of Proctor Needle

- c. Field compaction quality control – determination of FBD by Sand Replacement & Core Cutter methods – determination of FMC by Calcium Carbide method

7. Shear Strength Characteristics

- a. Evaluation of effect of dry density on shear parameters
- b. Evaluation of effect of submergence on shear parameters
- c. Evaluation of effect of water content on shear strength of clays by performing Vane Shear tests

8. CBR Characteristics

- a. Effect of soaking on CBR Value of Sands and Clays
- b. Practice of initial correction and finding CBR value

9. Permeability Characteristics

- a. Comparison of the coefficient of permeability using Constant and Variable head Permeability test
- b. Effect of dry density on the k-value
- c. Effect of Temperature on the k-value

Suggested Reading:

1. IS:2720 – Relevant Parts.
2. Lambe, T.W., "*Soil Testing for Engineers*", Wiley Eastern Ltd., New Delhi, 1969 (Reprint in 2012).

CE 361

SEMINAR

Instruction: 3 periods per week

CIE: 50 marks

Credits: 1.5

Duration of SEE: -- hours

SEE: -- marks

Course Objectives:

- *To get exposure to the latest innovations / developments in the field of Geotechnical Engineering which are currently outside the syllabus*
- *To develop abilities to collect the relevant literature, skill to organise and prepare a report and a PPT*
- *To gain confidence in oral presentation of the seminar and answer the questions raised*

Course Outcomes:

1. *Ability to identify and select an appropriate topic.*
2. *Ability to take up review of literature, collect relevant technical content*
3. *Skill to organize the content in to a technical seminar report*
4. *Competence to prepare a PPT, present and answer the questions*

Chapter-1

Identify appropriate topic of relevance. The topic must be relevant to the field of specialisation and must be the latest developments that are yet to be included in the syllabus. It should include latest research findings, innovative field practices, latest demonstration of instrumentation / software; that enable value addition to the knowledge of the peers /classmates / audience.

Chapter-2

Update literature on technical articles of selected topic and develop comprehension. The literature from authentic sources only should be consulted. The review of literature must include review articles published in top 20 standard SCOPUS indexed Journals / Key note lectures by eminent researchers delivered during International / National Conferences / Symposiums. The information should be collected with permission where ever applicable and should be acknowledged under the references.

Chapter-3

Prepare a technical report of about 50 pages and submit in quadruplicate (one for Faculty Advisor, Supervisor, two examiners). The report should essentially consist of standard thesis format with Cover page / Certificate / Abstract / Contents / Introduction / Body of the Seminar consisting of

Technical Analysis, design, case study, physical / software simulation / application / Concluding remarks / References.

Chapter-4

Prepare a PPT in standard format and deliver presentation within stipulated time. The PPT should essentially consist of Title slide consisting of Title of the Seminar, Presenters details followed by Supervisor details. The second slide should indicate outline of the presentation. The body of the seminar should be systematically arranged such that connectivity and central theme are not missed. After the concluding remarks, references followed by Acknowledgments should be presented. The slides in PPT should be numbered. The content in the slides should be in bullet form consisting of limited words not exceeding in three sentences. It should never be in bulk paragraphs.

Chapter-5

Answer the questions raised after the presentation is given in scheduled time. The ultimate objective of the seminar should be fulfilled.

CE 100

RESEARCH METHODOLOGY IN CIVIL ENGG.

Instruction: 3 periods per week

Duration of SEE: 3 hours

CIE: 30 marks

SEE: 70 marks

Credits: 3

Course Objectives:

- Learn the research types, methodology and formulation.
- Know the sources of literature, survey, review and quality journals.
- Understand the research design for collection of research data.
- Understand the research data analysis, writing of research report and grant proposal.

Course Outcomes:

1. Differentiate the research types and methodology.
2. Able to do literature survey using quality journals.
3. Able to collect research data.
4. Process research data to write research report for grant proposal.

UNIT – I

Scientific Research: Definition, Characteristics, Types, Need of research. Research methods vs Methodology. Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical.

Defining and formulating the research problem-Meaning of a research problem, Sources of research problems, Criteria of a good research problem, Importance of literature review in defining a problem, Errors in selecting a research problem, Scope and objectives of the research problem. Approaches of investigation of solutions for the research problem.

UNIT – II

Literature review-Source of literature, Critical literature review – Identifying gap areas from literature review - Development of working hypothesis.

Research design – Basic Principles, Need of research design, Features of good design, Important concepts relating to research design.

Developing a research plan - Exploration, Description, Diagnosis, Experimentation. Determining experimental and sample designs.

UNIT – III

Execution of the research - Necessary instrumentations, Various data collection methods in Civil Engineering. Data processing and data interpretation. Data presentation and illustration.

Types of the reports–Technical reports and thesis; Different steps in the preparation – Layout, structure and language of technical writing; Writing research papers; Developing a Research Proposal, Common formats of the research proposals;

Oral presentation–Planning, Preparation, Practice, Making a presentation, Importance of effective communication

UNIT – IV

Ethical issues - Research ethics, Plagiarism, Citation and acknowledgement

Patenting and development: technological research, innovation, patenting, and development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT Patent Rights. Problems encountered by researchers in India.

UNIT – V

Basics of statistics. Sampling and its types. Determination of sampling size. Sampling and non-sampling errors in statistics. Data: handling of data-significant figures & rounding. quality of data-precision & accuracy. Types of data.

Descriptive statistics: Summarization of Data- Measure of central tendency, Measure of central dispersion, Measure of symmetry.

Inferential statistics: Hypothesis of testing, Parametric (t-test & Analysis of variance) and Non-Parametric Tests. Univariate and Bivariate analysis; Correlational analysis.

Introduction to linear regression model and multi-linear regression models.
mathematical basis and introduction to SPSS

Suggested Reading:

1. C.R Kothari, “Research Methodology, Methods & Technique”, New Age International Publishers, New Delhi, 2004.
2. R. Ganesan, “Research Methodology for Engineers”, MJP Publishers, Chennai, 2011.
3. Ratan Khananabis and SuvasisSaha, “Research Methodology”, Universities Press, Hyderabad, 2015.
4. Stuart Melville and Wayne Goddard, “Research methodology: an introduction for science & Engineering students”
5. Ranjit Kumar, 2nd Edition, “Research Methodology: A Step by Step Guide for beginners”
6. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd ,2007.
7. T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008
8. Y.P. Agarwal, “Statistical Methods: Concepts, Application and Computation”, Sterling Publishing Pvt. Ltd., New Delhi, 2004.
9. Vijay Upagade and Aravind Shende, “Research Methodology”, S. Chand & Company Ltd., New Delhi, 2009.
10. G. Nageswara Rao, “Research Methodology and Quantitative methods”, BS Publications, Hyderabad, 2012.

SEMESTER - II

CE 303

DYNAMICS OF SOILS AND FOUNDATIONS

Instruction: 3 periods per week

Duration of SEE: 3 hours

CIE: 30 marks

SEE: 70 marks

Credits: 3

Course Objectives

- *To understand Theory of Vibrations and its application to the design of machine foundations*
- *To learn the laboratory and field test procedures for determination of dynamic properties of soils*
- *To gain knowledge of the dynamic earth pressure, dynamic bearing capacity of soils*
- *To learn the essentials of design of machine foundations*

Course Outcomes

1. *Competence in application of theory of vibrations in modeling and analysis of machine foundations*
2. *Competence in determination of dynamic properties of soils*
3. *Ability to compute the dynamic earth pressure, dynamic bearing capacity of soils*
4. *Acquiring comprehensive understanding about Liquefaction, ability to assess liquefaction potential and to recommend remediation*
5. *Competence in the standard design of Machine foundations*

UNIT-I

Theory of vibration, wave propagation in elastic, homogenous and isotropic medium - single degree of freedom - spring - dashpot, free and forced vibration – without and with damping – Magnification factor – Vibration Isolation – Transmissibility ratio - description and methods of use of vibration measuring equipment.

UNIT-II

Determination of dynamics soil properties - Laboratory methods – Resonant column test – Cyclic simple shear test – Cyclic torsional shear test – Cyclic triaxial compression test – Field tests – Vertical and Horizontal Block resonance test – Ultrasonic pulse velocity test – Seismic tests – Cyclic plate load test – Standard Penetration test- limitations and suitability.

UNIT-III

Determination of dynamic earth pressure – pseudo-static approach- Mononobe-Okabe's theory – determination of dynamic bearing capacity – Triandafilidis – Francis – Chummar's theory.

UNIT-IV

Liquefaction – necessary conditions – mechanism – initial, final liquefaction – Cyclic mobility – Factors affecting liquefaction – Classical studies of Lee & Seed ; Peacock & Seed – Evaluation of liquefaction potential – Remediation methods – Case studies – overview of recent research studies.

UNIT-V

General principles of machine foundation design - vibration isolation and screening methods. Earthquake resistant design of structures - stipulation of IS:1893 - Case studies

Suggested Reading:

1. “ Dynamics of Bases and Foundations” by D D Barkan, 2nd edition, McGraw Hill publications, 1970.
2. “ Vibrations of Soils and Foundations” by E E Rihcart.
3. “Soil Dynamis” by Shamsher Prakash, 3rd edition, John Wiley, 2000.
4. “ Soil Dynamics and Machine Foundations” by Swami Saran, Golgotia Publications, 3rd edition, 2016.
5. “Advance Soil Dynamics and Earthquake Engineering”, by Prasad.B.B., 1st Edition, Prentice Hall, 2011
6. “Hand Book of Machine Foundations” by P.Srinivasulu, S.Vaidyanathan, SERC Publications, 2017.

CE 304

GROUND IMPROVEMENT TECHNIQUES (PROGRAM ELECTIVE - I)

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 insitu densification of cohesive, cohesionless soils*
- *To learn the classification, functions and applications of Geosynthetics 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 and evaluation of potential of a ground for improvement*
2. *comprehensive understanding about the improvement of in-situ Cohesion less soils*
3. *Competence to plan, design the in-situ densification of cohesive soils*
4. *Knowledge of Grouting, soil stabilization methods, application of Geo synthetics and competence to apply them for ground improvement*
5. *Competence to analyse an in-situ ground, identification of ground improvement techniques feasible, 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 Cohesionless 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 – Sand 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 Groutability Ratio - grouting procedure – Applications of grouting in ground improvement.

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

UNIT - V

Geo-Synthetics: Classification of Geosynthetics – 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.

CE 316

**ENGINEERING ROCK MECHANICS
(PROGRAM ELECTIVE - III)**

Instruction: 3 periods per week

Duration of SEE: 3 hours

CIE: 30 marks

SEE: 70 marks

Credits: 3

Course Objectives:

- *To understand the formation of Rock, Classification, characterization, discontinuity analysis etc.*
- *To gain comprehensive understanding about state of stress in Rock mass and its measurement*
- *To learn the essentials of dynamic behavior of Rock Mass*
- *To learn analysis and design of Rock Slopes*

Course Outcomes:

1. *Competence in Rock Mass Characterization*
2. *Acquire knowledge about analysis of rock discontinuity, performing Laboratory and Field tests*
3. *Ability to assess stress in rocks and its application in Tunnels and shafts*
4. *Competence for analysis and design of Rock Slopes.*
5. *Gain understanding of determining dynamic rock properties*

UNIT - I

Introduction : Rock as an Engineering material. review of rockmass classification systems.

Friction of Rocks: Phenomena with smooth surfaces, stiff slip oscillations.

Elasticity and strength of Rock: Stress, strain curve for different rocks under classical and modern strength criteria.

UNIT-II

Rock Discontinuity Analysis: Planes of weakness in rocks and their influence on engineering works. Recording and plotting of discontinuity data.

Rock Testing: Laboratory and field testing of intact rocks masses as per standard practices.

UNIT-III

Initial stresses in rock and their Measurement: Influence of the primary or virgin rock stresses on engineering works. Techniques for measurement of insitu stresses. Hydraulic fracturing the flat jack method and overcoring. Tunnels and Shafts: Secondary stress distribution around tunnels and shafts in elastic and plastic rocks. Methods of stabilization of tension zones.

UNIT-IV

Rock Slopes: Modes of failures, analysis of slopes, stabilization techniques.

UNIT- V

Rock Dynamics: Dynamic properties of rocks and their determination in the laboratory and field, rock blasting, rock bursts.

Suggested Reading:

1. Jaeger, J.C. and Cook, N.G.W., *Fundamentals of Rock Mechanics*", Chapman and Hall, 1976
2. Goodman, R.E. *Introduction to Rock Mechanics*, John Wiley and Sons, 1989
3. Vutukuri, V.S., Lama, R.D. and Saluja, S.S., *Handbook on mechanical properties of rocks*, Transtech Pub.1974

CE 317

**OFFSHORE GEOTECHNICAL ENGINEERING
(PROGRAM ELECTIVE - III)**

Instruction: 3 periods per week

Duration of SEE: 3 hours

CIE: 30 marks

SEE: 70 marks

Credits: 3

Course Objectives:

- *To learn the soil mechanics of seabed and the forces acting on an offshore structure foundation.*
- *To gain comprehensive understanding about Dynamics of Offshore structures and the geotechnical response of offshore structure foundations*
- *To learn the geotechnical analysis and design of offshore structure foundations.*

Course Outcomes:

1. *Knowledge of the forces acting on an offshore structure*
2. *Ability to understand the Soil Mechanics of Seabed*
3. *Acquiring knowledge about geotechnical response of offshore structure foundations*
4. *Comprehensive understanding about Dynamics of Offshore structures*
5. *ability to evaluate the risk associated with design of offshore structure foundation*

UNIT – I

General: Nature of magnitude of loads on foundation of offshore structures – design consideration in relation to environment wave action on large offshore structures.

UNIT – II

Soil mechanics of seabed: Geotechnical studies of sea floor sediments – stability – bearing – capacity – features of foundation of gravity structures – bearing capacity and settlement under dynamic loads – immediate and long term behavior liquefaction under cyclic loads.

UNIT – III

Concrete structures and buried structures: dynamic stresses in pile driving – pile behavior, p-y curves – analysis of single and pile groups – long term performance of concrete in marine environment.

General appraisal offshore structure – sea bed foundation considerations for gravity structures – finite element methods for inter active analysis using linear, nonlinear foundation response – geotechnical aspects of anchor and submarine pipe lines – coastal structures – ports and harbors.

UNIT – IV

Dynamics of offshore structures – Waves and wave action – wave induced loading on dynamic structures, offshore platform.

UNIT – V

Risk factors – assessment of the accuracy of design process – problems areas in design calculation and classified offshore structures – general research problems – state of art for long term experience and maintenance and operations of the offshore structure drilling and production platforms for the oil industry.

Suggested Reading:

1. H. G. Poulos. “Marine Geotechnics”, Unwin Hyman Ltd, London, UK, 1988
2. D. V. Reddy and M. Arockiasamy, “Offshore Structures”, *Volume: 1*, R.E. Kreiger Pub and Co., 1991
3. D. Thomson and D. J. Beasley, “Handbook of Marine Geotechnical Engineering”, US Navy, 2012

CE 319

**EARTH RETAINING STRUCTURES
(PROGRAM ELECTIVE - III)**

Instruction: 3 periods per week

Duration of SEE: 3 hours

CIE: 30 marks

SEE: 70 marks

Credits: 3

Course Objectives

- To gain comprehensive understanding earth pressure and its computation
- To learn the stability analysis of retaining walls, sheet pile walls, bulk heads and braced excavations

Course Outcomes

- 1 Ability to compute earth pressure using theories
- 2 Competence in stability analysis of conventional and reinforced earth retaining systems
- 3 Ability to analyze the stability of sheet pile walls

Unit I: Earth Pressure: Rankine and Coulomb theories, active, passive and pressure at rest; concentrated surcharge above the back fill, earth pressure due to uniform surcharge, earth pressure of stratified backfills, saturated and partially saturated backfill.

Unit II: Retaining walls: Proportioning of retaining walls, stability of retaining walls, mechanically stabilized retaining walls/reinforced earth retaining walls

Unit III: Sheet Pile wall: free earth system, fixed earth system

Unit IV: Bulkheads: bulkheads with free and fixed earth supports, equivalent beam method, Anchorage of bulkheads and resistance of anchor walls, spacing between bulkheads and anchor walls, resistance of anchor plates

Unit V: Braced excavations: Earth pressure against bracings in cuts, Heave of the bottom of cut in soft clays

References:

1. Das, Braja M., "Principles of Foundation Engineering", PWS Publishing. 1998
2. Bowles. J.E., Foundation Analysis and Design, Tata McGraw-Hill International Edition, 5th Edn, 1997.

CE 418

**RURAL ROADS
(PROGRAM ELECTIVE - III)**

Instruction: 3 periods per week

CIE: 30 marks

Credits: 3

Duration of SEE: 3 hours

SEE: 70 marks

Course Objectives:

- Introduction to various factors affecting road alignment and planning
- Introduction to inputs required and design of flexible and pavements
- Concepts, equipment and procedures applicable for construction and maintenance of rural roads.

Course Outcomes:

1. Acquaintance with development of rural road network in India and learn to conduct alignment surveys
2. Application of basic principles in design of flexible pavement rural roads with different combination of layer compositions
3. Ability to analyze stresses in concrete pavement and application of basic principles in design of cement concrete pavements used for rural roads
4. Comprehensive understanding regarding the rural roads construction using different equipment and materials
5. Learn about use of waste materials in road construction and ability to apply knowledge to take up appropriate maintenance measures.

UNIT – I

Planning and Alignment: The Jayakar Committee, Initial Major Road Development Plans in India, Classification of Roads, Overview on Road Network in India, National Rural Roads Development Agency, PMGSY, Bharath Nirman, DRRP, Core Network. Planning of Rural roads, road alignment and surveys. Governing factors in route selection, factors considered for alignment; Reconnaissance Survey; Preliminary Surveys, Final Location Survey; Details of scales applicable for drawings.

UNIT – II

Guidelines and Design of Flexible Pavements: Introduction, Factors governing design, Calculation of traffic data, Salient features of DCP, Design procedure, pavement components, design of flexible pavement as per IRC:SP:72-2014: Design of Gravel/Soil-Aggregate Roads, Design of pavements for traffic over 100,000 cumulative ESAL and Recommended Pavement Designs. Types of drainage, General criteria for road drainage and shoulders, system of drainage, surface and subsurface systems.

UNIT – III

Guidelines and Design of Cement Concrete Pavements: Factors governing design, Calculation of traffic data, pavement components, Design of Slab thickness as per IRC:SP:62-2014, Sub-base types, calculation of stresses: Computation of equivalent radius of contact area of a dual-wheel, load stresses, temperature stresses, Recommended design procedure; Joints: Types of Joints and their details, Material used and specifications as per MORD.

UNIT – IV

Equipments used for road construction, Construction details of Subgrade, Sub-base and base courses: GSB, WBM, WMM, Quality Control in Construction

Construction steps of of bituminous pavements as per IRC:SP:72 and MORD specifications: Properties of Fly ash, aggregates, soil, sand, bitumen, emulsions, foamed bitumen and other locally available materials, Quality Control in Construction

Construction steps of concrete pavements as per IRC:SP:62 and MORD specifications: Properties of Fly ash, aggregates, soil, cement, sand and other locally available materials, Quality Control in Construction

UNIT – V

Waste Materials for Pavement Construction: Introduction, Fly ash for road construction, Design & Construction of Fly ash embankments, Lime fly ash stabilized soil. Lime fly ash bound Macadam as per IRC:SP:58, Control of compaction (IS:2720-27), Construction steps.

Maintenance: Introduction, specification and code of practices. Earth and Granular layers, bituminous courses, Semi rigid and rigid pavements, special requirements. Distresses/Defects in rigid and flexible pavements, Maintenance and Evaluation, Inventory of roads and inspections, Types of maintenance activities. Treatment options.

References:

- 1 Specifications for Rural Roads, First Revision, Published by IRC, New Delhi, 2014. and Training Manuals and Guidelines available at <http://pmgsy.nic.in/>
- 2 Quality Assurance Handbook for Rural Roads, Volume-I and Volume-II, NRRDA, MORD, 2007.
- 3 IRC:SP-20, 2002, IRC:SP72 and IRC:SP:62, IRC:SP:58 and other related code of IRC
- 4 Construction of Rural Roads, Learning Unit 2.2.1, Published by International Labor Organization, New Delhi, https://rural.nic.in/sites/default/files/2.2.1Roads_English.pdf
- 5 Srinivasa Kumar R, Text Book of Highway Engineering, Universities Press, 2014.

CE 318

**EXPANSIVE SOIL ENGINEERING
(PROGRAM ELECTIVE - IV)**

Instruction: 3 periods per week

CIE: 30 marks

Credits: 3

Duration of SEE: 3 hours

SEE: 70 marks

Course Objectives:

- *To gain comprehensive understanding about identification and characterization of expansive soils*
- *To learn the laboratory test procedures for evaluation of expansiveness*
- *To learn the swell control measures*

Course Outcomes:

1. *Ability to understand the Engineering behavior of Expansive Soils, their presence and identification*
2. *Acquiring knowledge about Clay mineralogy responsible for expansive behaviour*
3. *Competence in laboratory and field evaluation of swell potential of expansive soils*
4. *Appraisal of problems posed by expansive soils on Foundations and competence in providing remediation*
5. *Understanding about open excavations in expansive soils and the remedial measures to be taken.*

UNIT-I

General: Necessity of study and importance. Spread of expansive soils in India and other countries. Various problems encountered for structural safety of structures, remedial measures.

UNIT-II

Clay mineralogy: study of physico-chemical properties of clay mineral including their micro structures, their identification by thermal, x-ray diffraction, Electron Microscopic methods engineering properties.

UNIT-III

Determination of swell and swell potential of soil water systems- laboratory and field estimates of heave. Study of moisture movements- swelling and shrinkage behaviors- cyclic swells- multidimensional swells. Shear strength, consolidation and earth pressure (Characteristic) properties of swelling clays.

UNIT-IV

Problems and remedial measures: Problems encountered in shallow, deep foundations in swelling sub- soil strata- design considerations- study of case histories, methods of alteration or modification of swell properties. Use of under reamed piles and their design criteria – Reliability analysis of

foundations on expansive soils- settlement characteristics- hysteresis of deformations of swelling soils- Inter swelling. Safety factors.

UNIT-V

Open and underground excavations in swelling and shrinkage soils- construction techniques to be adopted. Remedial measures- stabilization methods use of chemical grouts etc.

Suggested Reading:

1. Proceedings of 2nd Int conf on expansive soils research and engg. Texas, 1963.
2. Proceedings of 3rd Int conf on expansive soils Haifa Israel, 1978.

CE 103

FINITE ELEMENT ANALYSIS (PROGRAM ELECTIVE - IV)

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 the rudiments of finite element analysis.*
- *Study the fundamentals of domain discretization, interpolation, application of boundary conditions, assembly of global matrices, and solution of the resulting algebraic systems.*
- *Explain the core concepts of variational and weighted residual methods in FEM.*
- *Derive the element stiffness matrix for 1-D, 2-D and 3-D problems.*
- *Formulate the simple structural problems in to finite elements.*

Course Outcomes:

1. *At the end of this course, students will be able to*
2. *Build and analyse the FEA models for various engineering problems.*
3. *Identify the information requirements and sources for analysis, design and evaluation.*
4. *Use the standard finite element software to solve the structural engineering problems.*
5. *Interpret the results obtained from FEA software, not only in terms of conclusions but also awareness of limitations.*
6. *To solve problems of non linear finite element*

UNIT – I

Introduction to FEM: Types of Problems – Types of Materials – Elastic / Inelastic situations – Types of forces: Body forces / Surface Traction / Point loads – Deformable bodies – 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 for 2-D / 3-D – Stress-strain relation for 2-D / 3-D – Plane stress / Plane strain problems.

Virtual Work Formulation: Application to problems of plane trusses with static indeterminacy not exceeding three.

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

UNIT – II

Variational Formulation: Finite Element Formulation - Stationarity of Functional – Given the Functional or Differential equation – Number of elements limited to two.

1-D Elements: Strain-displacement relation matrix / stiffness matrix / Minimum Potential Energy Approach / Rayleigh-Ritz Method / introduction to natural coordinates / stiffness matrix

of second order bar element / Axial bar subjected to point loads, body forces and surface traction forces / Problems with kinematic indeterminacy not exceeding two.

2-D Triangular Elements: Displacement models / criterion for convergence / geometric invariance / conforming and non-conforming elements - 3-node triangular elements (CST) / determination of strain-displacement matrix / area coordinates-shape functions / determination of element stiffness and load matrices, assembling global stiffness and load matrices / Problems with kinematic indeterminacy not exceeding three.

2nd Order triangular elements: Shape functions – degradation technique / strain-displacement matrix / Expression for stiffness matrix / Load matrices due to body forces and surface traction.

UNIT – III

Iso-parametric elements:

Quadrilateral elements: Construction of shape functions using natural coordinates/Strain-displacement matrices/Load matrices for body force and surface traction/ Expressions for stiffness matrix, load matrices for 4-noded quadrilateral elements/ Gauss Quadrature of numerical integration / Problems with rectangular elements, kinematic indeterminacy not exceeding three.

2nd Order Quadrilateral elements: - Determination of shape functions for 2nd order quadrilateral elements and for elements of with serendipity / Strain-displacement matrices / Load matrices for body force and surface traction.

UNIT – IV

Method of Weighted Residuals:

Galerkin's Method of Weighted Residuals – Application to problems of mathematics / structural engineering, number of trial functions not exceeding two.

Galerkin's Finite Element Method – Weak form of Trial Function - Application to problems of mathematics / structural engineering, number of elements limited to two.

Axi-symmetric Problems: Strain-displacement relationship/stress-strain relationship / determination of stiffness matrix for 3-noded ring element and load matrices for body force and surface traction/ Problems with kinematic indeterminacy not exceeding three for 3-noded ring elements only.

UNIT – V

Tetrahedron elements: Volume coordinates, Strain-displacement matrix, stiffness matrix, load matrices due to body force and surface traction/ introduction to Hexahedron (brick) elements.

Non-linear Finite element analysis: Introduction – problems with material non-linearity – problems with geometric non-linearity – problems with both material and geometric non-linearity.

Introduction to MSC Nastran: Illustration on different modules of Nastran / Structural engineering applications of the package/Creation of a simple 1-D model, 2-D model and a 3-D model/ analysis and post processing of the results.

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

CE 121

**ADVANCED CONCRETE TECHNOLOGY
(PROGRAM ELECTIVE - IV)**

Instruction: 3 periods per week

Duration of SEE: 3 hours

CIE: 30 marks

SEE: 70 marks

Credits: 3

Course Objectives:

- *Learn the characterization of constituents of concrete.*
- *Design concrete mix by various methods as per different codes.*
- *Study the different types of admixtures, mix design, properties and applications of special concretes.*

Course Outcomes:

1. *Learn hydration of cement and tests on properties of cement and aggregates.*
2. *Comprehend the properties and testing of concrete in fresh and hardened state.*
3. *Understand the shrinkage and creep mechanisms, curing and durability of concrete.*
4. *Design concrete mixes by various methods.*
5. *Familiarize with the types of admixtures, and applications of special concretes.*

UNIT - I

Cement: Types of cement and their composition - Manufacture of Portland cement - Hydration of cement and hydration product - Structure of hydrated cement - Heat of hydration - Gel theories - Review of tests on properties of cement.

Aggregate: Classification of aggregates - Particle shape and texture - Bond and strength of aggregate and its influence on strength of concrete - Porosity - Absorption and moisture content and their influence - Soundness of aggregate - Alkali aggregate reaction - Sieve analysis and grading of aggregate - Review of tests on properties of aggregate.

UNIT - II

Properties of Concrete: Mixing and batching - Workability - Factors affecting workability - Measurements of workability - Various tests and procedures - Segregation and bleeding - Vibration of concrete - Types of vibrators and their influence on composition - Analysis of fresh concrete - Strength of concrete - Water-cement ratio - Gel space ratio - Effective water in the mix - Mechanical properties of concrete - Tests and procedure - Influence of various parameters on strength of concrete - Relationship between various mechanical strengths of concrete.

UNIT - III

Shrinkage and creep of concrete: Types of shrinkage - Mechanism of shrinkage - Factors affecting shrinkage - Creep mechanism - Factors influencing creep - Rheological model - Effects of creep.

Curing of Concrete: Methods of curing - Maturity concept - Influence of temperature on strength of concrete.

Durability of Concrete: Permeability of concrete - Chemical attack of concrete - Tests on sulphate resistance - Effect of frost - Concreting in cold weather - Hot weather concreting and air entrained concrete.

UNIT - IV

Mix design of concrete: Basic considerations - Process of mix design - Factors in the choice of mix proportions and their influence - Quality control - Various methods of mix design - IS code method - British and ACI methods.

UNIT - V

Admixtures: Classification of admixtures - Chemical and mineral admixtures - Influence of various admixtures on properties of concrete and their applications.

Fly ash concrete: Mix design - Properties and its applications.

High strength concrete: Mix design - Properties and its applications.

Fiber reinforced concrete: Mix design - Properties and its applications.

Ferro cement - Lightweight concrete - High-density concrete - Recycled aggregate concrete and their applications.

Suggested Reading:

1. A.M. Neville, "Properties of Concrete", English Language Book Society-Longman Publications, 1988.
2. P.K. Mehta and J.M.M. Paulo, "Concrete – Microstructure – Properties and Material", McGraw-Hill, New York, 1997.
3. N. Krishna Raju, "Design of Concrete Mix", CBS Publications, New Delhi, 1985.

CE 614

**NEURAL, FUZZY AND EXPERT SYSTEMS
(PROGRAM ELECTIVE - IV)**

Instruction: 3 periods per week

CIE: 30 marks

Credits: 3

Duration of SEE: 3 hours

SEE: 70 marks

Course Objectives:

- *Explain the concepts of neural networks, fuzzy logic, and genetic algorithms.*
- *Solve problems that are appropriately solved by neural networks, fuzzy logic, and genetic algorithms.*
- *Understand the structure of expert systems.*
- *Get exposure to software packages in practice.*

Course Outcomes:

1. *Learn the mathematical theory behind the intelligent problem solving approaches and apply them to write the code to solve a particular design problem.*
2. *Carry out three design projects in the course in neural networks, fuzzy logic, and genetic algorithms.*
3. *Covers intelligent approaches to solving engineering problems that are appropriate for pattern matching, control, optimization, and other areas.*
4. *Solve the problems pertaining to artificial neural networks, fuzzy logic and expert systems using standard software packages.*

UNIT- I

Introduction: Brief introduction to the study of artificial intelligence - An insight to the concept of natural intelligence followed by the development of artificial neural networks, fuzzy logic systems and expert systems tool - Demonstration of the importance of artificial neural networks, fuzzy logic and expert systems with the help of at least two practical examples of civil engineering for each study - Importance of neuro-fuzzy systems.

UNIT - II

Neural networks: Components of artificial neural networks - Neurons - Inputs - Outputs - Error - Error propagation - Hidden layers - Threshold logic - Weights - Bias - Noise - Momentum - Rate of learning - Training and testing - Hebb's rule - Delta rule - Supervised learning - Generalized Delta rule - Unsupervised learning - Types of neural networks - Perceptions - Feed forward back propagation networks - Hop field networks.

UNIT - III

Fuzzy sets: Crispness - Vagueness - Uncertainty and fuzzy sets – Basic definitions and operations of Fuzzy sets - Approximate reasoning and membership function.
Fuzzy relations: Fuzzy relation and fuzzy composition - Fuzzy aggregation procedures - Dominance matrix - Weightages - Applications of fuzzy sets to civil engineering problems - Pattern recognition.

UNIT - IV

Expert systems: Structure of expert systems - Knowledge acquisition - Knowledge organization - Methods of representing knowledge - Types of inference engines - Reasoning under uncertainty - Various types of expert system tools - Heuristics - Search mechanism - Expert system development and hybrid expert systems.

UNIT - V

Exposure to software packages: Neural networks (Mat lab tool kit) - Fuzzy logic — Expert systems (L5 object) - Applications of artificial neural networks, fuzzy logic and expert systems in civil engineering - Case studies with at least one problem on each aspect of ANN, FL and Expert systems.

Suggested Reading:

1. H.J. Zimmerman, "Fuzzy Sets, Decision Making and Expert Systems", Kluwer Academic Publications, Boston, 1987.
2. Elaine Rich, Kevin Knight and S.B. Nair. "Artificial Intelligence", Tata McGraw-Hill, New Delhi, 2009.
3. H. Adeli, "Expert Systems in Construction and Structural Engineering" Chapman & Hall, London, 1988.
4. J.A. Freeman and D.A. Skapura, "Neural Networks Algorithms, Applications and Programming", Addition-Wesley Publishing, Massachusetts, 1991.

AC036

**PERSONALITY DEVELOPMENT THROUGH LIFE ENHANCEMENT SKILLS
(AUDIT COURSE - II)**

Instruction: 3 periods per week

Duration of SEE: 3 hours

CIE: 30 marks

SEE: 70 marks

Credits: 0

Course Objectives

- *To learn to achieve the highest goal happily*
- *To become a person with stable mind, pleasing personality and determination*
- *To awaken wisdom in students*

Course Outcomes: Upon completing this course, students will be able to:

1. *Develop their personality and achieve their highest goal of life.*
2. *Lead the nation and mankind to peace and prosperity.*
3. *To practice emotional self regulation.*
4. *Develop a positive approach to work and duties.*
5. *Develop a versatile personality.*

UNIT-I

Neetisatakam – Holistic development of personality - Verses 19, 20, 21, 22 (Wisdom) - Verses 29, 31, 32 (Pride and Heroism) - Verses 26,28,63,65 (Virtue)

UNIT-II

Neetisatakam – Holistic development of personality (cont'd) - Verses 52, 53, 59 (don't's) - Verses 71, 73, 75 & 78 (do's) - Approach to day to day works and duties.

UNIT-III

Introduction to Bhagavadgeetha for Personality Development - Shrimad Bhagawad Geeta: Chapter 2 – Verses 41, 47, 48 - Chapter 3 – Verses 13,21,27,35 - Chapter 6 – Verses 5,13,17,23,35 - Chapter 18 – Verses 45, 46, 48 Chapter – 6: Verses 5, 13, 17, 23, 35; Chapter – 18: Verses 45, 46, 48

UNIT-IV

Statements of basic knowledge - Shrimad BhagawadGeeta: Chapter 2- Verses 56, 62,68 - Chapter 12 – Verses 13, 14, 15, 16, 17, 18 - Personality of Role model from Shrimad Bhagawat Geeta.

UNIT-V

Role of Bahgavadgeeta in the present scenario - Chapter 2 – Verses 17 – Chapter 3 – Verses 36, 37, 42 - Chapter 4 – Verses 18, 38, 39 - Chapter 18 – Verses 37, 38, 63.

Suggested Reading:

1. "Srimad Bhagavad Gita" by Swami Swarupananda , dvaita Ashram (Publication Department), Kolkata.
2. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit

Sansthanam, New Delhi

Web resource:

5. NTPEL:<http://nptel.ac.in/downloads/109104115/>

AC035

**STRESS MANAGEMENT BY YOGA
(AUDIT COURSE - II)**

Instruction: 3 periods per week

Duration of SEE: 3 hours

CIE: 30 marks

SEE: 70 marks

Credits: 0

Course Objectives

- *Creating awareness about different types of stress and the role of yoga in the management of stress.*
- *Promotion of positive health and overall wellbeing (Physical, mental, emotional, social and spiritual).*
- *Prevention of stress related health problems by yoga practice.*

Course Outcomes:

Students will be able to:

1. *To understand yoga and its benefits.*
2. *Enhance Physical strength and flexibility.*
3. *Learn to relax and focus.*
4. *Relieve physical and mental tension through Asanas*
5. *Improve work performance and efficiency.*

UNIT-I

Meaning and definition of Yoga - Historical perspective of Yoga - Principles of Astanga Yoga by Patanjali.

UNIT-II

Meaning and definition of Stress - Types of stress - Eustress and Distress. Anticipatory Anxiety and Intense Anxiety and depression. Meaning of Management- Stress Management.

UNIT-III

Concept of Stress according to Yoga - Stress assessment methods - Role of Asana, Pranayama and Meditation in the management of stress.

UNIT-IV

Asanas- (5 Asanas in each posture) - Warm up - Standing Asanas - Sitting Asanas - Prone Asanas - Supine asanas - Surya Namaskar

UNIT-V

Pranayama- Anulom and Vilom Pranayama - Nadishudhi Pranayama – Kapalabhati- Pranayama - Bhramari Pranayama - Nadanusandhana Pranayama.

Meditation techniques: Om Meditation - Cyclic meditation : Instant Relaxation technique (QRT), Quick Relaxation Technique (QRT), Deep Relaxation Technique (DRT)

Suggested Reading:

1. “Yogic Asanas for Group Training - Part-I”: Janardhan Swami Yogabhyasi Mandal, Nagpur.
2. “Rajayoga or Conquering the Internal Nature” by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata.

3. Nagendra H.R nad Nagaratna R, “Yoga Perspective in Stress Management”, Bangalore, Swami Vivekananda Yoga Prakashan

Online Resources:

https://onlinecourses.nptel.ac.in/noc16_ge04/preview

<https://freevideolectures.com/course/3539/indian-philosophy/11>

AC037

**CONSTITUTION OF INDIA
(AUDIT COURSE - II)**

Instruction: 3 periods per week

CIE: 30 marks

Credits: 0

Duration of SEE: 3 hours

SEE: 70 marks

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: *Upon completing this course, students will be able to:*

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 to Equality, 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 and Functions, 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 Election Commissioner 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>

AC038

PEDAGOGY STUDIES

Instruction: 3 periods per week

CIE: 30 marks

Credits: 0

Duration of SEE: 3 hours

SEE: 70 marks

Course Objectives:

- Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

Course Outcomes:

1. What pedagogical practices are being used by teachers in formal and informal classrooms in Developing countries?
2. What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
3. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

UNIT-I

Introduction and Methodology:

- Aims and rationale, Policy background, Conceptual framework and terminology
- Theories of learning, Curriculum, Teacher education.
- Conceptual framework, Research questions.
- Overview of methodology and Searching.

UNIT-II

- Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries.
- Curriculum, Teacher education.

UNIT-III

- Evidence on the effectiveness of pedagogical practices
Methodology for the in depth stage: quality assessment of included studies.
- How can teacher education (curriculum and practicum) and the school
- Curriculum and guidance materials best support effective pedagogy?
- Theory of change.
- Strength and nature of the body of evidence for effective pedagogical practices.
- Pedagogic theory and pedagogical approaches.
- Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT-IV

- Professional development: alignment with classroom practices and followup support
- Peer support

- Support from the head teacher and the community.
- Curriculum and assessment
- Barriers to learning: limited resources and large class sizes

UNIT-V

- Research gaps and future directions
- Research design
- Contexts
- Pedagogy
- Teacher education
- Curriculum and assessment
- Dissemination and research impact

Suggested reading:

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, *Compare*, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, *Journal of Curriculum Studies*, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? *International Journal Educational Development*, 33 (3): 272–282.
5. Alexander RJ (2001) *Culture and pedagogy: International comparisons in primary education*. Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf.

CE 371

MINI PROJECT

Instruction: 6 periods per week

CIE: 50 marks

Credits: 3

Duration of SEE: -- hours

SEE: -- marks

Each student will be attached to a faculty member, (Guide) for project seminar during third semester. The student will carry out the project which may be development of Software/Hardware/Simulation. Studies/ Design/ Analysis/Experimental related to his/her specialization: The work will be monitored regularly by the guide. At the end of semester, student will write the report on the work done and submit to the guide. Student has to present his/her work before two faculty members (one guide and other to be appointed by Chairman BOS) on a fixed day during last week of the semester in which the project seminar is offered. The sessional marks will be awarded jointly by these two examiners based on report, the presentation and viva voice.

CE 352

GEOTECHNICAL ENGINEERING LAB-II

Instruction: 3 periods per week

Duration of SEE: --hours

CIE: 50 marks

SEE: -- marks

Credits: 1.5

Course Objectives:

- *To learn advanced laboratory tests for evaluation of Ground Improvement, Vibration characteristics*
- *To understand the application and use of advanced instrumentation.*
- *To practice the geotechnical investigation methods*

Course Outcomes:

1. *Competence in performing the advanced laboratory tests*
2. *Greater insight in to the soil behavior and hence enhanced understanding of Soil-Structure interaction*
3. *Acquire confidence in ground improvement mechanisms through the laboratory model tests*
4. *Experience the dynamic behavior of soils*
5. *Ability to plan, organize and conduct of advanced tests and application of the results to address geotechnical challenge*

1. Tri-axial Compression Test
 - (a) Determination of Shear strength parameters using Tri-axial Compression test under different drainage conditions
 - (b) Comparison of TCT with DST and verification of error in DST due to an imposed horizontal failure plane
2. Electro-osmosis method
3. Consolidometer Test
4. Swell Pressure Test
5. North Dakota Test
6. Laboratory model plate load test
 - a. Monotonic model plate load test
 - b. Cyclic model plate load test
 - c. Uplift resistance of model footing in Cohesionless soils
 - d. Uplift resistance of model footing in Cohesive soils
7. Model block resonance test
8. Ground Improvement
 - a. Mechanical stabilization by blending
 - b. Lime stabilization of Clays
 - c. Cement stabilization of Clays
 - d. Randomly distributed Fiber reinforced Sand
 - e. Improvement in Bearing Capacity using Geosynthetics

9. Cyclic Triaxial Compression Test (Demonstration)
10. Advanced Computational Laboratory
(Hands on exposure to Geo.5 and other softwares available)

Suggested Reading :

1. IS:2720 – Relevant Parts.
2. Lambe, T.W., "*Soil Testing for Engineers*", Wiley Eastern Ltd., New Delhi, 1969

CE 353

ROCK MECHANICS LABORATORY

Instruction: 3 periods per week

Duration of SEE: --hours

CIE: 50 marks

SEE: -- marks

Credits: 1.5

Course Objectives:

- *To learn characterization of rock*
- *To learn performing the engineering tests on rock*
- *To gain knowledge of estimation of bearing capacity of shallow foundations on rock*

Course Outcomes:

1. *Competence in finding CRR, RQD, RMR and to characterize the rock mass*
2. *Ability to prepare the rock core specimen for laboratory tests*
3. *Competence to perform strength tests on rock specimen*
4. *Acquire knowledge of finding elastic properties of the rock specimen*
5. *Ability to apply the rock specimen results to the rock mass and compute Bearing Capacity of shallow foundations laid on rock mass*

1. Determination of Core Recovery Ratio (CRR) and Rock Quality Designation (RQD)
2. Determination of Rock Mass Rating (RMR)
3. Rock specimen preparation- Core drilling, cutting and grinding
4. Determination of density, porosity and water absorption
5. Determination of Uni-axial Compressive Strength
6. Brazilian Test on Rock cores
7. Determination of Modulus of elasticity and Poisson's ratio
8. Demonstration of direct shear test on Rock specimen
9. Demonstration of True Tri-axial Compression Test on Rock specimen
10. Estimation of bearing capacity of shallow foundations on rock

Suggested Reading :

1. Relevant Indian Standard Codes of practice
2. Jaeger, J.C. and Cook, N.G.W., *Fundamentals of Rock Mechanics*", Chapman and Hall, 1976
3. Goodman, R.E. *Introduction to Rock Mechanics*, John Wiley and Sons, 1989

SEMESTER - III

CE 320

DESIGNING WITH GEOSYNTHETICS (PROGRAM ELECTIVE - V)

Instruction: 3 periods per week

Duration of SEE: 3 hours

CIE: 30 marks

SEE: 70 marks

Credits: 3

Course Objectives:

- *To understanding the necessity and scope of Geosynthetics in Ground Improvement*
- *To gain comprehensive understanding about different types of Geosynthetic Products their functions, application and suitability*
- *To learn the analysis and design of Reinforced Soil Walls*

Course Outcomes:

1. *Acquiring knowledge about genesis and classification of Geosynthetic products*
2. *Ability to analyse and design the application of geotextiles*
3. *Competence in the design of applications of Geogrids and Geonets*
4. *Gain knowledge about design of applications of Geomembrane*
5. *Comprehensive understanding about the applications of Geocomposites and the construction practices*

UNIT – I

An overview of Geosynthetics : Introduction – Classification & basic description of Geosynthetics – manufacturing process – Over view of Geotextiles, Geogrids, Geonets, Geomembranes and Geocomposites.

Design methods – Design by cost & availability – Design by specification – Design by function.

UNIT – II

Geotextile Properties and Test methods – Physical, Mechanical, Hydraulic, Endurance and Degradation properties.

Designing with Geotextiles : Geotextile functions and mechanisms – Designing for separation – Designing for reinforcement – Designing for stabilization – Designing for filtration – Designing for drainage – designing for multi functions.

UNIT – III

Geogrid Properties and Test methods – Physical, Mechanical, Endurance and Environmental properties.

Designing with Geogrids : Designing for geogrid reinforcement

Geonets Properties and Test methods – Physical, Mechanical, Hydraulic, Endurance and Environmental properties.

Designing with Geonets : Designing for geonet drainage

UNIT – IV

Geomembrane Properties and Test methods – Physical, Mechanical, chemical, biological, thermal and Identification properties.

Designing with Geomembranes – Liquid containment liners – Covers for reservoirs – Canal liners – Landfill liners – Caps & closures – Underground storage tanks etc.

UNIT – V

Designing with Geocomposites – Geocomposites for separation – reinforcement – filtration – drainage – liquid/ vapour barriers.

Construction methods & techniques using Geosynthetics.

Suggested Reading:

1. Hausman, M. R. (1990). “*Engineering Principles of Ground Modification*” McGraw-Hills
2. Moseley, M.P. (1193), “*Ground Improvemen.*” Champman and Hall.
3. Koener, R.M. (2012), “*Designing with Geosynthetics, Vol.1 & 2*, Xlibriss Corporation LLC.
4. Rao, G.V. and Raju, G.V.S.S. (1995). “*Engineering with Geosynthetics*”, Tata McGraw Hills.
5. Purushothama Raj, P. (2014). “*Ground Improvement Techniques*”. Lami Publishers (P), Ltd. New Delhi
6. Fang, H.Y. (1191). “*Foundation Engineering Hand Book*”, Second Edition, CBS Publications, New Delhi.

CE 321

**GEOTECHNICAL EARTHQUAKE ENGINEERING
(PROGRAM ELECTIVE - V)**

Instruction: 3 periods per week

CIE: 30 marks

Credits: 3

Duration of SEE: 3 hours

SEE: 70 marks

Course Objectives

- *To learn the causes and effects of Earth quakes on soils*
- *To gain comprehensive understanding about the earth quake ground motion and its response including liquefaction*
- *To learn the analysis and design of earth quake resistant geo-structures*

Course Outcomes

1. knowledge about causes and effects of earth quakes
2. Ability to understand the earth quake ground motion and to provide code based designs
3. Competence in evaluating the earth quake ground response
4. Comprehensive understanding about the liquefaction and its remediation measures
5. Competence in the preliminary design of earth quake resistant foundations and other geo-structures

UNIT – I

Earthquake Seismology – Causes of earthquake, Plate tectonics, Earthquake fault sources, Seismic waves, Elastic rebound theory, Earthquake, Intensity and magnitudes, Effects of earthquake, Modified Mercalis intensity scale and seismic instruments.

UNIT – II

Earthquake Ground Motion – Characteristics of ground motion, Effect of local site conditions on ground motions, Design earthquake, Design spectra, Development of site specification and code-based design.

UNIT – III

Ground Response Analysis – One-dimensional ground response analysis: Linear approach, Nonlinear approach, Comparison of one dimensional ground response analyses. Two-dimensional ground response analysis: Equivalent linear approach, Nonlinear approach, Comparison of two dimensional ground response analyses.

UNIT – IV

Liquefaction and Lateral Spreading - Liquefaction related phenomena, Liquefaction susceptibility: Historical, Geological, Compositional and State criteria. Evaluation of liquefaction by cyclic stress and cyclic strain approaches, Lateral deformation and spreading, Soil improvement for remediation of seismic hazards.

UNIT – V

Seismic Design of Foundations, Retaining Walls & Slopes - Seismic design requirements for foundation, Seismic bearing capacity, Seismic settlement, Design loads. Seismic slope stability analysis - Internal stability and weakening instability, Seismic design of retaining walls: Dynamic response of retaining walls, Seismic displacement of retaining walls.

Reference:

1. Kramer S. L - Geotechnical Earthquake Engineering, Prentice Hall, 2003.
2. Bharat Bushan Prasad- Advanced Soil Dynamics and Earthquake Engineering, PHI Learning Pvt. Ltd., New Delhi, 2011.
3. Kamalesh Kumar - Basic Geotechnical Earthquake Engineering – New Age International Publishers, 1st Edition, 2008
4. IS 1893 (Part-1), Criteria for Earthquake Resistance Design of Structures, Part-1, General Provision of Buildings, 2002.
5. R. W. Day - Geotechnical Earthquake Engineering Handbook, McGraw-Hill, 2002.
6. Bolt, B. A. - Earthquakes, W. H. Freeman and Company, 4th Edition, 1999.

CE 411

STATISTICAL TECHNIQUES (PROGRAM ELECTIVE - V)

Instruction: 3 periods per week

Duration of SEE: 3 hours

CIE: 30 marks

SEE: 70 marks

Credits: 3

Course Objectives:

- *To introduce fundamental knowledge of sampling technique*
- *To describe basic statistical techniques such as statistical distributions and correlation methods*
- *To impart knowledge on exact sampling distributions and the tests of significance*

Course Outcomes:

1. *Students who successfully complete this course will be able to:*
2. *Use sampling techniques for conducting various surveys related to transportation engineering*
3. *Decide best fit and develop the regression equations for the given variables*
4. *Applications of sampling distributions in Highway and Traffic Engineering problems.*

UNIT-I

Introduction: Frequency distribution; Measures of central tendency; Measures of dispersion; Standard error, Moments (about mean, arbitrary numbers and origin); Skewness; Kurtosis; Sampling-Definitions and Applications; Simple random sampling; Stratified sampling; Systematic sampling; Sample size determination; Applications in Highway and Traffic Engineering

UNIT-II

Statistical Distribution; Probability, Bayes' Theorem; Binomial, Poisson, Exponential and Normal distributions; Fitting of distributions; Mean and variance; Chi-square test of goodness-of-fit; Applications in Highway and traffic Engineering. Mathematical expectation.

UNIT-III

Regression and Correlation : Linear regression and correlation; Multiple correlation; Multiple correlation coefficient; Standard error of estimate; Analysis of variance; Curvilinear regression; Applications in Transportation Engineering.

UNIT-IV

Multi Variate Data Distributions ; Types of data; Basic vectors and matrices; Simple estimate of centroid, Standard deviation Variance and covariance ; Correlation matrices ; Principal component analysis;. Time series analysis. Estimation-Point Estimation, Interval Estimation, Box Plot, Maximum likelihood estimation, Biased & Non Biased Estimation.

UNIT - V

Exact Sampling Distributions and Tests of Significance; Chi-square distribution; students t-distribution; Snedecor's F-distribution. Large sample and small sample tests ; Tests for single mean. Means of two samples, Proportions, two variances, two observed correlation coefficients, paired T-tests, Applications. Intervals for mean, variance and regression coefficients; Applications in Highway and Traffic Engineering Problems.

Suggested Reading:

1. Basic Statistics - Simpson and Kafks; Oxford and IBH Calcutta,1969.
2. Fundamentals of Mathematical Statistics - Gupta, S.C. and Kapoor, K. V. Sultanchand
3. Multivariate Data Analysis – Cootey W.W & Cochens P.R; John Wiley & Sons

CE422

**PAVEMENT EVALUATION, MAINTENANCE AND MANAGEMENT
(PROGRAM ELECTIVE - V)**

Instruction: 3 periods per week

Duration of SEE: 3 hours

CIE: 30 marks

SEE: 70 marks

Credits: 3

Course Objectives:

- *Understand the basic working principles of various NDT equipment used for pavement evaluation*
- *Describe design aspects of overlay thickness of pavements*
- *Impart knowledge regarding the different types of distresses, PMS and LCCA of pavements*

Course Outcomes:

1. *Apply and acquainted with the fundamental principles of Pavement and understand functional evaluate by using different equipment*
2. *Awareness about various NDT equipment used for structural pavement evaluation of flexible and rigid pavements*
3. *Evaluating the distress condition of pavements through surface condition surveys and learn possible alternative treatments*
4. *Understanding the basic components of pavement management systems and Capacity to perform and apply LCCA to optimize funding expenditures*
5. *Understand the maintenance needs and propensity for application of knowledge towards of flexible and rigid pavements by using different type of layers.*

UNIT – I

Introduction to Pavement Inventories and Functional Evaluation: Purposes, Classification of pavement evaluation, Basic concept of pavement evaluation and management; functional Evaluation: AASHTO Serviceability concept, International Road Roughness Experiment, Methods of Measuring Roughness: World Bank Roughness Measurement Systems, Response type & Profile type; IRI: Quarter Car Model, Classification of equipment used for Measurement : MERLIN, Bump Integrator, Dipstick and High speed laser-profiler. Riding Number; Pavement Safety Evaluation: Skid Resistance, measurement of skid, skid resistance, Change of Skid resistance with time, traffic and climate; Control of Skid Resistance.

UNIT – II

Structural Evaluation: Purpose, Destructive Structural Evaluation, Non-destructive structural evaluation, Pavement Deflection: Different Methods of NDT(Working Principles): Benkelman Beam and limitations of BB, LaCroix Deflectometer, Dynaflect, Road Ratar, Rolling Dynamic Deflectometer, Loadman, Different Types of Falling Weight Deflectometers (FWD) for evaluation of rigid and flexible pavements; Working principle of Geophone, Factors influencing deflections. Overlay design as per IRC:81; Back-calculation of Pavement Layer Moduli and detection of loss of bonding of cement concrete pavements using FWD data.

UNIT – III

Distress/failures Surveys: Distress, definitions, significance of distress measurement, Categorisation of distresses in asphalt pavement: identification, causes and measurement of distresses of Bituminous and Concrete pavements; Visual Rating and severity levels; symbols of distresses observed, PSI, PCI, Distress modes; Distresses and the possible options of repairs to

treat distortion, deformation, deterioration disintegration of bituminous and concrete pavements.

UNIT – IV

Pavement Maintenance Management: Purpose of PMS, Uses of PMS, Basic terminology used in PMS, Components of PMS and related activities, Major steps in implementing PMS - Network and project level analysis, Pavement performance prediction models , Budgeting; Prioritization Techniques; Feedback system, Pavement Preservation, Decision tree, Methods of Priority Ranking, Basic approaches of PMS, Pavement Life Cycle Cost Analysis (LCCA): Cost Components, Basic steps in LCCA, Solution of LCCA – with typical Components involved.

UNIT – V

Highway Maintenance and Treatments: Need of Highway maintenance, Types of maintenance for flexible and rigid pavement layers; WBM, WMM, Bituminous and Cement Concrete pavements; Surface texturing practices, Details of overlay and seal coats: Slurry seal (IRC:SP:81), Open Graded Friction Course, Fibre-stabilized Stone Matrix Asphalt (IRC:SP:79), Microsurfacing, Surface dressing, Semi-Dense Bituminous Concrete, Dense Bituminous Concrete and Bituminous Concrete.

References:

- 1 Haas and Hudson W.R. *Pavement Management Systems* - McGraw Hill publications
- 2 Srinivasa Kumar R, *Pavement Evaluation Maintenance and Management*, Universities Press, 2014.
- 3 *Hand Book of Highway Engineering*, Rober F.Baker, Editor, L.G Byrd D.Garrit Mikle, Associate Edotor, Van Nostrand Reinhold Comp, 1.975
- 4 Shahin M.Y. 1994 - *Pavement Management for airports, roads and parking lots*, 1994.
- 5 Relevant IRC/Morth Codes and manuals

OE 941

**BUSINESS ANALYTICS
(OPEN ELECTIVE)**

Instruction: 3 periods per week

CIE: 30 marks

Credits: 3

Duration of SEE: 3 hours

SEE: 70 marks

Objectives:

- *Understanding the basic concepts of business analytics and applications*
- *Study various business analytics methods including predictive, prescriptive and prescriptive analytics*
- *Prepare the students to model business data using various data mining, decision making methods*

Outcomes: *Upon completing this course, students will be able to:*

1. *To understand the basic concepts of business analytics*
2. *Identify the application of business analytics and use tools to analyze business data*
3. *Become familiar with various metrics, measures used in business analytics*
4. *Illustrate various descriptive, predictive and prescriptive methods and techniques*
5. *Model the business data using various business analytical methods and techniques*

UNIT-I

Introduction to Business Analytics: Introduction to Business Analytics, need and science of data driven (DD) decision making, Descriptive, predictive, prescriptive analytics and techniques, Big data analytics, Web and Social media analytics, Machine Learning algorithms, framework for decision making, challenges in DD decision making and future.

UNIT-II

Descriptive Analytics: Introduction, data types and scales, types of measurement scales, population and samples, measures of central tendency, percentile, decile and quadrille, measures of variation, measures of shape-skewness, data visualization

UNIT-III

Forecasting Techniques: Introduction, time-series data and components, forecasting accuracy, moving average method, single exponential smoothing, Holt's method, Holt-Winter model, Croston's forecasting method, regression model for forecasting, Auto regression models, auto-regressive moving process, ARIMA, Theil's coefficient

UNIT-IV

Decision Trees: CHAID, Classification and Regression tree, splitting criteria, Ensemble and method and random forest. **Clustering:** Distance and similarity measures used in clustering, Clustering algorithms, K-Means and Hierarchical algorithms, **Prescriptive Analytics-** Linear Programming(LP) and LP model building,

UNIT-V

Six Sigma: Introduction, introduction, origin, 3-Sigma Vs Six-Sigma process, cost of poor quality, sigma score, industry applications, six sigma measures, DPMO, yield, sigma score, DMAIC methodology, Six Sigma toolbox

Suggested Reading:

1. Dinesh Kumar, "Data Analytics", Wiley Publications, 1st Edition, 2017
2. Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, "Business analytics Principles, Concepts, and Applications with SAS", Associate Publishers, 2015
3. S. Christian Albright, Wayne L. Winston, "Business Analytics - Data Analysis and Decision Making", 5th Edition, Cengage, 2015

Web Resources:

1. <https://onlinecourses.nptel.ac.in/noc18-mg11/preview>
2. <https://nptel.ac.in/courses/110105089/>

OE942

**INDUSTRIAL SAFETY
(OPEN ELECTIVE)**

Instruction: 3 periods per week

CIE: 30 marks

Credits: 3

Duration of SEE: 3 hours

SEE: 70 marks

Course Objectives:

- *Causes for industrial accidents and preventive steps to be taken.*
- *Fundamental concepts of Maintenance Engineering.*
- *About wear and corrosion along with preventive steps to be taken*
- *The basic concepts and importance of fault tracing.*
- *The steps involved in carrying out periodic and preventive maintenance of various equipments used in industry*

Course Outcomes:

1. *Identify the causes for industrial accidents and suggest preventive measures.*
2. *Identify the basic tools and requirements of different maintenance procedures.*
3. *Apply different techniques to reduce and prevent Wear and corrosion in Industry.*
4. *Identify different types of faults present in various equipments like machine tools, IC Engines, boilers etc.*
5. *Apply periodic and preventive maintenance techniques as required for industrial equipments like motors, pumps and air compressors and machine tools etc*

UNIT-I

Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes, Fire prevention and firefighting, equipment and methods.

UNIT-II

Fundamentals of Maintenance Engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT-III

Wear and Corrosion and their Prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications of Screw down grease cup, Pressure grease gun, Splash lubrication, Gravity lubrication, Wick feed lubrication, Side feed lubrication, Ring lubrication, Definition of corrosion, principle and factors affecting the corrosion, Types of corrosion, corrosion prevention methods.

UNIT-IV

Fault Tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, any one

machine tool, Pump, Air compressor, Internal combustion engine, Boiler, Electrical motors, Types of faults in machine tools and their general causes.

UNIT–V

Periodic and Preventive Maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of Machine tools, Pumps, Air compressors, Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

Suggested Reading:

1. H. P. Garg, “Maintenance Engineering”, S. Chand and Company
2. Audels, “Pump-hydraulic Compressors”, Mcgraw Hill Publication
3. Higgins & Morrow, “Maintenance Engineering Handbook”, Da Information Services.
4. Winterkorn, Hans, “Foundation Engineering Handbook”, Chapman & Hall London

OE 943

**OPERATION RESEARCH
(OPEN ELECTIVE)**

Instruction: 3 periods per week

CIE: 30 marks

Credits: 3

Duration of SEE: 3 hours

SEE: 70 marks

Objectives:

- *Introduce the concepts of optimization techniques*
- *Formulation of LPP models*
- *Basic concepts of Non-linear programming, Dynamic programming, Game theory are introduced.*

Outcomes:

1. *Students should able to apply the dynamic programming to solve problems of discreet and continuous variables.*
2. *Students should able to apply the concept of non-linear programming*
3. *Students should able to carry out sensitivity analysis*
4. *Student should able to model the real world problem and simulate it.*
5. *Student should able to apply graph theory, competitive models, and game theory simulations.*

UNIT I

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models

UNIT II

Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming

UNIT III:

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT

UNIT IV

Scheduling and sequencing - single server and multiple server models deterministic inventory models - Probabilistic inventory control models - Geometric Programming.

UNIT V

Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation

Suggested Reading :

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5. Pannerselvam, Operations Research: Prentice Hall of India 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010.

OE 944

**COST MANAGEMENT OF ENGINEERING PROJECTS
(OPEN ELECTIVE)**

Instruction: 3 periods per week

Duration of SEE: 3 hours

CIE: 30 marks

SEE: 70 marks

Credits: 3

Objectives:

- Introduce the concepts of cost management, inventory valuation , decision making
- Fundamentals of cost overruns, project execution and technical activities
- Introduce the concepts of Quantitative techniques for cost management, Linear Programming, PERT/CPM

Outcomes:

1. Understanding of strategic cost management process, control of cost and decision making based on the cost of the project.
2. Ability to appreciate detailed engineering activities of the project and execution of projects
3. Preparation of project report and network diagram
4. Able to plan Cost Behavior , Profit Planning , Enterprise Resource Planning, Total Quality Management.
5. Applications of various quantitative techniques for cost management

UNIT I

Introduction and Overview of the Strategic Cost Management Process-Cost concepts in decision-making; relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System- Inventory valuation- Creation of a Database for operational control; Provision of data for Decision-Making.

UNIT II

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning- Project execution as conglomeration of technical and non- technical activities- Detailed Engineering activities.

UNIT III

Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process

UNIT IV

Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems- Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector- Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints- Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets- Performance budgets- Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

UNIT V

Quantitative techniques for cost management, Linear Programming, PERT/CPM,- Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

Suggested Reading :

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

OE 945

**COMPOSITE MATERIALS
(OPEN ELECTIVE)**

Instruction: 3 periods per week

CIE: 30 marks

Credits: 3

Duration of SEE: 3 hours

SEE: 70 marks

Objectives:

- *Study the concepts of composite construction.*
- *Learn analysis and designs of composite beams, floors, columns and trusses as per the recommendations of IS codes of practice.*
- *Apply the concepts for design of multi-storey composite buildings.*
- *Scope of analysis is restricted to skeletal structures subjected to prescribed dynamic loads.*

Outcomes :

1. *Understand the fundamentals of composite construction, and analysis and designs of composite beams.*
2. *Analyse and design the composite floors*
3. *Select suitable materials for composite columns,*
4. *Analyse composite trusses and understand connection details.*
5. *Analyse and design the multi-storey composite buildings*

UNIT-I

Introduction of composite constructions: Benefits of composite construction - Introduction to IS - BS and Euro codal provisions.

Composite beams: Elastic behaviour of composite beams - No and full interaction cases - Shear connectors - Ultimate load behaviour - Serviceability limits - Effective breadth of flange - Interaction between shear and moment - Basic design consideration and design of composite beams.

UNIT-II

Composite floors: Structural elements - Profiled sheet decking - Bending resistance - Shear resistance - Serviceability criterion - Analysis for internal forces and moments - Design of composite floors.

UNIT-III

Composite columns: Materials - Concrete filled circular tubular sections - Non-dimensional slenderness - Local buckling of steel sections - Effective elastic flexural stiffness - Resistance of members to axial compressions - Composite column design - Fire resistance.

UNIT-IV

Composite trusses: Design of truss - Configuration - Truss members - Analysis and design of composite trusses and connection details.

UNIT-V

Design of multi-storey composite buildings: Design basis - Load calculations - Design of composite slabs with profile decks - Composite beam design - Design for compression members - Vertical cross bracings - Design of foundation.

Suggested Reading:

1. R.P. Johnson, “Composite Structures of Steel and Concrete - Beams, Slabs, Columns and Frames in Buildings”, Blackwell Publishing, Malden, USA, 2004.
2. “INSDAG Teaching Resources for Structural Steel Design”, Vol-2, Institute for Steel Development and Growth Publishers, Calcutta, India.
3. “INSDAG Handbook on Composite Construction – Multi-Storey Buildings”, Institute for Steel Development and Growth Publishers, Calcutta, India.
4. “INSDAG Design of Composite Truss for Building”, Institute for Steel Development and Growth Publishers, Calcutta, India.
5. “INSDAG Handbook on Composite Construction – Bridges and Flyovers”, Institute for Steel Development and Growth Publishers, Calcutta, India.
6. IS: 11384-1985, “Code of Practice for Composite Construction in Structural Steel and Concrete”, Bureau of Indian Standards, New Delhi, 1985.

OE 946

**WASTE TO ENERGY
(OPEN ELECTIVE)**

Instruction: 3 periods per week

CIE: 30 marks

Credits: 3

Duration of SEE: 3 hours

SEE: 70 marks

Objectives:

- *To know the various forms of waste*
- *To understand the processes of Biomass Pyrolysis.*
- *To learn the technique of Biomass Combustion.*

Outcomes: *Upon completing this course, students will be able to:*

1. *Understand the concept of conservation of waste.*
2. *Identify the different forms of wastage.*
3. *Chose the best way for conservation to produce energy from waste.*
4. *Explore the ways and means of combustion of biomass.*
5. *Develop a healthy environment for the mankind.*

UNIT-I:

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

UNIT-II:

Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNIT-III:

Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

UNIT-IV:

Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNIT-V:

Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

Suggested Reading:

1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

OE947

**INTERNET OF THINGS
(Open Elective)**

Instruction: 3 periods per week
CIE: 30 marks
Credits: 3

Duration of SEE: 3 hours
SEE: 70 marks

Course Objectives:

- To understand the concepts of Internet of Things and able to build IoT applications
- To learn the programming and use of Arduino and Raspberry Pi boards.
- To know about data handling and analytics in SDN.

Course Outcomes:

After Completion of the course Student will be able to:

1. Known basic protocols in sensor networks.
2. Program and configure Arduino boards for various designs.
3. Python programming and interfacing for Raspberry Pi.
4. Design IoT applications in different domains.

UNIT – I

Introduction to Internet of Things, Characteristics of IoT, Physical design of IoT, Functional blocks of IoT, Sensing, Actuation, Basics of Networking, Communication Protocols, Sensor Networks.

UNIT – II

Machine-to-Machine Communications, Difference between IoT and M2M, Interoperability in IoT, Introduction to Arduino Programming, Integration of Sensors and Actuators with Arduino,

UNIT – III

Introduction to Python programming, Introduction to Raspberry Pi, Interfacing Raspberry Pi with basic peripherals, Implementation of IoT with Raspberry Pi

UNIT - IV

Implementation of IoT with Raspberry Pi, Introduction to Software defined Network (SDN), SDN for IoT, Data Handling and Analytics,

UNIT - V

Cloud Computing, Sensor-Cloud, Smart Cities and Smart Homes, Connected Vehicles, Smart Grid, Industrial IoT, Case Study: Agriculture, Healthcare, Activity Monitoring

Suggested Readings:

1. "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by PethuruRaj and Anupama C. Raman (CRC Press).
2. "Make sensors": Terokarvinen, kemo, karvinen and villeyvaltokari, 1st edition, maker media, 2014.
3. "Internet of Things: A Hands-on Approach", by ArshdeepBahga and Vijay Madisetti Vijay Madisetti,
4. ArshdeepBahga, "Internet of Things: A Hands-On Approach"
5. WalteneagusDargie,ChristianPoellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice"
6. Beginning Sensor networks with Arduino and Raspberry Pi – Charles Bell, Apress, 2013

OE948

CYBER SECURITY
(Open Elective)

Instruction: 3 periods per week

CIE: 30 marks

Credits: 3

Duration of SEE: 3 hours

SEE: 70 marks

Course Objectives

- Learn the various threats in networks and security concepts.
- Apply authentication applications in different networks.
- Understand security services for email.
- Awareness of firewall and IT laws and policies

Course Outcomes:

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

1. Understand the various network threats.
2. Analyze 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, search 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 retrieval, 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. Behrouz A. Forouzan, "*Cryptography & Network Security*", Tata McGraw Hill, India, New Delhi, 2009.
3. William Stallings, "*Cryptography and Network Security*", Prentice Hall, New Delhi, 2006.
4. Charlie 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.

CE381

MAJOR PROJECT PHASE-I

Instruction: 6 periods per week

CIE: 100 marks

Credits: 10

Duration of SEE: -- hours

SEE: -- marks

Course Objectives:

- *Identification of the research problem*
- *Discussion of literature survey.*

Course Outcomes:

1. *Identification of the objectives of the Research Problem.*
2. *Ability to update the latest literature in chosen area of research & establishment of the scope of work.*
3. *Development of the methodology for the chosen research problem and perform basic theoretical /experiment studies.*

Each student will be attached to a faculty member/guide for project. The student will carry out the project which may be development of Software / Hardware / Simulation studies / Design analysis / Experimental related to his/her specialization. The work will be monitored regularly by the guide. At the end of the semester student will write the report on the work done and submit to the guide. Student has to present his/her work before two faculty members (one guide and other to be appointed by chairman BOS) on a fixed day during last week of the semester in which project is offered. The sessional marks will be awarded jointly by these examiners based on the report, presentation and viva voice

SEMESTER - IV

CE 382

MAJOR PROJECT PHASE-II

Instruction: 6 periods per week

CIE: 200 marks

Credits: 16

Duration of SEE: -- hours

SEE: -- marks

Course Objectives:

- *Expand on the defined research problem in dissertation.*
- *Conduct laboratory/analytical studies.*
- *Analyse data, develop models, offer solutions and give conclusions.*

Course Outcomes:

1. Develop on the defined research problem in dissertation.
2. Carry out laboratory/analytical studies.
3. Evaluate data, develop models, offer solutions and give conclusions.

Each student will be attached to a faculty member who will monitor the progress of the student. The student is required to submit a technical write-up, presentation of their study (about 20 minutes) followed by a discussion.

The dissertation shall be internally scrutinized by a Viva-Voce committee consisting of the Head of the Department, Chairman Board of Studies, Supervisor and Examiner.

The Dissertation will be scrutinized by an external examiner as per the institute guide lines applicable.