KERALA TECHNOLOGICAL UNIVERSITY

Master of Technology

Curriculum, Syllabus and Course Plan

Cluster	**:**	*01*
Branch	**:**	*Civil Engineering*
Stream	**:**	*Structural Engineering*
Year	**:**	*2015*
No. of Credits	**:**	*67*

SEMESTER 1

Examination Slot	Course Number	Name	L-T-P	Internal Marks	End Semester Examination		Credits
					Marks	Duration (hours)	
A	01CE6101	Advanced Numerical Methods	3-0-0	40	60	3	3
B	01CE6103	Theory of Elasticity	3-1-0	40	60	3	4
C	01CE6105	Structural Dynamics	3-1-0	40	60	3	4
D	01CE6107	Advanced Theory and Design of RC Structures	3-0-0	40	60	3	3
E		Elective I	3-0-0	40	60	3	3
S	01CE6999	Research Methodology	0-2-0	100			2
T	01CE6191	Seminar I	0-0-2	100			2
U	01CE6193	Structural Engineering and Computational Lab	0-0-2	100			1
		TOTAL	**15-4-4**	**500**	**300**	**-**	**22**

TOTAL CONTACT HOURS : 23
TOTAL CREDITS : 22

Elective I

01CE6111 Experimental Methods and Instrumentation
01CE6113 Forensic Engineering
01CE6115 Structural Optimisation

SEMESTER 2

Examination Slot	Course Number	Name	L-T-P	Internal Marks	End Semester Examination		Credits
					Marks	Duration (hours)	
A	01CE6102	Advanced Metal Structures	3-1-0	40	60	3	4
B	01CE6104	Finite Element Method	3-0-0	40	60	3	3
C	01CE6106	Analysis and Design of Earthquake Resistant Structures	3-0-0	40	60	3	3
D		Elective II	3-0-0	40	60	3	3
E		Elective III	3-0-0	40	60	3	3
V	01CE6192	Mini Project	0-0-4	100			2
U	01CE6194	Structural Dynamics Lab	0-0-2	100			1
		TOTAL	**15-1-6**	**400**	**300**	**-**	**19**

TOTAL CONTACT HOURS : 22
TOTAL CREDITS : 19

Elective II

01CE6112 Theory and Design of Plates and Shells

01CE6114 Composite Structures

01CE6116 Fracture Mechanics

Elective III

01CE6118 Advanced Prestressed Concrete Design

01CE6122 Analysis and Design of Substructures

01CE6124 High Rise Structures

SEMESTER 3

Examination Slot	Course Number	Name	L-T-P	Internal Marks	End Semester Examination		Credits
					Marks	Duration (hours)	
A		Elective IV	3-0-0	40	60	3	3
B		Elective V	3-0-0	40	60	3	3
T	01CE7191	Seminar II	0-0-2	100			2
W	01CE7193	Project (Phase 1)	0-0-12	50			6
		TOTAL	**6-0-14**	**230**	**120**	**-**	**14**

TOTAL CONTACT HOURS : 20
TOTAL CREDITS : 14

Elective IV

01CE7111 Design of Bridges
01CE7113 Structural Reliability
01CE7115 Operations Research

Elective V

01CE7117 Stability of structures
01CE7119 Random Vibration
01CE7121 Engineering Application of Artificial Intelligence and Expert Systems

SEMESTER 4

Examination Slot	Course Number	Name	L-T-P	Internal Marks	End Semester Examination		Credit
					Marks	Duration (hours)	
W	01CE7194	Project (Phase 2)	0-0-23	70	30		12
		TOTAL	**0-0-23**	**70**	**30**	**-**	**12**

TOTAL CONTACT HOURS : 23
TOTAL CREDITS : 12

TOTAL NUMBER OF CREDITS:67

SEMESTER – I

Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE6101	Advanced Numerical Methods	3-0-0	3	2015

Course Objectives

To enable students to:

1. Get awareness to different numerical solutions.
2. Impart ability to apply mathematics to finding solutions to real time problems.

Syllabus

Introduction to numerical methods- errors in numerical methods-Systems of linear algebraic equations- Eigen Value problems- power method- Jacobi method-Practical examples- Lagrangean and Hermitian interpolation- Quadratic and Cubic splines- Multiple linear regression-Numerical integration- Romberg integration- Gaussian quadrature- Newton – Cotes open quadrature- Taylor series expansion of functions-

Ordinary differential equations- 1st order equations- Solution by use of Taylor series- Euler method and its modifications- Runge-kutta method- Higher order equations of the initial value type-Predictor corrector methods- Milne's method and Hamming's method- Stability of solutions-Ordinary differential equations of the boundary value type- Partial differential equations in two dimensions- Finite difference method- Problems with irregular boundaries.

Expected Outcome

1. Students get awareness of different numerical solutions.
2. Impart ability to apply mathematics to finding solutions to real time problems.

References

1. Chapra S.C. and Canale R.P. Numerical Methods for Engineers,McGraw Hill 2006.
2. Smith G.D. Numerical solutions for Differential Equations,McGraw Hill
3. Ketter and Prawel, Modern Methods for Engineering Computations,McGraw Hill
4. Rajasekharan S., Numerical Methods in Science and Engineering, S Chand & company 2003.
5. Rajasekharan S., Numerical Methods for Initial and Boundary value problems,Khanna publishers 1989.
6. Terrence J.Akai, Applied Numerical Methods for Engineers, Wiley publishers 1994.

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester Examination
I	Introduction to numerical methods- errors in numerical methods- Systems of linear algebraic equations- Elimination and factorization methods-ill conditioned systems- symmetric and banded systems- Gauss Seidel iteration for sparse systems.	7	15
II	Eigen Value problems- power method- Jacobi method-Practical examples- Systems of non-linear equations- Newton-Raphson method.	7	15
FIRST INTERNAL EXAM			
III	Langrangean and Hermitian interpolation- Quadratic and Cubic splines (Examples with equal intervals only)- Data smoothing by least squares criterion- Non- polynomial models like exponential model and power equation- Multiple linear regression-Numerical integration- Romberg integration- Gaussian quadrature- Newton – Cotes open quadrature- Taylor series expansion of functions	7	15
IV	Ordinary differential equations- 1st order equations- Solution by use of Taylor series- Euler method and its modifications- Runge- kutta method- Higher order equations of the initial value type- Predictor corrector methods- Milne's method and Hamming's method- Stability of solutions.	7	15
SECOND INTERNAL EXAM			
V	Ordinary differential equations of the boundary value type- Finite difference solution- Weighted residual methods for initial value problems and boundary value problems- Collocation method- Sub domain method- Method of least squares- Galerkin's method.	7	20
VI	Partial differential equations in two dimensions- Parabolic equations- Explicit finite difference method- Crank-Nicholson implicit method- Ellipse equations- Finite difference method- Problems with irregular boundaries.	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE6103	Theory of Elasticity	**3-1-0**	**4**	**2015**

Course Objectives

1. To understand the behaviour of linear elastic solids under loads
2. Provide a firm foundation for more advanced courses, for research and practise in Civil engineering field
3. To provide the student with various solution strategies while applying them to practical cases

Syllabus

Analysis of stress in 3D - Analysis of strain in 3D - Stress Strain relations - Two dimensional problems in Rectangular coordinates - Two dimensional problems in polar coordinates - Torsion of prismatic bars.

Expected Outcome

1. Understand concepts, principles and governing equations related to the analysis of elastic solids
2. To obtain skill and capability in analysing and solving problems in Civil Engineering

References

1. TimoshenkoS.P and Goodier. J.N., Theory of Elasticity, McGraw Hill, 2010
2. SrinathL.S., Advanced Mechanics of Solids, Tata McGraw Hill, 2008
3. Sokolnikoff I.S., Mathematical theory of Elasticity, Tata McGraw Hill
4. Ameen.M., Computational Elasticity, Narosa Publishing House, 2005
5. BoresiA.P., SchimidtR.J., Advanced Mechanics of Materials, John Wiley, 2002
6. T.G.Sitharam, Applied Elasticity, Interline publishing, 2008
7. Phillips, Durelli and Tsao, Analysis of Stress and Strain, McGraw Hill Book.

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester Examination
I	Analysis of stress in 3D: Definition of stress at a point – Stress tensor – Equilibrium equations Stress on arbitrarily oriented plane – Transformation of stress – Principal stress - Stress invariants – Octahedral stresses – Traction boundary conditions, Hydrostatic and Deviatoric Stress Tensors. Numerical examples	10	15
II	Analysis of strain in 3D: Strain tensor – Strain displacement relations for small deformations – Compatibility conditions – Strain transformations– Principal strains – Strain invariants, Octahedral strains, Hydrostatic and deviatoric strains. Numerical examples	9	15
FIRST INTERNAL EXAM			
III	Stress Strain relations: Generalised Hooke's law – Reduction in number of elastic constants for orthotropic, transversely isotropic and isotropic media, Boundary value problems of elasticity – Displacement, Traction and Mixed types. Navier's Equations, Beltrami-Michell's Equations, Saint Venant's principle. Uniqueness of Solution. Numerical examples	9	15
IV	Two dimensional problems in Rectangular coordinates: Plane stress and plane strain problems - Airy's stress function -Solution by polynomials – Bending of cantilever loaded at free end, Bending of simply supported beam with udl., pure bending of curved beams	10	15
SECOND INTERNAL EXAM			
V	Two dimensional problems in polar coordinates: General equations- Equilibrium equations, Strain displacement relations and Stress strain relations, compatibility relations Biharmonic equations and Airy's stress functions- Problems of axisymmetric stress distributions - Thick cylinders - Stress concentration due to circular hole in plates (Kirsch's problem). Numerical examples	9	20
VI	Torsion of prismatic bars: Saint Venant's Semi inverse and Prandtl's stress function approach – Torsion of Straight bars – Elliptic and Equilateral triangular cross section. Membrane Analogy -Torsion of thin walled open and closed tubes, Numerical examples	9	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE6105	Structural Dynamics	**3-1-0**	**4**	**2015**

Course Objectives

To enable students :

1. To understand the behaviour of structures under dynamic loads
2. To familiarise with the dynamic analysis of structures subjected to time varying loads

Syllabus

Vibration studies and its importance–Systems with single degree of freedom –Undamped and damped free vibration– Logarithmic decrement. Response of single degree of freedom systems to harmonic, impulse, periodic and general loading. Multi-degree of freedom systems –Lumped mass and consistent mass – Shear building concept and models for dynamic analysis – Evaluation of natural frequencies and mode shapes. Co-ordinate coupling - Orthogonality of normal modes - Forced vibration analysis of multi-degree of freedom systems - Mode superposition .Distributed mass (continuous) systems -Forced vibration of single span beams – Lagrange's equation.Vibration isolation-Vibration measuring instruments - Methods of vibration control.

Expected Outcome

1. Students will be equipped with the analytical tools required to determine the dynamic response of structures
2. Will serve as a pre-requisite to study the subject "Analysis and design of earthquake resistant structures".

References

1. Clough R W and Penzien J, Dynamics of Structures, McGraw Hill, New Delhi.
2. Biggs J M, Introduction to Structural dynamics, McGraw Hill, New Delhi.
3. Mario Paz, Structural Dynamics – Theory and Computation, CBS Publishers and Distributors, Delhi.
4. Mukhopadhyay M, Structural Dynamics - Vibrations and Systems, Ane Books India, Delhi.
5. Humar J, Dynamics of Structures, CRC Press, Netherlands.
6. Anil K Chopra, Dynamics of Structures- Theory and Application to Earthquake Engineering, Pearson Education, New Delhi.
7. Roy R Craig, Structural Dynamics – An Introduction to Computer Method, John Wiley & Sons, New York.
8. Thomson W T, Theory of Vibration with Application, Pearson Education, New Delhi.
9. Weaver W, Timoshenko S P, Young D H, Vibration Problems in Engineering, John Wiley & Sons, USA.

COURSE PLAN			
Module	**Contents**	**Hours Allotted**	**% of Marks in End-Semester Examination**
I	Vibration studies and its importance to structural engineering applications – Types of dynamic loading – Systems with single degree of freedom – Elements of a vibratory system – Mathematical model for single degree of freedom systems- Equation of motion – damping in vibrating system-Undamped and damped free vibration of single degree of freedom system – Logarithmic decrement.	10	15
II	Response of single degree of freedom systems to harmonic, impulse, periodic and general loading (Duhamel integral) – Numerical solution of single degree of freedom systems – Central Difference Method – Average acceleration method, Wilson-θ method- Newmark – β method.	9	15
FIRST INTERNAL EXAM			
III	Multi-degree of freedom systems – Equation of motion – Lumped mass and consistent mass – Shear building concept and models for dynamic analysis – Evaluation of natural frequencies and mode shapes by solution of characteristic equation.	9	15
IV	Co-ordinate coupling - Orthogonality of normal modes – Stodola and Rayleigh's methods for the evaluation of natural frequencies and mode shapes – Forced vibration analysis of multi-degree of freedom systems - Mode superposition method of analysis - Response of discrete systems to support motion.	10	15
SECOND INTERNAL EXAM			
V	Distributed mass (continuous) systems – differential equation of motion – Axial vibration of rods – Flexural vibration of single span beams -simply supported beam, cantilever beam and fixed beam - Evaluation of frequencies and mode shapes	10	20
VI	Beam flexure including shear deformation and rotary inertia- Forced vibration of single span beams – Lagrange's equation. Vibration isolation –Vibration measuring instruments -Methods of vibration control – Tuned mass damper.	8	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE6107	Advanced Theory and Design of RC Structures	**3-0-0**	**3**	**2015**

Course Objectives

This course is designed to

1. Provide the ability for analysis and design of basic reinforced concrete components
2. Study of advanced topics including theory and design of reinforced concrete structures

Syllabus

Basic theory and design philosophies-Advanced theory in Stress-strain characteristics of concrete - Failure criteria for concrete.-Design concepts-Limit state method-Estimation of deflection and control of cracking, RCC beam – column joints-Design of special RC members-Strut and Tie Models-Development- Design methodology - Design of concrete corbels, deep beams, pile caps. Yield line analysis of slabs.

Expected Outcome

1. Understand the theory and design of the main elements in reinforced concrete structures
2. Understand the behaviour of reinforced concrete structures
3. Carry out calculations on safety verification of reinforced concrete members
4. Understand the design of special reinforced concrete members and components

References

1. Park, R. and Pauley, T., Reinforced Concrete Structures, John Wiley. 1976
2. Varghese, P.C., Limit State Design of Reinforced Concrete, Prentice-Hall. 2005
3. Arthur. H. Nilson, David Darwin and Charles W Dolan, Design of Concrete Structures, Tata McGraw Hill, 2004
4. IS 456 –2000, Indian Standard for Plain and Reinforced Concrete- Code of Practice, New Delhi
5. American Concrete Institute, Building Code Requirements for Structural Concrete (ACI 318-02) and Commentary (ACI 318R-02)

COURSE PLAN			
Module	**Contents**	**Hours Allotted**	**% of Marks in End-Semester Examination**
I	Review on Basic theory and design philosophies-Advanced theory in Stress-strain characteristics of concrete under uniaxial and multiaxial states of stress - confined concrete- Effect of cyclic loading on concrete and reinforcing steel. Stress block parameters-Failure criteria for concrete. Design concepts-Limit state method-comparison of different codal regulations- design of reinforced concrete members in flexure, flexural shear.	7	15
II	Design for Torsion-combined with flexure and flexural shear. Analysis and design of compression members-slender columns, including biaxial bending.	7	15
FIRST INTERNAL EXAM			
III	Estimation of deflection- immediate and long term deflection- control of cracking, estimation of crack width in RC members, codal procedures on crack width computations	7	15
IV	RCC beam – column joints - classification – shear strength- design of exterior and interior joints - wide beam joints. Analysis of shear walls - classification of shear walls, shear wall frame interactions.	7	15
SECOND INTERNAL EXAM			
V	Strut and Tie Models- Development- Design methodology- selecting dimensions for struts- ACI Provisions- Applications. Design of concrete corbels, deep beams, pile caps.	7	20
VI	Yield line analysis of slabs, yield line mechanisms-equilibrium and virtual work method, Limitations of yield line theory.	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE6111	Experimental Methods and Instrumentation	**3-0-0**	**3**	**2015**

Course Objectives

To enable students to:

1. Design experiments related to stress analysis problems
2. Learn methodology for conducting laboratory and field experiments
3. Analyse and interpret experimental observations and results

Syllabus

Generalised measuring system: Static & Dynamic Performance Characteristics; Errors in measurement; Measurement of Strain- Strain Gauge types- Electrical resistance strain gauges-circuits; Force & displacement transducers; Accelerometers; Two dimensional photo elasticity-Stressed model in Polariscopes; Non Destructive Testing Methods; Indicating & recording elements.

Expected Outcome

1. Capability to provide suitable instrumentation for conducting experiments
2. Acquire capacity to organize laboratory experiments for project work
3. Building capacity to conduct destructive and nondestructive experiments as a practicing engineer

References

1Bently JP - Principles of Measurement Systems – Longman, 1995
2. Nakra BC &Chaudhry - Instrumentation Measurement & Analysis - Tata McGraw Hill, 2004
3. Adams L F - Engineering Measurements and Instrumentation – English University Press, 1975
4. Doebelin E O - Measurement Systems Application & Design - McGraw Hill, 2003
5. Dally JW & Riley WF – Experimental stress Analysis - McGraw Hill, 1991

COURSE PLAN			
Module	**Contents**	**Hours Allotted**	**% of Marks in End-Semester Examination**
I	Generalised measuring system: Purpose, Structure and Elements – Types of measuring systems- Static Performance Characteristics; Accuracy, Precision, Repeatability, Range, Static Sensitivity, Linearity, Drift; Calibration – Standards and evaluation; Errors in measurement- classification –causes.	7	15
II	Dynamic Performance Characteristics of measurement systems- Zero order instruments; First order instruments – Step and Frequency response; Second order instruments –Step and Frequency response.	7	15
FIRST INTERNAL EXAM			
III	Measurement of Strain: Strain Gauge Characteristics-Mechanical Strain Gauges-types-working, Vibrating wire strain gauges, Capacitance Strain Gauges- working principle, Semiconductor strain gauges-construction and working. Electrical resistance strain gauges – principle -strain sensitivity of alloys- types -Gauge materials - gauge construction, gauge sensitivity& gauge factor, temperature compensation, elongation limits-dynamic response; Strain gauge circuits– Potentiometric and Wheatstone bridge - sensitivity , Strain analysis-Strain Gauge rosettes-	10	15
IV	Force transducers: Load cells - different types-tension, compression, shear beam, bending – design of force transducers; Diaphragm pressure gauges. Measurement of displacement: Potentiometers – types; Linear variable differential transformer – principle and working. Measurement of acceleration: Accelerometers - Characteristics– types- design– calibration techniques.	5	15
SECOND INTERNAL EXAM			
V	Photo elasticity: Wave equation, Polarised light- Polariscopes-Wave plates- Stress-Optic Law, Effect of stressed model in plane and circular polariscopes; Model materials; Two dimensional photo elasticity - analysis & reduction of data.	7	20
VI	Non Destructive Testing Methods: Ultrasonic Methods; Core sampling technique; Pullout test; Detection of embedded reinforcement. Indicating & recording elements – Chart recorders – Cathode ray oscilloscope; Computer based data acquisition systems – structure and components.	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE6113	Forensic Engineering	**3-0-0**	**3**	**2015**

Course Objectives

1. To discuss the causes of damages observed in concrete and steel structures
2. Know- how of repair and retrofitting

Syllabus

Failure of Structures: Causes of distress in structural members-Environmental Problems and natural Hazards. Causes of deterioration in concrete and steel structures. Preventive measures, Diagnosis and assessment of deterioration- Methods of repair of cracks- Repairing of corrosion damage of reinforced concrete. Modern techniques of Retrofitting. Strengthening by pre-stressing. Repair of steel structures

Expected Outcome

1. Student develops the capability to identify reasons of distress in structures and suggest repair/ remedial measures

References

1. Sidney M Johnson, Deterioration, Maintenance and Repairs of Structures, McGraw Hill Book Company, New York
2. Dovkaminetzky, Design and Construction Failures, Galgotia Publication, New Delhi
3.Jacob Field and Kennenth L Carper, Structural Failures, Wiley Europe

COURSE PLAN			
Module	**Contents**	**Hours Allotted**	**% of Marks in End-Semester Examination**
I	Failure of Structures: Review of the construction theory – performance problems – responsibility and accountability – causes of distress in structural members – design and material deficiencies – over loading. Environmental Problems and Natural Hazards.	5	15
II	Causes of deterioration in concrete and steel structures. Preventive measures, maintenance and inspection.	5	15
FIRST INTERNAL EXAM			
III	Diagnosis and assessment of deterioration, visual inspection, non-destructive tests, ultrasonic pulse velocity method, rebound hammer method, pull out tests, Windsor probe test, crack detection techniques, etc.	7	15
IV	Case studies on diagnosis of deterioration – single and multi-storey buildings – Fibre optic method for prediction of structural weakness. Effect of corrosive, chemical and marine environment – pollution and carbonation problems – durability of RCC structures – damage due to earthquakes and strengthening of buildings – provisions of BIS 1893 and 4326.	7	15
SECOND INTERNAL EXAM			
V	Methods of repair of cracks, repairing spalling and disintegration, repairing concrete floors and pavements. Repairing of corrosion damage of reinforced concrete. Repair of steel structures.	8	20
VI	Modern Techniques of Retrofitting. Structural first aid after a disaster – guniting, jacketing – use of chemicals in repair – application of polymers – ferrocement and fiber concretes as rehabilitation materials – strengthening by pre-stressing – case studies – bridges – water tanks – cooling towers – heritage buildings – high rise buildings.	10	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE6115	Structural Optimisation	**3-0-0**	**3**	**2015**

Course Objectives

1. The ability to identify the importance of optimization in the engineering field
2. Should be able to use optimization techniques for real life time applications
3. Ability to apply optimization concepts for solving multi task applications

Syllabus

Problem formulation with examples-Single Variable Unconstrained Optimization Techniques-Multi Variable Unconstrained Optimization Techniques-Constrained Optimization Techniques-Indirect methods-Direct methods-Specialized Optimization techniques

Expected Outcome

1. Understand various optimization methods
2. Understand capabilities of optimization programmes
3. Understand & analyse various techniques and apply them for real time situations

References

1. Rao S. S., Engineering Optimisation – Theory and Practice, New Age International.
2. Deb, K., Optimisation for Engineering Design – Algorithms and examples, Prentice Hall.
3. Kirsch U., Optimum Structural Design, McGraw Hill.
4. Arora J S. Introduction to Optimum Design, McGraw Hill
5. Rajeev S and Krishnamoorthy C. S., Discrete Optimisation of Structures using Genetic Algorithms,
6. Journal of Structural Engineering, Vol. 118, No. 5, 1992, 1223-1250.

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester Examination
I	Introduction to structural optimisation -Problem formulation with examples.	7	15
II	Single Variable Unconstrained Optimization Techniques –Optimality Criteria - Interpolation methods Quadratic Interpolation,Cubic Interpolation -Gradient Based methods-Bisection, Newton Raphson, Secant Methods.	7	15
FIRST INTERNAL EXAM			
III	Multi Variable Unconstrained Optimization Techniques-Unidirectional Search, Pattern Search– Optimality Criteria. Simplex method - Gradient based methods-Cauchy's method, Newton's method, Quasi Newton Methods, Fletcher reeves method, Marquardt's method.	7	15
IV	Constrained Optimization Techniques –Classical methods - Linear programming problem.	7	15
SECOND INTERNAL EXAM			
V	Indirect methods- Transformation Techniques, Exterior and Interior penalty function. Direct methods—Zoudentijk's method, Rosen's GRG method.	7	20
VI	Specialized Optimization techniques –Dynamic programming, Geometric programming, Genetic Algorithms.	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE6999	**Research Methodology**	**0-2-0**	**2**	**2015**

Course Objectives

1. To prepare the student to do the M. Tech project work with a research bias.
2. To formulate a viable research question.
3. To develop skill in the critical analysis of research articles and reports.
4. To analyze the benefits and drawbacks of different methodologies.
5. To understand how to write a technical paper based on research findings.

Syllabus

Introduction to Research Methodology-Types of research- Ethical issues- Copy right-royalty-Intellectual property rights and patent law-Copyleft- Openacess-
Analysis of sample research papers to understand various aspects of research methodology:
Defining and formulating the research problem-Literature review-Development of working hypothesis-Research design and methods- Data Collection and analysis- Technical writing- Project work on a simple research problem

Approach

Course focuses on students' application of the course content to their unique research interests. The various topics will be addressed through hands on sessions.

Expected Outcome

Upon successful completion of this course, students will be able to
1. Understand research concepts in terms of identifying the research problem
2. Propose possible solutions based on research
3. Write a technical paper based on the findings.
4. Get a good exposure to a domain of interest.
5. Get a good domain and experience to pursue future research activities.

References

1. C. R. Kothari, Research Methodology, New Age International, 2004
2. Panneerselvam, Research Methodology, Prentice Hall of India, New Delhi, 2012.
3. J. W. Bames, Statistical Analysis for Engineers and Scientists, Tata McGraw-Hill, New York.
4. Donald Cooper, Business Research Methods, Tata McGraw-Hill, New Delhi.
5. Leedy P. D., Practical Research: Planning and Design, McMillan Publishing Co.
6. Day R. A., How to Write and Publish a Scientific Paper, Cambridge University Press, 1989.
7. Manna, Chakraborti, Values and Ethics in Business Profession, Prentice Hall of India, New Delhi, 2012.
8. Sople, Managing Intellectual Property: The Strategic Imperative, Prentice Hall ofIndia, New Delhi, 2012.

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester Examination
I	Introduction to Research Methodology: Motivation towards research - Types of research: Find examples from literature. Professional ethics in research - Ethical issues-ethical committees. Copy right - royalty - Intellectual property rights and patent law - Copyleft- Openacess-Reproduction of published material - Plagiarism - Citation and acknowledgement. Impact factor. Identifying major conferences and important journals in the concerned area. Collection of at least 4 papers in the area.	5	No end semester written examination
II	Defining and formulating the research problem -Literature Survey- Analyze the chosen papers and understand how the authors have undertaken literature review, identified the research gaps, arrived at their objectives, formulated their problem and developed a hypothesis.	4	
FIRST ASSESSMENT			
III	Research design and methods: Analyze the chosen papers to understand formulation of research methods and analytical and experimental methods used. Study of how different it is from previous works.	4	
IV	Data Collection and analysis.Analyze the chosen papers and study the methods of data collection used. - Data Processing and Analysis strategies used– Study the tools used for analyzing the data.	5	
SECOND ASSESSMENT			
V	Technical writing - Structure and components, contents of a typical technical paper, difference between abstract and conclusion,layout, illustrations and tables, bibliography, referencing and footnotes-use of tools like Latex.	5	
VI	Identification of a simple research problem – Literature survey- Research design- Methodology –paper writing based on a hypothetical result.	5	
END SEMESTER ASSESSMENT			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE6191	Seminar **I**	**0-0-2**	**2**	**2015**

Course Objectives

To make students

1. Identify the current topics in the specific stream.
2. Collect the recent publications related to the identified topics.
3. Do a detailed study of a selected topic based on current journals, published papers and books.
4. Present a seminar on the selected topic on which a detailed study has been done.
5. Improve the writing and presentation skills.

Approach

Students shall make a presentation for 20-25 minutes based on the detailed study of the topic and submit a report based on the study.

Expected Outcome

Upon successful completion of the seminar, the student should be able to

1. Get good exposure in the current topics in the specific stream.
2. Improve the writing and presentation skills.
3. Explore domains of interest so as to pursue the course project.

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE6193	Structural Engineering and Computational Lab	**0-0-2**	**1**	**2015**

Course Objectives

1. Practical training for conducting experiments related to structural engineering.
2. Ability to solve stress analysis problems.
3. Ability to write algorithms for problem solving

Syllabus

List of experiments

1. Review of testing methods of cement, coarse aggregate and fine aggregate as per Indian Standards.
2. Design of concrete mixes as per Indian Standard
3. Study of behaviour of RCC beams
4. Study of behaviour of RCC columns.
5. Accelerated curing experiments for concrete.
6. Study of behaviour of steel beams.
7. Free vibration analysis of steel cantilever beams.
8. Non- destructive testing of concrete
    a) Rebound hammer
    b) Core cutting
    c) Ultrasonic pulse velocity
    d) Pullout test
    e) Detection of embedded reinforcements
9. Analysis of plates using software package.
10. Analysis of shells using software package.
11. Analysis of frames using software package.
12. Writing programs in any high level language for solving computational problems

Expected Outcome

1. Acquire capacity to organise experiments for project work.
2. Capability to use finite element packages for stress analysis.
3. Building capacity to write programs for problem solving

COURSE PLAN		
Expt. No.	Title	Hours Alloted
1	Review of testing methods of cement, coarse aggregate and fine aggregate as per Indian Standards.	2
2	Design of concrete mixes as per Indian Standard	2
3	Study of behaviour of RCC beams	2
4	Study of behaviour of RCC columns.	2
5	Accelerated curing experiments for concrete.	2
6	Study of behaviour of steel beams.	2
7	Free vibration analysis of steel cantilever beams	2
8	Non- destructive testing of concrete a) Rebound hammer b) Core cutting c) Ultrasonic pulse velocity d) Pullout test e) Detection of embedded reinforcements	2
9	Analysis of plates using software package.	2
10	Analysis of shells using software package.	2
11	Analysis of frames using software package	2
12	Writing programs in any high level language for solving computational problems	6

SEMESTER - II

Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE6102	Advanced Metal Structures	**3-1-0**	**4**	**2015**

Course Objectives

1. Ability to perform analysis and design of steel members and connections
2. Familiarity with professional and contemporary issues in steel design

Syllabus

Methods of Analysis-Beam to column connections- Bolted connections-Welded connections-Industrial buildings-Steel – Concrete Composite structures-Aluminium Structures-Cold formed Steel Structures - Analysis of single and two bay portal frames, gable frames. Plastic design

Expected Outcome

1. Ability to design steel structural elements and connections
2. Understanding of the ASD and LRFD design philosophies

References

1. Gaylord, Design of Steel Structures, McGraw Hill, New York.
2. Dayaratnam, P., Design of Steel Structures, Wheeler Pub.
3. Wie-Wen Yu, Cold-Formed Steel Structures, McGraw Hill Book Company.
4. Lothers, Advanced Design in Steel, Prentice Hall, USA.
5. N. Subramanian, Design of Steel Structures, Oxford University Press.
6. R.P. Johnson, Composite Structures in Steel & Concrete, Blackwell Scientific Publications, UK.
7. Relevant IS codes

COURSE PLAN			
Module	**Contents**	**Hours Allotted**	**% of Marks in End-Semester Examination**
I	Design Requirements & Design Process. Analysis Procedures & Design Philosophy. Introduction to Limit State Design. Connections: - Classification (Simple, Rigid, Semi rigid); Moment-rotation Characteristics - Beam to Column and Beam to Beam connections; Bolted connections - Types of bolts - Bearing and High strength bolts- Prying force. Beam to Column connections - Design of seat angle - (Stiffened and unstiffened), Web angle & end plate connections, Beam and column bolted splices.	10	15
II	Welded connections – Structure and properties of weld metal. Beam-to-column connections-Angle seat, Stiffened beam seat connection, Web angle and end plate connections, Beam and column welded splices. Tubular connections - Welds in tubular joints - Curved weld length at intersection of tubes – Weld defects.	9	15
FIRST INTERNAL EXAM			
III	Introduction to Bases and Footings. Design of Solid Slab Base , Gusseted Base ,eccentrically loaded base plate ; Other Types of footings - Anchor bolts and shear connectors	9	15
IV	Industrial buildings - Layout - Structural framing - Braced and unbraced-Roof Systems - Industrial Floors (design not expected).Design of crane and Gantry Girders Steel-Concrete Composite structures – shear connectors – types of shear connectors– degrees of shear connections – partial and full shear connections – composite sections under positive and negative bending(design not expected)	10	15
SECOND INTERNAL EXAM			
V	Aluminium Structures: Introduction–Stress-strain relationship-Permissible stresses; Design of Aluminium Tension members, Compression members and Beams. Cold formed Steel Structures - local and post buckling of thin sections -Behaviour under axial, bending and shear forces (design not expected)	9	20

VI	Methods of Analysis- Elastic analysis (first order, second order), buckling analysis (linear, inelastic). Sources of non-linearity. First order plastic analysis, second order inelastic analysis. Plastic method of analysis - moment redistribution - Theorems; Effect of axial and shear force on plastic moment capacity. Analysis of single and two bay portal frames, Analysis of gable frames; Plastic design with LRFD concepts - Requirements and advantages of plastic design, Plastic design of continuous beams and portal frames.	9	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE6104	Finite Element Method	3-0-0	3	2015

Course Objectives

1. Impart an understanding of fundamental knowledge and technique of FEM
2. To enable students to develop tools to analyse engineering problems using FEM and typical commercial FEA packages.

Syllabus

Basics of elasticity- Equations of equilibrium, Strain-displacement relation, constitutive relation; Energy principles; Introduction to weighted residual methods; Evolution of FEM, Review of direct stiffness method, Outline of the FE procedure; Element properties, convergence requirements, equilibrium and compatibility in the solution;Types of finite elements; Plane stress and plane strain problems; Stiffness matrix for truss and beam elements, Development of consistent nodal load vector; Concept of isoparametric formulation- Line element, Plane bilinear element, Subparametric and superparametric elements; Assembly procedure and storage techniques of stiffness matrix, Application of boundary Conditions, Solution techniques; Introduction to plate and shell elements; Types of 3D elements; Discussion of finite element packages.

Expected Outcome

Students will be able to:

1. Analyse and build FEA model for various engineering problems.
2. Extend the theory to the dynamic analysis of structures

References

1. Cook RD, Malkus D S, Plesha M E and Witt R.J. , Concepts and Applications of Finite Element Analysis, John Wiley & Sons, Singapore.
2. Krishnamoorthy C S, Finite Element Analysis: Theory and Programming, Tata McGraw Hill, New Delhi.
3. Bathe K J, Finite Element Procedures in Engineering Analysis, Prentice Hall, New Delhi.
4. Zienkiewicz O C and Taylor R W, Finite Element Method, Elsevier Butterworth-Heinemann, UK.
5. Rajasekharan S, Finite Element Analysis in Engineering Design, Wheeler, New Delhi.
6. Chandrupatla T R and Belegundu A D, Introduction to Finite Elements in Engineering, Pearson Education, New Delhi.
7. Hutton D V, Fundamentals of Finite Element Analysis, Tata McGraw Hill Education Private Ltd. New Delhi.
8. Mukhopadhyay M and Abdul Hamid Sheikh, Matrix and Finite Element Analyses of Structures, Ane Books Pvt. Ltd., New Delhi.

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester Examination
I	Basics of elasticity- Equations of equilibrium, Strain-displacement relation, constitutive relation; Energy principles- Principle of virtual work, Principle of stationary potential energy; Variational formulation- Rayleigh-Ritz method; Introduction to weighted residual methods	7	15
II	Evolution of FEM, Review of direct stiffness method, Outline of the FE procedure; Element properties- Displacement functions, convergence requirements, equilibrium and compatibility in the solution, Development of equilibrium equation	7	15
FIRST INTERNAL EXAM			
III	Types of finite elements- Development of shape functions for truss and beam, CST, LST; Lagrange and Serendipity elements; Plane stress and plane strain problems.	7	15
IV	Development of stiffness matrix for truss and beam elements; Development of consistent nodal load vector; Concept of isoparametric formulation- Line element, Plane bilinear element; Subparametric and superparametric elements.	7	15
SECOND INTERNAL EXAM			
V	Assembly procedure and storage techniques of stiffness matrix, Application of boundary Conditions; Solution techniques of equilibrium equation; patch test; static condensation.	7	20
VI	Gauss quadrature technique; Introduction to plate and shell elements; Types of 3D elements; Discussion of finite element packages	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE6106	Analysis and Design of Earthquake Resistant Structures	**3-0-0**	**3**	**2015**

Course Objectives

1. To impart awareness about the effect of earthquakes on structures.
2. To study IS code provisions for the analysis, design and detailing of earthquake resistant structures

Syllabus

Elements of earthquake engineering; Earthquake response spectrum; Earthquake effects on structures; Review of damages during past earthquakes; Earthquake resistant design of structures; Design philosophy and guidelines ; IS 1893 Codal provisions- Determination of lateral forces; IS 13920 Codal provisions- basic principles for design and reinforcement detailing for members and joints ; Methods for repair & rehabilitation of damaged structure; Disaster mitigation

Expected Outcome

1.Understand various aspects of earthquake engineering
2.Capability for design and detailing of earthquake resistant structures
3. Awareness of disaster management after earthquakes

References

1. IS: 1893-2002, Indian Standard criteria for Earthquake Resistant Design of Structures, Bureau of Indian Standards, New Delhi
2. IS: 4326-1993, Indian Standard code for practice for Earthquake Resistant Design and Construction of Buildings, Bureau of Indian Standards, New Delhi.
3. IS: 13920-1993, Indian Standard Ductile Detailing of RCC Structures subjected to seismic forces- Code of practice, Bureau of Indian Standards, New Delhi
4. SP: 22-1982, Explanatory Handbook on codes of Earthquake Engineering, Bureau of Indian Standards, New Delhi
5. PankajAgarwal and Manish Shrikhande, Earthquake Resistant Design of Structures, Prentice-Hall of India, New Delhi.
6. Anil K Chopra, Dynamics of Structures, Prentice- Hall of India, New Delhi.
7. S. K. Duggal, Earthquake Resistant Design of Structures-Oxford University Press-2007

COURSE PLAN			
Module	**Contents**	**Hours Allotted**	**% of Marks in End-Semester Examination**
I	Elements of earthquake engineering: plate tectonics theory- seismic waves- earthquake intensity and magnitude- characteristics of ground motion - recording instruments - consequences of earthquake- seismic zoning.	7	15
II	Earthquake response spectrum - characteristics-design spectrum; Earthquake effects on structures: effect of architectural features and structural irregularities- review of damages during past earthquakes.	7	15
FIRST INTERNAL EXAM			
III	Earthquake resistant design of structures: Design philosophy and guidelines –IS 1893 codal provisions; Determination of lateral forces-Seismic coefficient method of analysis – Dynamic analysis.	7	15
IV	Torsion in buildings - calculation of shear force; Stress-Strain behaviour of concrete and steel under cyclic loads- Effect of concrete confinement-Ductility of RC members- Modes of failure of beams and columns- Desirable collapse mechanisms -Capacity Design philosophy; IS 13920 Code provisions- basic principles for design and reinforcement detailing for members and joints.	7	15
SECOND INTERNAL EXAM			
V	Examples on design of RC beams and columns using IS 13920; Shear Walls – functions, modes of failure- Design Examples.	7	20
VI	Methods for Repair and rehabilitation of damaged structures; Methods for disaster mitigation; Vulnerability assessment and seismic evaluation of structures – vulnerability reduction.	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE6112	Theory and Design of Plates and Shells	**3-0-0**	**3**	**2015**

Course Objectives

To enable students to:

1. Identify the various thin walled structures in the form of plates and shells suitable for use in different structural systems.
2. Study the behaviour of the plates and shells with variable geometry under the action of different types of loads.

Syllabus

Introduction to plates and shells - Assumptions in the theory of thin plates; Bending of long rectangular plates; Pure bending of plates ; Small deflections of laterally loaded plates -Navier solution and Levy's solution for simply supported rectangular plates; Symmetrical bending of circular plates - Classical Plate theory; Mindlin's plate theory. Theory of folded plates; Introduction to shell theory ;Cylindrical shells; Hyperbolic shells, Hyperbolic paraboloid shells and Conoids;

Expected Outcome

Students will be able to:

1. Identify the various thin walled structures such as plates and shells that are suitable for different structural systems.
2. Analyse the behaviour of plates and shells of different geometry under the action of various types of loads

References

1. Timoshenko S.P. and Krieger S. W., Theory of Plates and Shells, Tata McGraw Hill, 1959
2. Chandrashekhara K., Theory of Shells, Universities(India)Press Ltd., 2001
3. Ramaswamy G. S., Design and Construction of Concrete Shell Roofs, CBS Publishers, 2005.
4. Bairagi N. K., Plate Analysis, Khanna Publishers, 1986
5. Kelkar V. S. and Sewell R.T., Fundamentals of the Analysis and Design of Shell Strutures, Prentice Hall Inc., 1987
6. T.K.Varadan& K. Bhaskar, Análysis of plates – Theory and problems, Narosa Publishing Co., 1999.
7. Reddy J N., Theory and Analysis of Plates and Shells, Taylor and Francis, 2006

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester Examination
I	Introduction to plates and shells – Classifications, Assumptions in the theory of thin plates; Differential equation to Bending of long rectangular plates to a cylindrical surface. Pure bending of plates – Relation between slope and curvature, bending moments and curvature; Particular cases of pure bending	7	15
II	Small deflections of laterally loaded plates - Differential equation; Navier solution and Levy's solution for simply supported rectangular plates-Effect of transverse shear deformation.	7	15
FIRST INTERNAL EXAM			
III	Symmetrical bending of circular plates - Differential equations; Uniformly loaded circular plates with simply supported and fixed boundary conditions. Annular plate with uniform moments and shear forces along the boundaries.	7	15
IV	Classical Plate theory for Orthotropic plates and layered plates; Mindlin's plate theory. Theory of folded plates, Design aspects of reinforced concrete folded plates	6	15
SECOND INTERNAL EXAM			
V	Introduction to shell theory. Classification of shells, Membrane theory of shells, Application to spherical, conical and cylindrical shells, Deformation of shells without bending - definitions and notations. Shells in the form of a surfaceof revolution and loaded symmetrically with respect to their axis. Membrane and General theories ofcylindrical shells - Circular cylindrical shell loaded symmetrically with respect to its axis; stresses incylindrical shell under dead and snow loads, symmetrical deformation.	6	20
VI	General case of deformation ofcylindrical shells with supported edges; Hyperbolic shells, hyperbolic paraboloid shells and Conoids. Analysis and design aspects ofcylindrical shells. Detailing of reinforcement in shells, edge and transfer beams.	9	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE6114	**Composite Structures**	**3-0-0**	**3**	**2015**

Course Objectives

Composite materials are finding immense application in the field of aerospace, automobile and civil engineering presently due to its outstanding material capability. It is required for the present structural engineers to know the fundamentals of composite materials for designing composite structures in various fields.

Syllabus

Introduction to composites; Composite Fundamentals, Structural applications of Composite Materials; Manufacturing Processes. Mechanics of Composite Lamina; Failure theories. Micro Mechanical Behaviour of Composite Laminates - Classical Lamination Theory, stress-strain variation, In-plane forces, bending and twisting moments, special cases of laminate stiffness. Laminate strength analysis procedure, Failure envelopes,. Free-Edge Interlaminar Effects, Analysis of free edge interlaminar stresses, Effects of stacking sequence, Design guidelines. Bending and Buckling Laminated Beams and Plates.

Expected Outcome

1. An ability to identify the properties of fiber and matrix materials used in commercial composites, as well as some common manufacturing techniques.
2. A basic understanding of linear elasticity with emphasis on the difference between isotropic and anisotropic material behavior.
3. An ability to predict the failure strength of a laminated composite plate.
4. An ability to use the ideas developed in the analysis of composites towards using composites in aerospace design.

References

1. Jones M. Roberts, Mechanics of Composite Materials, Taylor and Francis,1998
2. Reddy, J.N , Mechanics of Laminated Composite Plates: Theory and Analysis, CRC Press, 2003
3. Calcote, L. R., Analysis of Laminated Composite structures, Van Nostrand, 1969
4. Vinson, J. R. and Chou P, C., Composite materials and their use in Structures, Applied Science Publishers, Ltd. London, 1975
5. Agarwal, B.D. and Broutman, L. J., Analysis and performance of Fibre composites.

3rd Edn., Wiley, 1990			
COURSE PLAN			
Module	**Contents**	**Hours Allotted**	**% of Marks in End-Semester Examination**
I	Introduction. Composite Fundamentals: Definition of composites, Objectives, constituents and Classification of composites Structural applications of Composite Materials, Manufacturing Processes. Review of Basic Equations of Mechanics and Materials and Linear Elasticity in 3D and 2-D plane stress and plane strain	7	15
II	Number of elastic constants and reduction from 81 to 2 for different materials. Stress-Strain relations for a unidirectional and orthotropic lamina Effective Moduli of a continuous fibre-reinforced lamina - Models based on mechanics of materials, theory of elasticity. Failure of Continuous Fibre-reinforced orthotropic Lamina. Maximum stress/strain criteria, Tsai-Hill and Tsai-Wu criterion.	7	15
FIRST INTERNAL EXAM			
III	Micro mechanical behaviour of composite laminates - Classical Lamination Theory, stress-strain variation, In-plane forces, bending and twisting moments, special cases of laminate stiffness.	7	15
IV	Laminate strength analysis procedure, Failure envelopes, Progressive failure Analysis. Free-Edge InterlaminarEffects, Analysis of free edge interlaminar stresses, Effects of stacking sequence, Hygrothermal effects on material properties on response of composites.	7	15
SECOND INTERNAL EXAM			
V	Bending of Laminated Beams and Plates - Governing equations and boundary conditions, Solution techniques, deflection of composite beams and plates under transverse loads for different boundary conditions	7	20
VI	Buckling of laminated beams and plates under in-plane loads and under different boundary conditions.	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE6116	Fracture Mechanics	3-0-0	3	2015

Course Objectives

1. To gain knowledge of fracture mechanics
2. To gain knowledge of using fracture mechanics in the actual design
3. To gain knowledge of using materials with existing cracks and know the behavior of existing cracks.

Syllabus

Introduction: Significance and theory of fracture mechanics –instability and R curve-Stress analysis of cracks- fracture -Crack tip plasticity - LEFM testing- Elastic plastic fracture mechanics (EPFM) - Application to engineering problems- Mechanisms of fracture and crack growth- prediction of fatigue crack growth under constant amplitude and variable amplitude loading - Fatigue - practical significance of sustained load fracture testing- Basic Aspects of Dynamic Crack Growth-Basic Principles of Crack Arrest -Fracture Mechanics Analysis of fast fracture and Crack Arrest.

Expected Outcome

1. Students will understand how the theory is used in actual design
2. Students will know about how to restrict the propagation of cracks

References

1. T. Anderson, Fracture Mechanics, CRC Pub.
2. D. Broek, Elementary Engineering Fracture Mechanics, 4th Revised Edition, Kluwer Academic Pub., 1991, ISBN 90-247-2656-5.
3. K. Hellan, Introduction to Fracture Mechanics, McGraw-Hill, 1984.
4. G. Sih, Handbook of Stress Intensity Factors.
5. M. Janssen, J. Zuidema and R. J. H. Wanhill, Fracture Mechanics, Taylor & Francis.
6. Prashant Kumar, Elements of Fracture Mechanics, Wheeler Publishing.

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester Examination
I	Fundamentals of the Theory of Elasticity and Indicial Notations. Elastic Crack Model: Elastic Stress Field at Crack Tip, William's Problem, Stress Intensity Factors, Fracture Toughness, Different Modes of fracture, Direction of Crack Propagation.	7	15
II	Griffith Energy Balance: Basic Energy Balance, Fixed Grip and Fixed Force Conditions, Strain Energy Release Rate, Experimental Calibration.	7	15
FIRST INTERNAL EXAM			
III	Plasticity Effects: Elementary estimates of Size and Shape of Plastic Zones, Plasticity Correction Factor, Plane Strain vs. Plane Stress Conditions, Dugdale Model, Crack Tip Opening, J-integral and its Applications.	7	15
IV	Applied Fracture Mechanics: 3-D Effects at the Crack Front, Fatigue Crack Growth, Penny and Elliptical Shaped Flaws, Part-Through Surface Cracks, Summary and Relevant Crack Tip Stress Intensity Factors.	7	15
SECOND INTERNAL EXAM			
V	Numerical Stress Analysis: Boundary Collocation, Conventional Finite Elements, Special Crack Tip Elements, Quarter Point Eight Node Isoparametric Elements.	7	20
VI	Analytical Stress Analysis: Westergaard Stress Function. Advanced Topics: Fracture Toughness of Fiber Reinforced Brittle Matrix Composites, Stress Intensity Factors at Crack Corners, Interface Cracks.	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE6118	Advanced Prestressed Concrete Design	**3-0-0**	**3**	**2015**

Course Objectives

1. To impart to students the knowledge of methods of prestressing, analysis and design of various prestressed concrete elements under relevant codal provisions

Syllabus

Basic concepts and need of prestressing, types and systems of prestressing, Devices and materials used in prestressing, losses in prestressing. Analysis of members under flexure, shear and torsion, Design of axially loaded members, flexural members and design for shear and torsion. Detailing of reinforcement. Calculation of deflection and crack width, Design of end block, design of slabs. Analysis and design of continuous beams, Composite construction and partial prestressing Circular prestressing, Design of prestressed concrete bridge decks.

Expected Outcome

1. Understand and use suitably the different concepts of prestressing
2. Comprehend the design of various prestressed concrete members used in practice

References

1. Krishna Raju N., Prestressed concrete, Tata McGraw Hill Company, New Delhi 1998
2. Mallick S.K. and Gupta A.P., Prestressed Concrete,Oxford and IBH publishing Co. Pvt. Ltd. 1997.
3. Rajagopalan, N, Prestressed Concrete, Alpha Science, 2002
4. Ramaswamy G.S., Modern prestressed concrete design, Arnold Heinimen, New Delhi, 1990
5. Lin T.Y. Design of prestressed concrete structures, Asia Publishing House, Bombay 1995.
6. IS 1343: 1980 Indian Standard Code of Practice for Prestressed Concrete
7. IS 456: 2000 Indian Standard Code of Practice for Plain and Reinforced Concrete

COURSE PLAN			
Module	**Contents**	**Hours Allotted**	**% of Marks in End-Semester Examination**
I	Basic concepts and need of prestressing, types and systems of prestressing, Devices and materials used in prestressing, losses in prestressing.	7	15
II	Analysis of members under flexure, shear and torsion. Design of axially loaded members	7	15
FIRST INTERNAL EXAM			
III	Design of flexural members and design for shear and torsion. Detailing of reinforcement	7	15
IV	Calculation of deflection and crack width; Design of end block, design of slabs.	7	15
SECOND INTERNAL EXAM			
V	Analysis and design of continuous beams,Composite construction and partial prestressing	7	20
VI	Circular prestressing, Design of prestressed concrete bridge decks	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE6122	Analysis and Design of Substructures	**3-0-0**	**3**	**2015**

Course Objectives

1. Ability to identify the soil-structure interaction
2. Ability to select suitable foundation for different types of structures
3. Should be able to analyse and design substructures

Syllabus

Soil-structure interaction, Contact pressure distribution, Selection of foundations, Design of foundations -spread footing, combined Footing and raft foundation. Pile foundation, Estimation of pile capacity, Design of pile cap. Retaining Walls-Different Types - Stability analysis and Design. Introduction to well foundations – Types, Sinking stresses in wells, Design of well cap, Well steining, well curb, cutting edge and bottom plug.

Expected Outcome

1. Basic understanding of type and selection of foundations
2. To analyse and design foundations

References

1. Swami Saran, Analysis and design of substructures, Oxford and IBH Publishing Company Pvt. Ltd.
2. Donald P. Coduto, Foundation Design: Principles and Practices, Dorling Kinderseley (India) Pvt. Ltd., 2012
3.Bowles J.E., Foundation Analysis and Design (4^{th} Ed.), McGraw Hill Book Company, NY, 1988.
4. Varghese P.C, Foundation Engineering, Prentice Hall India, New Delhi 2005.

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester Examination
I	Introduction to soil-structure interaction - Soil-structure interaction problems. Contact pressure distribution beneath rigid and flexible footings on sand and clay - Contact pressure distribution beneath raft. Selection of foundations. Structural design of spread footing, combined Footing and raft foundation.	7	15
II	Structural Design of Shallow Foundation- spread footing, combined Footing and raft foundation.	7	15
FIRST INTERNAL EXAM			
III	Pile foundation: Introduction - Estimation of pile capacity by static and dynamic formulae- Settlement of single pile - Laterally loaded piles - Brom's method - Ultimate lateral resistance of piles - Pile groups - Consideration regarding spacing - Efficiency of pile groups	7	15
IV	Structural Design of Pile and pile cap	7	15
SECOND INTERNAL EXAM			
V	Retaining Walls-Types - Stability analysis of cantilever retaining walls against overturning and sliding-Bearing capacity considerations- Structural design of retaining walls	7	20
VI	Introduction to well foundations – Elements of well foundations – Types – Sinking stresses in wells – Design of well cap, Well steining, well curb, cutting edge and bottom plug	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE6124	High Rise Structures	3-0-0	3	2015

Course Objectives

To enable students to:

1. Identify the various structural systems for combinations of gravity and horizontal loading based on their use considering its function.
2. Analyse the structural behaviour and drift capacities of various high rise structural forms.

Syllabus

Tall buildings/ High rise buildings – definition, need, historic background; Design Criteria/ philosophy of high rise structures; Materials, Loading – Dead, live, impact, wind, earthquake; Wind Characteristics –static, dynamic wind effects; Earthquake loading – methods of analysis -equivalent lateral force method, modal analysis, performance based seismic design; Structural Systems - Floor systems, Structural forms- Rigid frames, Braced frames, Infilled frames, analysis of drift; Shear wall Structures - coupled shear walls, Wall frame structures, Tubular structures, Framed tube structures, Core structures, Outrigger Braced Structures; Foundations for tall structures - pile foundation, mat foundation; Finite Element Packages for the analysis of High rise structures

Expected Outcome

Students will be able to:

1. Identify the various structural systems suitable for combinations of loading with due consideration of its functions.
2. Estimate the structural behaviour of various high rise structural systems from their analysis.

References

1. Bryan Stafford Smith and Alex Coull, Tall Building structures: Analysis and Design, Wiley Interscience, New York, 1991.
2. Bungale S Taranath, Structural Analysis and Design of Tall Buildings, Tata McGraw Hill,1988.
3. Kolousek V, Pimer M, Fischer O and Naprstek J, Wind effects on Civil Engineering Structures, Elsevier Publications, 1984.
4. Robert L Wiegel, Earthquake Engineering, Prentice Hall, 1970.
5. ATC40- Seismic evaluation and retrofitting of concrete buildings, Seismic safety commission, California 1996.
6. Wolfgang Schuller, High Rise Building Structures, John Wiley and sons,1977.
7. Mark Fintel, Hand book of Concrete Engineering, Van Nostrand Reinhold, 1985.
8. FEMA 445, Next generation Performance based seismic design guidelines, FEMA, 2006.

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester Examination
I	Definition of tall buildings - need for constructing tall buildings, historic background, factors affecting growth; Design Philosophy of High Rise structures; Materials; Gravity loading - Dead and live load, live load reduction techniques-sequential loading, Impact loading.	7	15
II	Wind Loading, Wind Characteristics - Static and Dynamic wind effects, Analytical and wind tunnel experimental method; Earthquake loading - equivalent lateral force method, modal analysis; Introduction to Performance based seismic design.	7	15
FIRST INTERNAL EXAM			
III	Structural Floor systems, Structural forms - Rigid frame Structures, rigid frame behaviour –approximate determination of member forces by gravity loading- two cycle moment distribution, portal method, cantilever method; approximate analysis of drift.	7	15
IV	Braced frames - Types of bracings, behaviour of bracings, behaviour of braced bents; Infilled frames - behaviour of Infilled frames, stresses in infill, design of infill, design of frame - horizontal deflection.	7	15
SECOND INTERNAL EXAM			
V	Shear wall structures - behaviour of shear wall structures; proportionate and non-proportionate wall systems, horizontal deflection; Coupled shear walls -behaviour of coupled wall structures; Wall frame structures - behaviour of wall frames; Tubular structures - framed tube structures, bundled tube structures, braced tube structures, core structures, outrigger braced structures.	7	20
VI	Foundations for tall structures - pile foundation, mat foundation; Modeling for analysis for high rise structures – approximate analysis, accurate analysis and reduction techniques; Discussion of various Finite Element Packages for the analysis of High Rise Structures.	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE6192	Mini Project	**0-0-4**	**2**	**2015**

Course Objectives

To make students

Design and develop a system or application in the area of their specialization.

Approach

The student shall present two seminars and submit a report. The first seminar shall highlight the topic, objectives, methodology, design and expected results. The second seminar is the presentation of the work / hardware implementation.

Expected Outcome

Upon successful completion of the miniproject, the student should be able to

1. Identify and solve various problems associated with designing and implementing a system or application.
2. Test the designed system or application.

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE6194	Structural Dynamics Lab	**0-0-2**	**1**	**2015**

Course Objectives

1. Ability to identify the response of structures subjected to dynamic loading
2. Provide a firm foundation for research and practice in civil engineering
3. Ability to solve dynamic problems numerically

Syllabus

Lists of Experiments

1. Dynamics of a single storied building frame with planar asymmetry subjected to harmonic base motion
2. Dynamics of a three storied building frame with planar asymmetry subjected to periodic (non harmonic) base motion
3. Vibration isolation of a secondary system
4. Dynamics of a vibration absorber
5. Dynamics of a four storied building frame with and without an open ground floor
6. Dynamics of a single span and two span beams
7. Earthquake induced waves in rectangular water tanks (Demonstration only)
8. Dynamics of free standing rigid bodies under base motion (Demonstration only)
9. Seismic wave amplification, liquefaction and soil structure interaction. (Demonstration only)

   f) **Note:** Results obtained from experiments may be numerically verified wherever possible

Expected Outcome

1. Understand concepts and principles involved in structural dynamics
2. To train the students to perform experiments for project work

COURSE PLAN

Expt. No.	Title	Hours Alloted
1	Dynamics of a single storied building frame with planar asymmetry subjected to harmonic base motion	2
2	Dynamics of a three storied building frame with planar asymmetry subjected to periodic (non harmonic) base motion	2
3	Vibration isolation of a secondary system	2
4	Dynamics of a vibration absorber	2
5	Dynamics of a four storied building frame with and without an open ground floor	2
6	Dynamics of a single span beam	2
7	Dynamics of a two span beam	2
8	Earthquake induced waves in rectangular water tanks (Demonstration only)	2
9	Dynamics of free standing rigid bodies under base motion (Demonstration only)	2
10	Seismic wave amplification, liquefaction and soil structure interaction. (Demonstration only)	2

SEMESTER - III

Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE7111	Design of Bridges	3-0-0	3	2015

Course Objectives

To understand the theory and design methods of various forms of bridges.

Syllabus

Classification and components of bridge: road and railway bridge specifications, IRC provisions, Foundation and substructure: Analysis and Design of piers- Analysis and Design of abutments, bed blocks –Bearings-Design of R. C bridge slab –Design of T beam bridges-Design of Balanced cantilever bridges- Pre- stressed Concrete Bridges- Steel bridges-Composite bridges

Expected Outcome

Students should be able to select a particular form of bridge to suit the requirements, analyse and design the same.

References

1. Johnson Victor D., Essentials of Bridge Engineering, Oxford & IBH Pub. Co.
2. Vazirani V. N., Design of Concrete Bridges, Khanna publishers, 2004
3. Jagadeesh T.R and Jayaram M.A, Design of Bridge Structures, Prentice Hall, 2004
4. Krishnaraju. N, Design of Bridges, Oxford & IBH Pub. Co.,2010
5. Krishnaraju.N, Prestressed Concrete bridges, CBS Publishers,2010
6. IRC 6-2000, IRC 21-2000, IS 800-2007, IRC 18-1985, IRC 24-2001, IRC 83-1987

COURSE PLAN			
Module	**Contents**	**Hours Allotted**	**% of Marks in End-Semester Examination**
I	Classification and components of bridge. Review of road and railway bridge specifications and IRC provisions. Foundation and substructure: Types of foundations, Piers - Forces on pier, Analysis and Design of piers.	7	15
II	Types of Abutments- Forces in abutments, Analysis and Design of abutments, bed blocks. Bearings: Concrete, steel and neoprene bearings, Design of elastomeric pad bearings.	7	15
FIRST INTERNAL EXAM			
III	Design of R. C bridge – deck slab bridges (Culvert). Design of T beam bridges Grid analysis- Courbon's method-Orthotropic plate theory	7	15
IV	Design of Balanced cantilever bridge Introduction to – continuous girder bridges, box girder bridges, rigid frame bridges , arch bridges, Suspension bridge and Cable Stayed Bridge	7	15
SECOND INTERNAL EXAM			
V	Pre- stressed Concrete Bridges: Design of single span bridges-Introduction to various forms-Slab bridges-girder bridges-box girder bridges	7	20
VI	Steel bridges: Design of plate girder [bolted and welded connection] Design of Composite bridge (RCC slab over steel girder)	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE7113	Structural Reliability	**3-0-0**	**3**	**2015**

Course Objectives

- Should be able to identify the uncertainty in structural systems
- Ability to extend reliability analysis concepts from structural elements to structural systems

Syllabus

General introduction to structural safety and reliability, Concept of uncertainty in reliability based analysis and design. Random variables- Concept and definition, Probability axioms and probability functions, Conditional probability, Common probability density and distribution functions and its descriptors, Correlation between random variables. Joint probability distributions, Functions of random variables- Expectation and moments of functions of random variables. Concept of failure of a structure, Reduced variable space and basic definition of reliability index, First order second moment index, Hasofer-Lind reliability index, Rackwitz - Fiessler reliability index. Second order reliability method. System reliability, Simulation techniques in reliability estimation. Importance of sampling, Variation reduction techniques, Time variant reliability- (introduction alone)

Expected Outcome

Students will be able to:

- Understand reliability concept and reliability indices
- Analyse structural systems using reliability method

References

1. Andrzej S. Nowak & Kevin R. Collins, Reliability of Structures, McGraw-Hill,1999.
2. Robert E. Melchers, Structural Reliability Analysis and Prediction, John Wiley & Sons,1999.
3. R. Ranganathan, Reliability Analysis and Design of Structures, Jaico Publishing House, Mumbai,1999.
4. Ang, A.H.S. and Tang, W.H. (1975). Probability Concepts in Engineering Planning and Design, Vol. 1, Basic Principles, John Wiley, New York,1975.
5. Ang, A.H.S. and Tang, W.H. (1984). Probability concepts in engineering planning and design. Volume II, John Wiley & Sons, Inc., New York, 1984.

COURSE PLAN			
Module	**Contents**	**Hours Allotted**	**% of Marks in End-Semester Examination**
I	General introduction to structural safety and reliability, Concept of uncertainty in reliability based analysis and design	7	15
II	Random variables- Concept and definition, Probability axioms and probability functions, Conditional probability, Common probability density and distribution functions and its descriptors, Correlation between random variables.	7	15
FIRST INTERNAL EXAM			
III	Joint probability distributions, Functions of random variables- Expectation and moments of functions of random variables.	7	15
IV	Concept of failure of a structure, Reduced variable space and basic definition of reliability index, First order second moment index, Hasofer-Lind reliability index, Rackwitz - Fiessler reliability index. Second order reliability method.	7	15
SECOND INTERNAL EXAM			
V	System reliability, Simulation techniques in reliability estimation	7	20
VI	Importance of sampling, Variation reduction techniques, Time variant reliability- (introduction alone)	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE7115	Operations Research	3-0-0	3	2015

Course Objectives

1. Introduce important ideas in Operations Research (OR)
2. Prepare and motivate future specialists to continue in their study by having an insightful overview of OR
3. To develop student's skill in formulating and building models
4. To translate a verbal description of a decision problem into an equivalent mathematical model
5. To demonstrate the cohesiveness of OR methodology

Syllabus

Overview of OR modelling approach; Linear programming- The Transportation and Assignment problems.- Dynamic Programming- Game Theory- Replacement Problems- Introduction to Nonlinear programming -: Network Optimization models- Sequencing- Queuing Theory; Introduction to software for OR

Expected Outcome

1. The students improve their skills in formulating and building formal models of complex decision environments and in perceiving the critical issues to be resolved.
2. The students learn how to achieve sound and incisive evaluations of the important alternatives.
3. The students learn how to attain crucial insights to actual managerial problems.
4. Students appreciate and understand the pivotal concepts in operations research

References

1. H.A. Taha, Operations Research: An Introduction, Pearson Education-9th edition
2. A P Verma, Operations Research, S K Kataria& Sons.-7th edition
3. H. M. Wagner, Principles of Operations Research, Prentice- Hall of India Pvt. Ltd.
4. Gross and Harris, Fundamentals of Queuing Theory, John Wiley & Sons- 4th edition
5. Frederick S Hiller and Gerald J Lieberman, Introduction to Operations Research, TataMcGraw-Hill Publishing Co., New Delhi-9th edition
6. S.S. Rao, Engineering Optimization: Theory and Practice, New Age International Publishers.-4th edition

COURSE PLAN			
Module	**Contents**	**Hours Allotted**	**% of Marks in End-Semester Examination**
I	Overview of OR modeling approach; Mathematical formulation of linear programming problem: Formulation of LPP : canonical and standard forms of LPP, Graphical method of solution, Simplex method - artificial variables - Charnes M method , revised simplex algorithm- sensitivity analysis Dual Simplex method, Parametric linear programming.	7	15
II	Transportation problems – Formulation, Balanced and Unbalanced problems -Solution methods to find basic feasible solution and optimal solution, Degeneracy in transportation problem-Unimodularity, Trans-shipment problem, Sensitivity analysis in Transportation problem. Assignment problems – Formulation, Solution methods-Hungarian algorithm-Auction algorithm. Scheduling on machines- Two-job – Two-machine problem – Johnson’s algorithm – graphical solution.	7	15
FIRST INTERNAL EXAM			
III	Dynamic Programming – Introduction to Dynamic programming - Stage coach problem, reliability problem, manpower planning problem, continuous variables etc. Deterministic DP, Probabilistic DP; Integer Programming – Binary IP,B&B technique, Branch & Cut approach;	7	15
IV	Game theory – Practical application of game theory – Two-person Zero–Sum games – Mixed strategy – Rules of Dominance-solution methods., Games with mixed strategies, Graphical solution; Replacement Problems – Individual replacement policy, Group replacement policy; Introduction to Nonlinear programming (Overview only)	7	15
SECOND INTERNAL EXAM			
V	Network Optimization models – The Shortest path problem, The Minimum spanning tree problem, The Maximum flow problem, The Minimum cost flow problem, PERT/CPM.	7	20
VI	Sequencing – n jobs on 1 machine, Hodgson’s algorithm, n jobs on m machines, Johnson’s procedure. Queuing Theory; Introduction to software for OR.(Matlab)	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE7117	Stability of Structures	**3-0-0**	**3**	**2015**

Course Objectives

1. Provides students a strong background in buckling phenomenon, buckling in columns, beam columns, frames, plates and shells
2. Gives an idea of situations where the different structures are susceptible to buckling

Syllabus

Buckling of Columns -Methods of Neutral Equilibrium, Large Deformation Theory for Columns, Energy method for calculating critical loads, Buckling of Built up Columns, Torsional Buckling, Buckling of Frames, Stability of a frame by Matrix Analysis Buckling of Plates, Instability of shells

Expected Outcome

- Students become aware of the actual situations where stability becomes a governing factor

References

1. S. P. Timoshenko, J. M. Gere. Theory of Elastic Stability, McGraw Hill Book Co.,2009
2. A. Chajes, Principles of Structural Stability Theory, Prentice Hall Inc.,1974
3. Iyenger, N.G.R. Structural Stability of columns and plates, Affiliated East West Press Pvt Ltd., 1990.
4. F. Bleich, Buckling Strength of Metal Structures, McGraw Hill Book Co., 1975
5. H. G. Allen, P. S. Bulson, Background to Buckling, McGraw Hill Book Co.,1980
6. T. V. Galambos, Structural Members and Frames, Prentice Hall, 1968
7. D. O. Brush and B. O. Almroths, Buckling of Bars, Plates and Shells, 1975
8. Ashwini Kumar, Stability Theory of Structures McGraw Hill Book Co., 1985

COURSE PLAN			
Module	**Contents**	**Hours Allotted**	**% of Marks in End-Semester Examination**
I	Buckling of Columns – Introduction – Concepts of Stability – Methods of Neutral Equilibrium – Euler Column – Eigen Value Problem – Axially Loaded Column – Effective Length Concept and Design Curve	7	15
II	Large Deformation Theory for Columns. The Behaviour of Imperfect Columns. Eccentrically Loaded Column. Inelastic Buckling of Columns- Double Modulus Theory- Tangent Modulus Theory	7	15
FIRST INTERNAL EXAM			
III	Energy method for calculating critical loads – Rayleigh Ritz Method – Galerkin Method – Numerical Methods – Matrix Stiffness Method- Flexural Members and Compression Members	7	15
IV	Buckling of Built up Columns, Non-prismatic members- Effect of shear on critical Loads Beams and Beam Columns – Introduction– Beam Column with Concentrated and Distributed Loads – Effect of Axial Load on Bending Stiffness. Design of Beam Columns- Interaction Formula.	7	15
SECOND INTERNAL EXAM			
V	Torsional Buckling. Torsional and Torsional – Flexural Buckling of Columns, Lateral Buckling of Beams. Continuous beams with axial load. Buckling of Frames – Introduction – Modes of Buckling – Critical Load Using Neutral Equilibrium Methods. Stability of a frame by Matrix Analysis.	7	20
VI	Buckling of Plates – Differential Equation of Plate Buckling – Critical Load of a plate uniformly compressed in one direction. Tension field behaviour in Plate Girder Webs Post-buckling behaviour of axially compressed plates. Instability of shells.	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE7119	Random Vibration	**3-0-0**	**3**	**2015**

Course Objectives

1. To understand the statistical concepts in vibration analysis
2. To understand the behaviour of systems subjected to random vibrations.

Syllabus

Basic concepts in Probability Theory – Random process - spectral density functions – Properties of various random processes - Random vibration - response of linear SDOF, MDOF and continuous systems – Basics of nonlinear random vibration.

Expected Outcome

1. Students will be equipped to solve random vibration problems
2. Students willacquire basic knowledge in nonlinear random vibration analysis

References

1. Nigam, N. C., Introduction to Random Vibration, MIT Press. 1983
2. Preumont Andre, Random Vibration and Spectral Analysis, Kluwer Academic Publishers.1994
3. Lin, Y. K., Probabilistic Structural Dynamics Advanced Theory and Applications, McGraw Hill.1995
4. Cho T. W. S., Nonlinear Random Vibration, Taylor and Francis. 2000
5. Lalanne, C., Random Vibration, CRC Press. 2002
6. Wirsching, P. H, Paez, T. L. and Ortiz, H., Random Vibration, Dover Publications.2006
7. Nigam N.C and Narayanan S, Applications of random vibration, Narosa, 1994.

COURSE PLAN			
Module	**Contents**	**Hours Allotted**	**% of Marks in End-Semester Examination**
I	Probability Theory – Random variables, Probability distribution and density functions – Expected value mean, variance, conditional probability, characteristic functions, Chebyshev inequality, functions of random variable	7	15
II	Random process - concepts of stationary and ergodicity– nonstationary process – auto and cross correlation and covariance functions – Mean square limit, differentiability and integrability	7	15
FIRST INTERNAL EXAM			
III	Spectral decomposition, power spectral and cross spectral density functions – Wiener Khintchine relation	7	15
IV	Properties of Guassian, Poisson and Markov process. Broad band and narrow band random process – white noise	7	15
SECOND INTERNAL EXAM			
V	Random vibration - response of linear SDOF and MDOF systems to stationary and non-stationary random excitation. Response of continuous systems – normal mode method	7	20
VI	Nonlinear random vibration - Markov vector – equivalent linearisation and perturbation methods - Level crossing, peak and envelope statistics – First excursion and fatigue failures - Applications	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE7121	Engineering Application of Artificial Intelligenceand Expert Systems	**3-0-0**	**3**	**2015**

Course Objectives

1. Introduces the different algorithms that can be applied in Artificial Intelligence.
2. Impart an idea about how these algorithms can be used to solve Civil Engineering problems

Syllabus

Introduction to Artificial Intelligence, Knowledge representation, Expert system & Search, Search techniques Computer Vision, Advanced Topics- Machine Learning Genetic Algorithm – Neural Networks

Expected Outcome

- Students become aware of expert systems for knowledge representation, neural networks for knowledge organization and search techniques for knowledge manipulation.

References

1. Alison Cawsey, The Essence of Artificial Intelligence, Prentice Hall Europe, 1998
2. Charniak& McDermott, Introduction to Artificial Intelligence, International Student Edition, Addison Wesley, 1998.
3. Dan W Patterson, Introduction to Artificial Intelligence and Expert Systems, Prentice Hall of India, New Delhi 1992.
4. Winston, Artificial Intelligence, Addison-Wesley, 1992
5. Nilsson, Principles of Artificial Intelligence, Narosa, 1998
6. Elian Rich, Artificial Intelligence, McGraw Hill, 1991
7. Robert J. Schalkoff, Artificial Intelligence an Engineering Approach, McGraw Hill, 1990.

COURSE PLAN			
Module	**Contents**	**Hours Allotted**	**% of Marks in End-Semester Examination**
I	Introduction to AI – Definition – Typical AI Problems – Knowledge representation and search – philosophical issues – Requirements of knowledge representation languages – semantic Networks – Frames – Predicate Logic – Rule Based Systems – Forward and Backward chaining – Comparison of different – representation methods.	7	15
II	Expert system & Search – Heuristic – Knowledge Engineering – expert System – Designing an Expert System – Backward chaining – Rule based expert systems – Explanation facilities – Bayers's theorem – case study of MYCIN.	7	15
FIRST INTERNAL EXAM			
III	Search techniques, Breadth first search, depth first search, Heuristic search – Hill climbing, Best – first – search, A* algorithm	7	15
IV	Graphs and Tree Representation. Problem solving as search, Planning, Game planning – Minimax and alpha – beta proving. Searching AND –OR Graph, Optimal Search – The Best path and Redundant Path	7	15
SECOND INTERNAL EXAM			
V	Computer Vision – Different levels of vision processing – Low level processing edge deletion line filling – depth & Orientation information – Object recognition – Practical vision system.	7	20
VI	Advanced Topics – Machine Learning – Introduction – Genetic Algorithm – Neural Networks – Back propagation – Multi layer network – Applications – Software agents – Robots – different types – applications.	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE7191	Seminar II	**0-0-2**	**2**	**2015**

Course Objectives

To make students

1. Identify the current topics in the specific stream.
2. Collect the recent publications related to the identified topics.
3. Do a detailed study of a selected topic based on current journals, published papers and books.
4. Present a seminar on the selected topic on which a detailed study has been done.
5. Improve the writing and presentation skills.

Approach

Students shall make a presentation for 20-25 minutes based on the detailed study of the topic and submit a report based on the study.

Expected Outcome

Upon successful completion of the seminar, the student should be able to

1. Get good exposure in the current topics in the specific stream.
2. Improve the writing and presentation skills.
3. Explore domains of interest so as to pursue the course project.

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE7193	Project (Phase 1)	**0-0-12**	**6**	**2015**

Course Objectives

To make students

1. Do an original and independent study on the area of specialization.
2. Explore in depth a subject of his/her own choice.
3. Start the preliminary background studies towards the project by conducting literature survey in the relevant field.
4. Broadly identify the area of the project work, familiarize with the tools required for the design and analysis of the project.
5. Plan the experimental platform, if any, required for project work.

Approach

The student has to present two seminars and submit an interim Project report. The first seminar would highlight the topic, objectives, methodology and expected results. The first seminar shall be conducted in the first half of this semester. The second seminar is the presentation of the interim project report of the work completed and scope of the work which has to be accomplished in the fourth semester.

Expected Outcome

Upon successful completion of the project phase 1, the student should be able to

1. Identify the topic, objectives and methodology to carry out the project.
2. Finalize the project plan for their course project.

SEMESTER - IV

Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01CE7194	Project (Phase 2)	**0-0-21**	**12**	**2015**

Course Objectives

To continue and complete the project work identified in project phase 1.

Approach

There shall be two seminars (a mid-term evaluation on the progress of the work and pre submission seminar to assess the quality and quantum of the work). At least one technical paper has to be prepared for possible publication in journals / conferences based on their project work.

Expected Outcome

Upon successful completion of the project phase II, the student should be able to

1. Get a good exposure to a domain of interest.
2. Get a good domain and experience to pursue future research activities.