KERALA TECHNOLOGICAL UNIVERSITY

ERNAKULAM- I CLUSTER

SCHEME AND SYLLABI

FOR

M. Tech. DEGREE PROGRAMME

IN

COMPUTER AIDED STRUCTURAL ENGINEERING

(2015 ADMISSION ONWARDS)

SCHEME AND SYLLABI FOR M. Tech. DEGREE PROGRAMME IN COMPUTER AIDED STRUCTURAL ENGINEERING

SEMESTER-1

Exam Slot	Course No:	Name	L-T -P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
A	06CE6011*	Advanced Structural Design	4-0-0	40	60	3	4
B	06CE6021*	Structural Dynamics	4-0-0	40	60	3	4
C	06CE6031	Theory of Elasticity	4-0-0	40	60	3	4
D	06CE6041*	Numerical Methods in Civil Engineering	3-0-0	40	60	3	3
E	06CE6X51	Elective – I	3-0-0	40	60	3	3
F	06CE6061****	Research methodology	1-1-0	100	0	0	2
G	06CE6071	Seminar I	0-0-2	100	0	0	2
H	06CE6081	Computer Applications Lab	0-0-2	100	0	0	1

Credits: 23

	Elective I (06CE6X51)
06CE6151	Advanced Analysis of Structures
06CE6251	Soft Computing Tools for Engineering
06CE6351	Random Vibrations

* - Common to Structural Engineering and Construction Management

****- Common to Structural Engineering and Construction Management, Construction Engineering and Management, Geo-Mechanics and Structures and Environmental Engineering.

SEMESTER-II

Exam Slot	Course No:	Name	L- T – P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
A	06CE6012	Advanced Finite Element Methods	4-0-0	40	60	3	4
B	06CE6022	Prestressed Concrete	3-0-0	40	60	3	3
C	06CE6032	Theory of Plates and shells	3-0-0	40	60	3	3
D	06CE6X42	Elective II	3-0-0	40	60	3	3
E	06CE6X52	Elective III	3-0-0	40	60	3	3
F	06CE6062	Mini Project	0-0-4	100	0	0	2
G	06CE6072	Structural Engineering Design Studio	0-0-2	100	0	0	1

Credits: 19

Elective II - **(**06CE6X42)		Elective III- (06CE6X52)	
06CE6142**	Bridge Engineering	06CE6152	Structural Stability
06CE6242	Structural Reliability	06CE6252	High Rise Structures
06CE6342	Design of Substructures	06CE6352	Experimental Stress Analysis

** - Common to Structural Engineering and Construction Management and Geo-Mechanics and Structures.

SEMESTER-III

Exam Slot	Course No:	Name	L- T – P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
A	06CE7X11	Elective IV	3-0-0	40	60	3	3
B	06CE7X21	Elective V	3-0-0	40	60	3	3
C	06CE7031	Seminar II	0-0-2	100	0	0	2
D	06CE7041	Project(Phase 1)	0-0-8	50	0	0	6

Credits: 14

Elective-IV**(**06CE7X1**)**		Elective-V**(**06CE7X21**)**	
06CE7111	Advanced Metal Structures	06CE7121	Concrete Material Science
06CE7211	Analysis of Composite Structures	06CE7221	Engineering Fracture Mechanics
06CE7311	Structural Optimization	06CE7321	Forensic Engineering

SEMESTER-IV

Exam Slot	Course No:	Name	L- T – P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
A	06CE7012	Project (Phase 2)	0-0-21	70	30	0	12

Credits: 12

Total Credits for all semesters: 68

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6011	Advanced Structural Design	4-0-0-4	2015
Pre-requisites	**Basic concepts of analysis and design of structures**		

Course Objectives

To instruct the students on

- The concept of yield line and its analysis in structures
- The design aspects for special RC elements
- Concept of earthquake resistant design of structures

Syllabus

Yield line method of analysis of slabs: Characteristic features of yield lines, Design of special RC elements: Design of shear walls (with and without boundary elements), Design of Deep beams, Design of continuous beams Design of flat slabs Concept of Earthquake Resistant Design: Concept of capacity design, Strong Column weak beam. Ductile design - detailing of beams and shear walls. Calculation of Base shear and its distribution by using codal provisions.

Course Outcome

On completion of the course the students shall attain knowledge on the fundamental concepts on the analysis of slabs by yield line theory & design of R.C structures like grid floors, flat slabs, deep beams etc. and also earthquake resistant design of structures and ductile detailing.

Textbooks

1. Krishna Raju N., "Advanced Reinforced Concrete Design", CBS Publishers and distributers, New Delhi.
2. S. K. Duggal, "Earthquake Resistant Design of Structures", Oxford University Press, New Delhi

References

1. P C Varghese, "Limit State Design of concrete structures".
2. Pankaj Agarwal and Manish Shrikhande, "Earthquake Resistant Design of Structures", Prentice Hall of India Private Limited, New Delhi, India.

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I **Yield line method of analysis of slabs**:Characteristic features of yield	13	25

lines– analysis by virtual work method – Yield line analysis by equilibrium method, Design of grid floor – Approximate method– Rigorous method (Concept only).		
Module II **Design of special RC elements**: Design of shear walls (with and without boundary elements), Design of Deep beams, Design of continuous beams– Redistribution of moments. Design of flat slabs: – Introduction–components–IS Code recommendations– IS code method of design (with and without drop).	15	25
Module III **Concept of Earthquake Resistant Design:** Objectives, Design Philosophy, Limit states, Inertia forces in Structure. Response of Structures – Effect of deformations in structure, Lateral Strength, Stiffness, Damping and ductility. **Building Configurations:** Size of Building, Horizontal and Vertical layout, Vertical irregularities, Adjacency of Building, Open-ground storey and soft storey, short columns. Effect of shear wall on Buildings. **Torsion and Twists in Buildings:** Causes, Effects, Centre of mass and rigidity. , Effect of torsion, Torsionally coupled and uncoupled system, Lateral load distribution, Numerical example based on IS code recommendation.	15	25
Module IV **R.C.C for Earthquake Resistant Structures**: Concept of capacity design, Strong Column weak beam. Ductile design, detailing of beams and shear walls. Calculation of Base shear and its distribution by using codal provision. Detailing of columns and Beam joints. Performance of R.C.C. Building. **Ductiledetailing:**-Study of IS: 13920-1993. **Repair/Reduction of Earthquake Effects**: - Methods, Materials and retrofitting techniques.- Base Isolation and dampers.	13	25
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6021	Structural Dynamics	4-0-0-4	2015
Pre-requisites	• Basic knowledge of Mechanics of Materials • A slight insight into the concepts of vibrations		

Course Objectives

To provide an understanding of how structures vibrate under the influence of different types of dynamic loads.

Syllabus

Dynamic load - Degrees of freedom –Formulation of equations of motion - Natural frequency- -D' Alemberts Principle –Energy principle - Rayleigh's method − Principle of virtual displacements − Hamilton's principle.Single Degree of Freedom Systems -Undamped and damped free and forced vibrations − Vibration isolation − Transmissibility Response to periodic forces- Vibration measuring and absorbing equipments -Duhamel integral for undamped system-Response to impulsive loads–Earthquake excitation- Response history and construction of response spectra-Multiple Degrees of Freedom Systems and Continuous systems -Natural modes − orthogonality conditions − modal Analysis − free and harmonic vibration −Continuous systems- Mode superimposition method- Mode acceleration method Approximate methods Rayleigh's method − Dunkerley's method − Stodola's method − Rayleigh –Ritz method − Matrix method.

Course Outcome

On successful completion of the course the students will be able to

1. Convert any structural system into its equivalent mechanical system
2. Formulate and solve the equation of notion and calculate the structural response
3. Determine the natural frequency by means of analytical and approximate methods

Textbooks

1. Clough & Penzien, "Dynamics of Structures".
2. M.Mukhopadhyay , "Vibrations, Dynamics & Structural systems".

References

1. Timoshenko, "Vibration Problems in Engineering".
2. Anil K Chopra, "Dynamics of structures", Pearson Education

Course Plan		
Contents	**Contact Hours**	**Sem. Exam Marks**
Module I **Introduction**: Dynamic load - Types of dynamic loading–Significance of structural dynamics in civil engineering practice - Degrees of freedom –Equivalent mechanical systems –Formulation of equations of motion - Natural frequency- Determination of natural frequency-D' Alemberts Principle –Energy principle - Rayleigh's method − Principle of virtual displacements − Hamilton's principle.	10	20
Module II **Single Degree of Freedom Systems:** Undamped and damped free and forced vibrations − Critical damping − Over damping − Under damping − Logarithmic decrement –Energy dissipated in damping-Coulomb damping - Response to harmonic loading − Evaluation of damping − Vibration isolation − Transmissibility Response to periodic forces-Vibration measuring and absorbing equipments -Duhamel integral for undamped system-Response to impulsive loads–Earthquake excitation-Response history and construction of response spectra-Response spectrum characteristics-Base excited systems	16	30
Module III **Multiple Degrees of Freedom Systems and Continuous systems:** MDF sytems - Natural modes − orthogonality conditions − modal Analysis − free and harmonic vibration −Continuous systems- Free longitudinal vibration of bars − Flexural vibration of beams with different end conditions − Forced vibration - Mode superimposition method- Mode acceleration method	16	25
Module IV **Approximate methods:** Rayleigh's method − Dunkerley's method − Stodola's method − Rayleigh –Ritz method − Matrix method.	14	25
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6031	Theory Of Elasticity	4-0-0-4	2015
Pre-requisites	**Nil**		

Course Objectives

To enable the students to learn

- The fundamentals of stress, strain and displacement relationships, constitutional law, material characterization and Lami's parameters.
- Equilibrium equations, compatibility equations, stress functions, solution of two dimensional problems in Cartesian and polar coordinates.
- Torsion of circular bars.
- Fundamentals of Engineering Theory of Plasticity

Syllabus

Concept of Stress at a point. Strain and displacement. Constitutive equations Generalized Hooke's law. Equations of equilibrium. Compatibility equations. Stress functions. Two dimensional problems in Cartesian and Polar coordinates. Axis symmetrical problems and their solutions. Torsion of non circular bars. Saint Venant's method. Multi cellular sections. Shear flow. Membrane analogy. Enginering theory of plasticity**.** Levy-Misces and Prandtl-Rauss equations. flow rule. Mohr – Coulomb yield criterion for concrete. Yield surface in 3 D space of Principal stresses- Testing of concrete stress strain curve. Flow rule.

Course Outcome

- On successful completion of the course one will be able to apply the principles of theory of elasticity to find solutions to the engineering problems related to the analysis and design of engineering structures and components. The determination of stress distributions will enable him to design satisfactorily the components.
- A student will also be able to use the principles of plasticity to be applied to solve simple problems and to design components.

Textbooks

1. Timoshenko S P and Goodier J. N, "Theory of Elasticity", Tata Mcgraw Hill International Student Edition.
2. Srinath L. S, "Advanced mechanics of solids", Tata McGraw– Hill Publishing Company Ltd., New Delhi**.**

References

1. Akhtar Khan, Sujian Huang "Continuum Theory of Plasticity", Wiley Publications.

2. Wai-Fah Chen, "Plasticity in reinforced concrete", J-Ross Publishing

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I **Theory of Elasticity:** Introduction to ToE-Equilibrium of a body subjected to forces-Continuum-Stress at a point-Stress Tensor-Stress matrix-Notations-Sign Conventions-Traction Vector on an oblique plane with arbitrary orientation-Stress Transformation rule-Normal Stress and Shear stresses on any plane- Principal Stresses and their directions-Stress invariants-Octahedral normal and shear stresses-Spherical and deviatoric stresses-Stress ellipsoid-Cauchy's stress quadric-One sheeted and two sheeted hyperboloids-Transformation equations in two and three dimensions-Mohr's Circle representations-Equilibrium equations(2D and 3D). Introduction to strain-Kinematic or strain displacement equations-Normal strain-Shearing strain-Strain matrix formulation-Displacement components and strain-Pure deformation-Rotation in three dimensions-Principal strains-Strain along a line in terms of components of strain-Strain and rotation rates-Strain transformation rule(3D and 2D Cases)-Strain compatibility equations-physical meaning-Strain measurement-Rosette analysis-Rectangular, Star, Delta rosettes. Material characterization-Typical uniaxial stress strain curve for steel and concrete -Conventional and true values-Generalized Hooke's law-Anisotropic materials-Materials with elastic symmetries-Orthotropic and isotropic cases-Homogeneous materials-Lami's constants -Hooke's law for linear elastic isotropic solids..	18	25
Module II **Two dimensional stress–strain problems in elasticity:** Formulation and method of solutions-Plane stress and plane strain problems–Equations of compatibility in stress- Airy's stress function-Boundary conditions-Polynomial solutions-Examples of loaded beams-2D	10	25

problems in polar coordinates-Axis symmetrical problems-Stress distribution in a hollow cylinder subjected to uniform internal and external pressures-Pure bending of curved bars-Strain components in polar coordinates-Rotating discs-stress components-effects of circular hole on stress distribution of plates-Concentrated force on a straight boundary-Stress function and stress components.		
Module III **Torsion of non-circular straight bars:** Saint Venant's semi inverse method-Assumed displacements-Warping function-Components of stress-Conditions satisfied by warping functions-Determination of stress function and its properties along the boundary of the cross section-Shearing stresses give torque-Solution for elliptic cross section and equilateral triangular cross section-Comparison of a closed tubular section and Slit tubular cross section-Multi cellular sections-Shear flow-Shear stresses-Torque-Membrane analogy and its applications to solution of torsional problems-Stress function contours and warping displacement contours for elliptical and triangular cross sections-Hollow thin walled sections-Shear stress, torque and angle of twist-Very thin rectangular sections-Stress function-Shear Stress-Torque for a composite section.	12	25
Module IV **Engineering theory of plasticity:** Introduction-foundation of plasticity-the criterion of yielding-representation in the principal stress space-the deviatoric stress vector-Tresca and Misces criterion-Plane stress yield locus-Strain hardening postulates-Rule of plastic flow-Plastic potential-Plastic flow rule in the deviatoric plane-Associated flow rule-Stress increment and strain increment vector for a given state of stress-Regular yield surface- singular yield surface-constitutive equations. Levy-Misces and Prandtl-Rauss equations-Geometrical representations for work hardening material-Tresca's associated flow rule-Plastic strain increment vector associated with the Tresca and Misces criteria-Anisotropic flow rule-Uniaxial stress strain cycles in a cyclic hardening material. Mohr-Coulomb yield criterion for concrete-Yield surface in 3D space	16	25

of principal stresses – Drucker- Prager yield surface Mohr – Coulomb strength criterion in the stress space and in the π plane. Testing of concrete – Uniaxial stress-strain curve, pre and post failure regime-Criteria of loading and unloading.-Elastic strain increment tensor-Flow rule- associated and non-associated-Uniqueness of solution and normality condition of flow.		
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6041	Numerical Methods In Civil Engineering	3-0-0-3	2015
Pre-requisites	**Nil**		

Course Objectives

- To give awareness to different numerical solutions
- To impart ability to apply mathematics for finding solutions to real-time problems

Syllabus

Systems of Linear Equations: Gaussian Elimination - Factorisation - Cholesky's Method. Systems of Non- linear equations:Newton Raphson Method- Newton's Modified Method. Finite difference methods.Initial and Boundary value problems .Eigen value Problems.Numerical Integration.Interpolation: Lagrange – Hermitian and cubic spline methods.Numerical Solution of Partial differential equations: Classification of second order equations – finite difference approximation to partial derivatives – Solution of Laplace equation and solution of wave equation.

Course Outcome

- Understand various computational methods available to solve practical problem
- Enhance the capacity to select appropriate techniques for tackling problems in engineering and science.

Textbooks

1. Krishna Raju N and Muthu K.U "Numerical Methods for Engineering Problems" Maemillan India Limited
2. Grewal B. S, "Numerical Methods in Engineering and Science", Khanna Publications.

References

1. Rajasekaran. S, "Numerical Methods in Science and Engineering – A practical approach", A.H Wheeler & Co.
2. Stanton R.C, "Numerical Methods for Science and Engineering", Prentice Hall ofIndia.
3. Smith G.D "Numerical Solutions for Differential equation".

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I **Systems of Linear Equations**: Gaussian Elimination - Factorisation - Cholesky's Method	10	25

Systems of Non- linear equations: Newton Raphson Method- Newton's Modified Method		
Module II **Finite difference methods:** Forward, Central and Backward differences. Initial and Boundary value problems – statically determinate and indeterminate beam problems- Buckling of columns. **Eigen value Problems**: Power method – Jacobi method	12	25
Module III **Numerical Integration:** Trapezoidal and Simpson's Rules - Gaussian quadrature formula – New mark's Method **Interpolation:** Lagrange – Hermitian and cubic spline methods.	10	25
Module IV **Numerical Solution of Partial differential equations:** Classification of second order equations – finite difference approximation to partial derivatives – Solution of Laplace equation and solution of wave equation.	10	25
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6151	Advanced Analysis Of Structures	3-0-0-3	2015
Pre-requisites	**Basic knowledge in structural analysis**		

Course Objectives

To instruct the students on

- The fundamentals of structural analysis and work energy principles
- Concept of matrix analysis of structures
- Advanced methods for the analysis of structures

Syllabus

Review of basic concepts of structural analysis and work energy principles, Stiffness method–coordinate systems–element stiffness matrix. Stiffness method- Physical and Element approach: – analysis of pin and rigid jointed frames,and continuous beams. Direct stiffness approach: analysis of pin jointed frames, rigid jointed frames and continuous beams, Flexibility method: analysis of beams & frames (rigid and pin jointed).

Course Outcome

On completion of the course the students shall attain knowledge on the fundamental concepts in the advanced topics in structural analysis. This course is also expected to enable a good understanding of how standard software packages operate.

Textbooks

1. Rajesekharan & Sankarasubramanian,G., "Computational Structural Mechanics", Prentice Hall of India, 2001.
2. Pandit G.S. and Gupta S.P., "Structural Analysis-A Matrix Approach", Tata McGraw-Hill PublishingCompany Limited, New Delhi

References

1. Mukhopadhyay M., "Matrix Finite Element Computer and Structural Analysis", Oxford & IBH, 1984.
2. Reddy C.S., "Basic Structural Analysis", Tata McGraw Hill Publishing Co.1996.

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I **Matrix methods**: Classification of structures–discrete structures–elements–nodes – Generalised Measurements -Degrees of freedom – static& kinematic indeterminacy Constrained Measurements -	10	25

Behaviour of structures - Principle of superposition- Stiffness method– coordinate systems–element stiffness matrix		
Module II **Stiffness method -Physical approach and Element approach**:– Analysis of pin jointed frames, continuous beams and rigid jointed frames (temperature effect, settlement of supports).	10	25
Module III **Direct stiffness approach**: Structure stiffness matrix–assembly– equivalent joint load – incorporation of boundary conditions – solutions–Gauss elimination–matrix inversion– principle of contra-gradience -Analysis of pin jointed frames, continuous beams and rigid jointed frames (temperature effect, settlement of supports).	12	25
Module IV **Flexibility method**: ElementFlexibility matrix–truss element–beam element–force transformation matrix – equilibrium–compatibility– analysis of beams & rigid and pin jointed frames (temperature effect, settlement of supports and lack of fit).	10	25
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6251	Soft Computing Tools For Engineering	3-0-0-3	2015
Pre-requisites	**Nil**		

Course Objectives

To instruct the students on

- The concept of Classical Optimization Techniques
- Engineering applications of Optimization
- Non-Linear Programming
- Optimum design RC, PSC, Steel structural elements

Syllabus

Need for soft computing techniques - components of soft computing, Classical Optimization Techniques: Engineering applications -Linear Programming: Standard form of Linear programming problem, simplex method, revised simplex Method. Non-Linear Programming Stochastic Programming Application Problems: Optimum design RC, PSC, Steel structural elements. Algorithms for optimum designs. Introduction to genetic algorithms: Natural evolution – properties –classification.

Course Outcome

The course will give the students knowledge on the concept of Classical Optimization Techniques, the Engineering applications of Optimization, Linear Programming: Standard form of Linear programming problem, its applications and also Engineering optimization problem solving using genetic algorithm

Textbooks

1. Rao.S.S - Optimization Theory and Applications, Wiley Eastern Limited,1978.
2. Fox.R.L. - Optimization Methods for Engineering Design, Addison Wesley, 1971.

References

1. Stark. R.M. Nicholls.R.L., Mathematical Foundations for Design, McGraw Hill Book Company.
2. Narsingk Deo – System simulation with digital computer, Prentice – Hall of India Pvt, Ltd. New Delhi – 1989.

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I **Introduction**: Need for soft computing techniques - components of soft		

computing, Classical Optimization Techniques: Engineering applications, Statement of optimization problem, Classification of optimization problems, Optimization techniques. Single variable optimization, Multivariable optimization with no constrains, with equality constraints - Lagrange multiplier -method, constrained variation method - and with inequality constraints Kuhn Tucker conditions.	12	25
Module II **Linear Programming:** Standard form of Linear programming problem, simplex method, revised simplex Method. Non-Linear Programming: One dimensional minimization methods, Elimination and Interpolation methods, unconstrained Optimization Techniques, Direct Search methods, Descent Methods, Constrained Optimization Techniques, Direct methods, indirect methods.	12	25
Module III **Stochastic Programming:** For optimization of design of structural elements with random variables. **Application Problems**: Optimum design RC, PSC, Steel structural elements. Algorithms for optimum designs.	8	25
Module IV **Introduction to genetic algorithms:** Natural evolution – properties – classification- GA features – coding – selection – reproduction – cross over and mutation operators - basic GA and structure. Engineering optimization problem solving using genetic algorithm.	10	25
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6351	Random Vibrations	3-0-0-3	2015
Pre-requisites	Nil		

Course Objectives

To instruct the students on

- The concept of Probability Theory & Random variables
- Concepts of stochastic processes & The power spectral density function
- Linear Vibration Analysis

Syllabus

Introduction to Random vibration & probabilistic modeling Axioms of probability theory: probability space & random variables. Probability distributions and density functions of random variables concepts of stochastic processes power spectral density function. Numerical simulation of random processes.Linear Vibration Analysis system response to random excitations.Generalization to multi degree-of-freedom systems.Nonlinear Stochastic Vibration Method of equivalent statistical linearization. State space moment and cumulant equations. State space moment and cumulant equations

Course Outcome

On successful completion of the course the students shall attain knowledge on the concepts of Probability Theory & Random variables, stochastic processes, power spectral density function, probability distributions, moments, correlation and covariance functions, Linear Vibration Analysis- Review of deterministic dynamics and impulse response functions.

Textbooks

1. Nigam N.C, Introduction to random vibration, MIT press, 1983
2. Lin Y.K, Probabilistic theory in structural dynamics, McGraw Hill, 1983

References

1. Bendat J.S and Piersol A.G, Random data analysis and measurement procedure, John Wiley, 2011
2. Clough R.W and Penzien J, Dynamics of structures, McGraw Hill, 1975

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I Probability Theory & Random variables - Introduction to Random vibration & probabilistic modeling. Axioms of probability theory: probability space & random variables. Probability distributions and	12	25

density functions of random variables, joint and marginal distribution and density functions, functions of random variables. Expectations and moments of random variables, Baye's theorem, conditional random variables, conditional expectations. Characteristic functions, moment generating functions, cumulants, relationship between joint probability density functions and characteristic functions, numerical issues, covariance and independence. Sequences of random variables, stochastic convergence, limit theorems.		
Module II Concepts of stochastic processes, probability distributions, moments, correlation and covariance functions The power spectral density function. Stationarity and non-stationarity of stochastic processes, ergodicity of a stochastic process. Limits of a stochastic process, Continuity & Differentiability, stochastic derivatives and integrals. The Fokker-Planck-Kolmogorov equation. Introduction to stochastic calculus. Numerical simulation of random processes.	12	25
Module III Linear Vibration Analysis Review of deterministic dynamics and impulse response functions of systems, system response to random excitations. Response to stationary & weakly stationary excitations and to delta-correlated excitations, Response to Gaussian excitations.Non-stationary excitations.Joint behavior of the time deriative and its response & Markov vector approach.Linear dynamics and harmonic transfer functions.Generalization to multi degree-of-freedom systems.State space formulation of equations of motion.The Fokker-Planck equation for linear systems.	8	25
Module IV Nonlinear Stochastic Vibration The Fokker-Planck equation for sdof systems. The Fokker-Planck equation for mdof systems. Methods for Numerical solutions for the FPK equation: finite difference. Methods for Numerical solutions for the FPK equation: finite element Method. Numerical solutions for the FPK equation: Path integral method. Method of equivalent statistical linearization. State space moment and cumulant equations. State space moment and cumulant equations.	10	25
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6061	Research Methodology	1-1-0-2	2015
Pre-requisites	**Nil**		

Course Objectives

To teach and make the student aware about the methodology and techniques of doing research both in technology as well as in social sciences.

Syllabus

Objectives and types of research, research methods vs methodology, Different types of research, Research design and execution, Execution of the research, data collection and analysis, Reporting and thesis writing.

Course Outcome

On successful completion of the course the students will be equipped to carry out their research and emanate its outcomes to the outside world.

Textbooks

1. Kothari C.R., Research Methodology, New Age International Publishing.
2. Sam Daniel P. and Aroma G. Sam, Research Methodology, Gyan Publishing House

References

1. Panneerselvam R., Research Methodology, PHI Learning Pvt. Ltd.
2. Bhattacharyya D.K., Research Methodology, Excel Books India.

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I Objectives and types of research, research methods vs methodology; Different types of research, Defining and formulating the research problem, selecting the problem, necessity of defining the problem, importance of literature review in defining a problem, Literature review - primary and secondary data/information sources, reviews, monographs, patents, discussion series, white papers, research databases like CMIE, BB, UNSD etc., critical literature review, identifying gap areas from literature review.	7	25
Module II Research design and execution: Research design – basic principles, need of research design, features of good design, important concepts		

relating to research design, observation and facts, laws and theories, prediction and explanation, development of models	7	25
Module III Execution of the research, data collection and analysis: Aspects of method validation, observation and collection of data, methods of data collection, different sampling methods, data analysis techniques of hypothesis testing, ANOVA, randomized block design (RBD) and completely randomized design (CRD).	7	25
Module IV Reporting and thesis writing: Structure and components of scientific reports, types of report, technical reports and thesis. Different steps in thesis writing, layout, structure and language of typical reports, bibliography, referencing and footnotes. Research ethics – ethical issues, ethical committees, Scholarly publishing – design of research paper, citation and acknowledgement, plagiarism, reproducibility and accountability.	7	25
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6071	Seminar – I	0-0-2-2	2015
Pre-requisites	**Nil**		

Course Objectives

To enable the students to

Refer national & international journals

- Interpret the data available and present the same in a systematic manner.

Syllabus

Students have to register for the seminar and select a topic in consultation withany faculty member offering courses for the programme. A detailed write-up onthe topic of the seminar is to be prepared in the prescribed format given by theDepartment. The seminar shall be of 30 minutes duration and a committee withthe Head of the department as the chairman and two faculty members from thedepartment as members shall evaluate the seminar based on the report and coverage of the topic, presentation and ability to answer the questions putforward by the committee.

Course Outcome

- The student will be able to present the seminar in a befitting manner and answer to the queries regarding the selected topic.

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6081	Computer Applications Lab	0-0-2-1	2015
Pre-requisites	**Nil**		

Course Objectives

To instruct the students on

- Practical training related to structural engineering.
- Structural analysis & design software STAAD Pro.
- Structural analysis & design software NISA with emphasis on NISA Civil.

Syllabus

Analysis and design of various structural elements like beams, portal frames , trussesAnalysis and design of framed structures under different loading conditions like Dead Load, Live Load, Wind Load (IS: 875 Part 1 / Part 2 / Part 3), Earth Quake Load (IS: 1893 Part 1) and its Combinations as per codal Provisions

Course Outcome

The student has to practice and attain thorough knowledge on the software packages by solving different types of problems.

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6012	Advanced Finite Element Methods	4-0-0-4	2015
Pre-requisites	**Basic knowledge in structural analysis**		

Course Objectives

To familiarize the students on

- The concept of Basics of finite element method (FEM), Idealization of structures and general procedure of FEA
- Finite Element modeling of one and two dimensional problems.
- Applications of FEM in analysis of trusses Continuous Beam ,Plane Frames etc.

Syllabus

Introduction to FEM - Basic Equations of Solid Mechanics - Different approaches of FEM, Variational principles weighted residual approach and method of virtual work Basics of finite element method (FEM), Idealization of structures -Mathematical model - General procedure of FEA- Shape functions – Lagrange and serendipity elements, Isoparametric elements- Polynomials - Lagrangian and Hermition Interpolation -Convergence criteria - Conforming & nonconforming elements – Patch test. Stiffness matrix - Bar element - Beam element - Plane stress and plane strain and axisymmetric problems static condensation - Isoparametric elements - Numerical Integration.- Gauss- Quadrature ,Analysis of trusses, Finite Element Analysis of Continuous Beam ,Plane Frame Analysis, Introduction to plate and shell elements

Course Outcome

On completion of the course the students shall attain knowledge on the fundamental finite element method (FEM), general procedure, development of stiffness matrices etc.The students shall gain ample knowledge on Finite Element Analysis of Continuous Beam ,Plane Frame Analysis,Analysis of Grid and Space Frame ,plate and shell elements etc.

Textbooks

1. O C Zienkiewicz,."Finite Element Method", fifth Edition,McGraw Hill, 2002
2. R.D.Cook, "Concepts and Applications of Finite Element Analysis", John Wiley & Sons

References

1. C.S.Krishnamoorthy, "Finite Element Analysis",Tata McGraw Hill .New Delhi,1987.
2. S.Rajasekharan, "Finite Element Analysis in Engineering Design", S Chand & Co. Ltd.1999

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I **Introduction to FEM** - Basic Equations of Solid Mechanics - Review of equilibrium conditions, Strain-displacement relations, Stress - Strain relations, Plane stress and plane Strain problems, Variational principles weighted residual approach and method of virtual work. Basics of finite element method (FEM), Idealization of structures -Mathematical model - General procedure of FEA	15	25
Module II **Shape functions** – Generalised coordinates – Natural coordinates - Compatibility - C^0 and C^1 elements - Convergence criteria - Conforming & nonconforming elements – Patch test. Lagrange and serendipity elements, Element properties-One and two dimensional problems. Isoparametric elements- four noded-eight node elements. Polynomials - Lagrangian and Hermition Interpolation functions	15	25
Module III **Stiffness matrix** - Bar element - Beam element - Plane stress and plane strain problems -Triangular elements - Constant Strain Triangle - Linear Strain Triangle – Legrangian and Serendipity elements, static condensation - Isoparametric elements- axisymmetric problems - Numerical Integration.- Gauss- Quadrature .	12	25
Module IV Applications of FEM -Analysis of trusses-Continuous Beam-Plane Frames-Introduction to plate and shell elements-FEM for thin and thick Plates – Shells-Plate bending theory	14	25
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6022	Prestressed Concrete	3-0-0-3	2015
Pre-requisites	Nil		

Course Objectives

To impart to students

- Basic concept of Prestressing, Analysis of prestress and bending stress
- Design of Pretensioned and Post-Tensioned Flexural Members
- Prestressing of statically indeterminate structures
- Composite construction of Prestressed and in situ Concrete

Syllabus

Basic concept of Prestressing,Systems of Prestressing: - Pre tensioning and Post tensioning, Analysis of prestress and bending stress: - Stress concept, Strength concept-Losses of Prestress .

Deflection of beams Effect of tendon profile on deflections, Prediction of long term defelection-Elastic Design: Shear and Torsional Resistance of PSC members Simplified code procedure for bonded and unbonded symmetrical and unsymmetrical sections.Design of sections for flexure: - Expressions for minimum section modulus, Prestressing force and Eccentricity. Limiting zone for prestressingforce.Design of Pretensioned and Post-Tensioned Flexural Members- Prestressing of statically indeterminate structures Concept of Linear transformation, Guyon's theorem, Concordant cable profile.End blocks: - Anchorage zone Stresses Composite construction -Tension members- Design and analysis of PSC slabs

Course Outcome

On completion of the course the students shall attain knowledge on analysis and design of prestressed concrete beams(determinate and indeterminate),post tensioned slabs, tension members etc andComprehend the design of various prestressed concrete members used in practice**.**

Textbooks

1. N. Krishna Raju, "Prestressed concrete", Tata McGraw Hill Publishing Co.Ltd.
2. N. Rajagopal, "Prestressed Concrete", Narosa Publishing House, New Delhi.

References

1. S. Ramamrutham, "Prestressed Concrete", DhanpatRai Publishing Company (P) Ltd., New Delhi.
2. Y. Guyon, "Prestressed Concrete", C. R. Books Ltd., London

Course Plan

Contents	Contact	Sem.

	Hours	Exam Marks
Module I **Introduction:** Basic concept of Prestressing,Systems of Prestressing: - Pre tensioning and Post tensioning, Thermo elastic and Chemical prestressing. Need of high strength concrete and steel, Advantages of prestressed concrete over reinforced concrete., Analysis of prestress and bending stress: - Stress concept, Strength concept: - Pressure line and internal resisting couple and Load balancing concept for extreme fiber stresses for various tendon profile. **Losses of Prestress:** Losses of Prestress:- Stages of losses,Types of losses in pre-tensioning and post-tensioning due to Elastic shortening, Shrinkage, Creep, Relaxation, Anchorage Slip, Friction and Sudden changes in temperature. **Deflection of beams:** Short term, Load deflection curve, Importance of control of deflections, factors influencing deflections, Effect of tendon profile on deflections, Prediction of long term	10	25
Module II **Elastic Design**: Shear and Torsional Resistance of PSC members: - shear and Principal stresses, Ultimate shear resistance of PSC members: - Section cracked and uncracked, Design for shear using IS code. PSC members in torsion:-Pure torsion, Combined bending moment and torsion, Combined bending moment, shear and torsion, modes of failure, Design of reinforcement using IS code provision. Flexuralstrength: - Simplified code procedure for bonded and unbonded symmetrical and unsymmetrical sections. Behavior under flexure: - Codel provision for Limit state design:-Design stress strain curve for concrete. Design of sections for flexure: - Expressions for minimum section modulus, Prestressing force and Eccentricity. Limiting zone for prestressing force. **Design of Pretensioned and Post-Tensioned Flexural Members:** Dimensioning of Flexural members, Estimation of Self Weight of Beams, Design of Pre tensioned and Post tensioned members symmetrical about vertical axis.	12	25
Module III	12	25

Prestressing of statically indeterminate structures: Advantages, Effect, Method of achieving continuity, Primary, Secondary and Resultant moments, Pressure line, Concept of Linear transformation, Guyon's theorem, Concordant cable profile. End blocks: - Anchorage zone Stresses, Stress distribution in end block, Methods of investigation, Anchorage zone reinforcements, Design (IS Code method only)		
Module IV **Composite construction of Prestressed and in situ Concrete:** Types, Analysis of stresses, Differential shrinkage, Flexural strength, Shear strength, Design of composite section. **Tension members:** Load factor, Limit state of cracking, Collapse, Design of sections for axial tension. **Design of Special Structures:** Design PSC slabs, Pipes, Circular water tanks.(Concepts only)	8	25
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6032	Theory Of Plates And Shells	3-0-0-3	2015
Pre-requisites	Nil		

Course Objectives

To enable the students to learn

- Classical and modern method of analysis of Love – Kirchhoff theory of thin plates under small deflections.
- Pure bending and symmetrical bending of circular plates.
- Bending of laterally loaded circular plates. Differential Equations.
- Navier and Levy's solutions for simply supported plates.
- Shell theories, shell statics, deformation of shells, Membrane theory of shells,
- Pucher stress function

Syllabus

Pure Bending of Thin Plates, Symmetrical Bending of Circular Plates. Small deflection of laterally loaded plates. Kirchhoff's –Love Theory. Navier and Levy's solutions for rectangular plates.

Shells – Geometrical relations. CODAZZI and GAUSS equations. Gauss curvature. Synclastic and anticlastic surfaces. General Shell classification. Shell theories. Love – Kirchhoff theory.Statics of a shell. Basic equation of doubly curved shell. Stress resultants and moment resultants. Membrane theory of doubly curved shell other than shell of revolutions. Pseudo stress resultant . Shell equations of equilibrium. Pucher stress function and applications.

Course Outcome

On successful completion of the course the student will be able to analyse and design plate structures as well as shell structures. A student is expected to acquire skill in the application of Membrane theory to analyse and design shells of different types like hyperbolic paraboloid, elliptic paraboloid and conoids.

Textbooks

1. Theory of Plates and Shells, Stephen P. Timoshenko, S. WoinowskyKrieger , Tata McGraw Hills Ltd Publications 2010.

2. Thin Shell Structures- Classical and Modern Analysis, J.N Bandyopadhyay, Hard cover -2007, New Age International Publications

References

1. Design and Construction of Concrete Shell Roofs , G.S Ramaswamy, CBS Publications

2. Thin Plates and Shells, Theory, Analysis and Applications, Edward Ventsel, TheodorKrauthammer.

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I **Plate Theory**: Introduction to Pure Bending of Thin Plates with Small Deflections: Slpoe and curvature of slightly bent plates- Relation between curvature and bending moments in pure bending. Particular cases of pure bending. Symmetrical Bending of Circular Plates:- Differential equation for symmetrical bending of laterally loaded circular plates- Uniformly loaded circular plates- Circular plate with a circular hole at the center- Circular plate concentrically loaded- Circular plate loaded at the center.	10	25
Module II **Small Deflections of Laterally Loaded Plates:** The Differential equation of the deflection surface based on Kirchhoff's -Love hypothesis and assumptions. Boundary conditions – Reduction of the problem of bending of a plate to that of deflection of a membrane. **Simply Supported Rectangular Plates Under Sinusoidal Load:**Navier solution for simply supported rectangular plates. Navier solution for a single load uniformly distributed over the area of a small rectangle (Patch Load). Levy's solution for a simply supported and uniformly loaded rectangular plate. Simply supported rectangular plates under hydrostatic pressure.	8	25
Module III **Shell Theory:** Introduction to the General Shell Theory: Examples of shell structures in engineering and other fields- Advantages of Shell	9	25

forms- General definitions and fundamentals. Classifications- Thin shells – Linear shell theories- Love- Kirchhoff hypothesis- First order,second order approximation theories – improved theories- subsequent development of general nonlinear theories and specialized shell theories – shallow shells- Membrane or momentless state of stress. The highest efficiency of a shell as a structural member is associated with its thinness and curvature. **Statics of a shell:** Hookes law for thin shell – Differential element isolated from a shell by means of four sections normal to its middle surface and tangential to the lines α and $\alpha + d\alpha$, β and $\beta + d\beta$. Stress resultants and Couples – Equilibrium of shell element – Six equations of equilibrium (reduced to 5 with 8 unknowns)- Reduced to three equations of equilibrium- Expressions for stress resultants and stress couples in terms of strains and curvatures. **Folded Plates:** Classifications, applications – analysis methods		
Module IV **Deformation of Sells:** Definitions and notations- Stress resultants and moment resultants – Bending strain considering the unit elongation of a thin lamina at a distance from the middle surface – Considering radii of curvature after deformation and stretching of the middle surface – Resultant forces per unit length and moment resultants in terms of the three components of the strains of the middle surface and three quantities representing the changes of curvature and the twist of the middle surface. Discussion on deformation of shells where bending stresses can be neglected and membrane theory can be accepted. Shells in the form of surface of revolution and loaded symmetrically with respect to their axis: Particular cases of shell in the form of surface of revolution – Spherical Dome. Membrane Theory of Cylindrical Shells: Equations of equilibrium and solutions. **Membrane Theory of Shells of Double Curvature other than Shells of Revolution :** Geometrical relations – Radius vector of a point on a	15	25

surface given in the form z = f(x,y) – Area of element – the first and second quadratic forms- Equations of CODAZZI and GAUSS. Principal curvatures – Gauss curvature. Synclastic , developable or anticlastic surfaces. **Pseudo stress resultant:** Equations of equilibrium – Reduction of three equations of equilibrium to a single differential equation by introducing a stress function as suggested by Pucher . A shell in the form of an Elliptic Paraboloid – A shell in the form of a Hyperbolic Paraboloid.		
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6142	Bridge Engineering	3-0-0-3	2015
Pre-requisites	Nil		

Course Objectives

To instruct the students on

- The basic concepts in planning of bridges in terms of geographical location and functionality
- The design of various types of bridges
- The design aspects of bearings ,substructure and foundation
- Construction methods and rehabilitation of bridges

Syllabus

Planning of bridges:– selection of site, design of right, skew and curved slab bridges. Design of girder bridges, balanced cantilever bridges- pre stressed concrete bridges. Design of elastomeric bearings, Substructure design– piers and abutments, Bridge foundations design. Design of composite bridges (steel & concrete).Major construction methods and maintenance and rehabilitation of bridges.

Course Outcome

On completion of the course the students shall attain knowledge on the basic concepts in proportioning and design of various types of bridges, helps to determine the actions to be considered for the design of bridge according to IRC codes, and the design of substructure and foundations for the bridge.

Textbooks

1. Krishna Raju N (1996), "Design of Bridges", TataMcGrawHill, publishing company, New Delhi.
2. Victor D.J (19991), "Essentials of Bridge Engineering", Oxford & IBH publishing company, New Delhi.

References

1. Ponnuswami S (1993), "Bridge Engineering", Tata Mc–GrawHill, publishing company, New Delhi.
2. Raina V.K (1988), "Concrete Bridge Practice– Construction Maintenance &Rehabilitation", Tata Mc–GrawHill, publishing company, New Delhi

Course Plan

Contents	Contact Hours	Sem. Exam Marks

Module I **Planning of bridges:** Investigation for bridges– selection of site. Design of RCC bridges– IRC loading– types of bridges– components of bridges– analysis and design of right, skew and curved slab bridges.	12	25
Module II **Design of girder bridges:**T-beam bridges– Analysis and design of deck slab, longitudinal girders and cross girders–Pigeaud's method– Courbon's method– Morice and Little method– Hendry–Jaegar method– grillage analogy method- balanced cantilever bridges- prestressed concrete bridges(simply supported case only).	12	25
Module III **Bearings:**importance of bearings– bearings for slab bridges– bearings for girder bridges–Design of elastomeric bearings –Joints – Appurtenances.Substructure- different types- materials for piers and abutments- Forces on piers and abutments- substructure design– piers and abutments and approach structures - Bridge foundations - open, pile, well and caisson.	10	25
Module IV **Design of composite bridges (steel & concrete):**Introduction to analysis and design of long span bridges like suspension and cable stayed bridges. Major construction methods and maintenance and rehabilitation of bridges.	8	25
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6242	Structural Reliability	3-0-0-3	2015
Pre-requisites	Nil		

Course Objectives

To instruct the students on

- Basic Concepts of structural safety
- Probability theory, resistance distribution and parameters-statistics of properties of concrete and steel, strength of bricks and mortar
- Probabilistic analysis of loads, Basic structural reliability

Syllabus

Concepts of structural safety-histograms-sample correlation, Probability theory, resistance distribution and parameters-statistics of properties of concrete and steel, characterisation of variables of compressive strength of concrete in structures Probabilistic analysis of loads Wind load-introduction-wind speed-return period, Basic structural reliability computation of structural reliability. Monte carlo study of structural safety and applications, Level-2 Reliability method: - Introduction-basic variables and failure surface

Course Outcome

Students, on completion of the course will have the understanding on basic Concepts of structural safety, Probability theory, resistance distribution and parameters, dimensional variations, characterisation of variables of compressive strength of concrete in structures, yield strength of concrete in structures and yield strength of steel. Probabilistic analysis of loads: - Gravity load, Wind load, probability model of wind load and Basic structural reliability.

Textbooks

1. NobrertLlyd Enrick, "Quality control and reliability", Industrial press New York.
2. A K Govil, "Reliability engineering", Tata McGraw Hill, New Delhi.

References

1. Alexander M Mood, "Introduction to the theory of statistics", McGraw Hill, Kogakusha Ltd.
2. Ranganathan, "Reliability of structures".

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I **Concepts of structural safety**:-Basic statistics:-Introduction-data reduction-histograms-sample correlation.	8	25

Module II **Probability theory, resistance distribution and parameters:-** Introduction- statistics of properties of concrete and steel, statistics of strength of bricks and mortar, dimensional variations-characterisation of variables of compressive strength of concrete in structures and yield strength of concrete in structures and yield strength of steel – allowable stresses based on specified reliability.	14	25
Module III **Probabilistic analysis of loads: -** Gravity load-introduction-load as a stochastic process. Wind load-introduction-wind speed-return period-estimation of lifetime wind speed-probability model of wind load. **Basic structural reliability**: - Introduction-computation of structural reliability. Monte carlo study of structural safety and applications	12	25
Module IV **Level-2 Reliability method: -** Introduction-basic variables and failure surface-first order second moment methods like Hasofer and Linds method-nonnormal distributions-determination of B for present design-correlated variables.	8	25
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6342	Design Of Substructures	3-0-0-3	2015
Pre-requisites	**Nil**		

Course Objectives

To give the students an understanding on

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

Syllabus

Soil -Structure Interaction Contact pressure distribution beneath rigid and flexible footings Principles of design of foundations for reciprocating and impact type of machine –Vibration isolation – types and methods of isolation – isolating materials and their properties. Foundations in Expansive soils Bearing capacity of Footings subjected to Eccentric and Inclined Loading –Design of spread footing, column footing,combined footing. Mat foundations on cohesive and cohesion less soilPile Foundations Pile Groups –Efficiency of pile groups – Laterally loaded piles –Pile-raft system-Caissons and well foundations -Design Criteria

Course Outcome

- Basic understanding of type and selection of foundations
- To analyse and design foundations

Textbooks

1. Soil Mechanics & Foundation Engineering by B.C. Punmia.
2. Vibration of Soils & Foundations – Richant Hall & Woods.

References

1. Analysis and Design of Substructures – Swami Saran
2. Donald P. Coduto, Foundation Design: Principles and Practices, Dorling Kinderseley (India) Pvt. Ltd., 2012

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I Soil -Structure Interaction - Introduction to Soil -Structure interaction		

problems -Contact pressure distribution – factors influencing Contact pressure distribution beneath rigid and flexible footings contact pressure distribution beneath rafts – concentrically and eccentrically loaded Principles of design of foundations for reciprocating and impact type of machine – as per I.S. Codes. Vibration isolation – types and methods of isolation – isolating materials and their properties Foundations in Expansive soils – Problems in Expansive soils – Mechanism of swelling – Swell Pressure and Swelling potential – Heave foundation practices – Sand cushion – CNS cushion – under – reamed pile Foundations – Granular pile – anchor technique, stabilization of expansive soils.	14	25
Module II Bearing capacity of Footings subjected to Eccentric and Inclined Loading – Meyrhoff's and Hanse's theories – elastic settlement of Footings embedded in sands and clays of Infinite thickness – Footings on soils of Finite thickness-Schmertamaunn's method, Jaubu and Morgenstern method Bearing capacity of foundation based on in-situ tests. Design of spread footing, column footing , combined footing. Mat foundations on cohesive and cohesion less soil- rigid beam analysis- Winkler model	10	25
Module III Pile Foundations - Introduction – Estimation of pile capacity by static and dynamic formulae – Wave equation method of analysis of pile resistance – Load -Transfer method of estimating pile capacity – Settlement of single pile – Elastic methods. Pile Groups – Consideration regarding spacing – Efficiency of pile groups – Stresses on underlying soil strata – Approximate analysis of pile groups –Settlement of pile groups- Pile caps –Pile load tests – Negative skin friction, Under reamed piles.	10	25
Module IV Laterally loaded piles – Modulus of sub grade reaction method – ultimate lateral resistance of piles. Load deflection prediction for	8	25

laterally loaded piles, Subgrade reaction and elastic analysis, Interaction analysis, Pile-raft system, Solutions through influence charts Caissons and well foundations : Types of caissons – well foundation Different shapes of wells – Components of wells – functions and Design – Design Criteria – Sinking of wells – lateral stability by Terzaghi's analysis.		
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6152	Structural Stability	3-0-0-3	2015
Pre-requisites	• Basic knowledge of Strength of Materials • Basic understanding of buckling, crushing and crippling		

Course Objectives

- To impart the need for stability concepts
- To explain buckling
- To demonstrate the critical load computations on different structural members using analytical, approximate and numerical methods

Syllabus

Introduction to stability analysis:–Stable, unstable and neutral equilibrium–Stability Criteria.–Euler's theory–assumptions and limitations - Energy approach and principles-Approximate methods-Rayleigh Ritz–Galerkin's method. General treatment of column:- Stability problem as an Eigen value problem–Short and long columns - Elastic instability of columns Stability of Beam columns:–Beam column equation– Energy method – Solutions for various end conditions–Stability of Frames:-Buckling of frames with and without sway for fixed and hinged end conditions-Energy approach Stability of plates:–Inplane and lateral loads–Introduction to torsional buckling, lateral buckling and inelastic buckling. Finite element application to stability analysis– Finite element stability analysis–Element stiffness matrix –Derivation of element stiffness matrix and geometric stiffness matrix for a beam element.

Course Outcome

On the successful completion of the course students are expected to

- Understand the physical interpretation of buckling
- Compute critical load on columns, beam columns, frames and plates
- Use equilibrium, energy, approximate and numerical methods for the computation of critical loads

Textbooks

1. Ziegler H, "Principles of structural stability", Blarsdell, Wallham, Mass, 1963.
2. Thompson J M, G W Hunt, "General stability of elastic stability", Wiley,New York.
3. Timoshenko, Gere, "Theory of elastic stability", McGraw Hill, New York.

References

1. Don O Brush, B O OAlmorth, Buckling of Bars, plates and shells,
2. Cox H L, The buckling of plates and shells, Macmillam, New York, 1963.
3. O C Zienkiewicz ,.Finite Element Method ,fourth Edition,McGraw Hill.

Course Plan

Contents	Contact Hours	Sem. Exam Marks

Module I **Introduction to stability analysis:**–Stable, unstable and neutral equilibrium–Stability Criteria. Fourth order Elastica – large deflection of bars differential equation for generalized bending problems–Euler's theory–assumptions and limitations -Introduction to methods for the determination of buckling loads on columns – Moment equilibrium method-Fourth order elastica - Energy approach and principles-Approximate methods-Rayleigh Ritz–Galerikin's method.	14	25
Module II **General treatment of column:-** Stability problem as an Eigen value problem–Short and long columnns - Elastic instability of columns - Various modes of failure for various end conditions– both ends hinged–both ends fixed–one end fixed other end free– one end fixed other end hinged–Energy approach.	14	25
Module III **Stability of Beam columns:**–Beam column equation–Solution of differential equation for various lateral loads–udl and concentrated loads– Energy method – Solutions for various end conditions–bottom fixed– bottom hinged –Horizontal compression members- **Stability of Frames**:-Buckling of frames with and without sway for fixed and hinged end conditions-Energy approach	16	30
Module IV **Stability of plates:–**Inplane and lateral loads– Boundary conditions–Critical buckling pressure–Aspect ratio – Introduction to torsional buckling, lateral buckling and inelastic buckling. **Finite element application to stability analysis**– Finite element stability analysis–Element stiffness matrix –Geometric stiffness matrix–Derivation of element stiffness matrix and geometric stiffness matrix for a beam element.	12	20
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6252	High Rise Structures	3-0-0-3	2015
Pre-requisites	Nil		

Course Objectives

- To impart the ability to identify the structural systems for various combinations of gravity and horizontal loading considering their functional use and heights.
- To analyse the behaviour and drift capacities of various high rise structuralforms

Syllabus

Design Criteria, Design Philosophy of High Rise structures, Loading –gravity loading- Dead and live load, live load reduction techniques-sequential loading, Impact loading,Wind Loading, Earthquake loading- Introduction to Performance based seismic design.Structural form, Floor systems, Rigid frame Structures- Determination of member forces by lateral loading- Braced frames- Infilled frames -Shear 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,foundations for tall structures-Modelling for analysis for high rise structures – Design for differential movement, creep and shrinkage effects, temperature effects and fire resistance

Course Outcome

On the successful completion of the course students are expected to

- Understand behaviour of common high rise structures under gravity and lateral loading
- Understand the drift capabilities of different structural forms

Textbooks

1. Beedle.L.S., “Advances in Tall Buildings”, CBS Publishers and Distributors, Delhi, 1986.

2. Bungale S Taranath, Structural Analysis and Design of Tall Buildings, Tata McGraw Hill,1988.

References

1. Gupta.Y.P.,(Editor), Proceedings of National Seminar on High Rise Structures - Design and Construction Practices for Middle Level Cities, New Age International

Limited, New Delhi,1995.

2. Lin T.Y and Stotes Burry D, "Structural Concepts and systems for Architects and Engineers", John Wiley, 1988.

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I Definition of tall building-need for constructing tall building-Historic background-factors affecting growth. Design Criteria, Design Philosophy of High Rise structures, Materials Loading –gravity loading- Dead and live load, live load reduction techniques-sequential loading, Impact loading, 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..	14	25
Module II Structural form, Floor systems, Rigid frame Structures- rigid frame behaviour –approximate determination of member forces by gravity loading- two cycle moment distribution, approximate Determination of member forces by lateral loading- Portal method, Cantilever method, approximate analysis of drift, Braced frames- Types of bracings-behaviour of bracings-behaviour of braced bents method of member force analysis-method of drift analysis, Infilled frames- behaviour of infilled frames-stresses in infill-forces in frame- design of infill- design of frame- horizontal deflection.	10	25
Module III	8	25

Shear wall Structures-behaviour of shear wall structures-proportionate wall systems, non proportionate wall systems- horizontal deflection, Coupled shear walls-behaviour of coupled wall structures-method of analysis, Wall frame structures- behaviour of wall frames, Tubular structures-framed tube structures-bundled tube structures-braced tube structures, Core structures, Outrigger-Braced Structures,		
Module IV Foundations for tall structures-pile foundation-mat foundation, Modelling for analysis for high rise structures – approximate analysis, accurate analysis and reduction techniques, Design for differential movement, creep and shrinkage effects, temperature effects and fire resistance,Discussion of various Finite Element Packages for the analysis of High Rise Structures.	10	25
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6352	Experimental Stress Analysis	3-0-0-3	2015
Pre-requisites	Nil		

Course Objectives

- To impart the basic knowledge to design experiments related to stress analysis problems
- To familiarize the methodology for conducting laboratory and field experiments
- To Analyse and interpret experimental observations and results

Syllabus

The measurement system: Purpose Structure and Elements Dynamic Characteristics – zero order, first order and second order instruments. Measurement of Strain: Electrical resistance strain gauges - strain gauge bridges - Load cells different types – design of force transducers; Force balance pressure gauges –Potentiometers – different types; Linear variable differential transformer – principle and working. Accelerometers - Photo elasticity- Two dimensional photo elasticity. Moire fringe method- Non Destructive Testing Methods: Ultrasonic Methods; Hardness methods-Computer based data acquisition systems-Multi-Scale Analysis in Experimental Mechanics

Course Outcome

Capability to provide suitable instrumentation for conducting experiments , Acquire capacity to organize laboratory experiments for project and thesis works ,Building capacity to conduct destructive and non-destructive experiments as a practicing engineer.

Textbooks

1. Dally JW & Riley WF – Experimental stress Analysis - McGraw Hill, 1991
2. L.S.Srinath, M.R. Raghavan,K. Lingaiah, G. Gargesa,B.Pant, and K. Ramachandra, Experimental Stress Analysis, Tata McGraw Hill, 1984

References

1. Nakra B.C & Chaudhry - Instrumentation Measurement & Analysis - Tata McCraw Hill, 2004
2. Adams L F - Engineering Measurements and Instrumentation – English University Press, 1975.

Course Plan

Contents	Contact Hours	Sem. Exam Marks

Module I The measurement system: Purpose Structure and Elements - Characteristics of measurement system - Accuracy, Precision, Repeatability; Calibration – Standards and evaluation; Dynamic Characteristics – zero order, first order and second order instruments. Measurement of Strain: Electrical resistance strain gauges - Gauge materials - gauge construction – gauge factor; Vibrating wire strain gauges ; strain gauge bridges – Potentiometric and Wheatstone bridge - sensitivity Force transducers: Load cells different types – design of force transducers; Force balance pressure gauges – construction - sensitivity. Measurement of displacement: Potentiometers – different types; Linear variable differential transformer – principle and working.	14	25
Module II Measurement of acceleration: Accelerometers - Characteristics of Accelerometers – typesdesign of accelerometers – calibration techniques - Integration technique for displacement from acceleration. Photo elasticity- use of polarised light - Maxwell's law - polariscopes and their use; Photoelastic model materials ; Two dimensional photo elasticity - analysis and reduction of data. Moire fringe method-techniques and its use..	12	25
Module III Non Destructive Testing Methods: Ultrasonic Methods; Hardness methods - Rebound Hammer ; Core sampling technique; Pullout experiment; Detection of embedded reinforcement . Indicating & recording elements – Chart recorders – Cathode ray oscilloscope; Computer based data acquisition systems – structure and components. Statistical Analysis - Errors in measurement - best estimate of true value Normal Distribution - Confidence level.	8	25
Module IV Multi-Scale Analysis in Experimental Mechanics Trends in experimental mechanics, Discussion on selection of an experimental technique, Selection of an Experimental Technique Discussion on selection of an experimental technique contd., Review of solid	8	25

mechanics, definition of free surface, ambiguity in associating the correct value of principal stress direction to the magnitude of the principal stress, Eigen value approach or use of Mohr's circle,Shear distribution in a three point bend specimen.		
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6062	Mini Project	0-0-4-2	2015
Pre-requisites	STAAD Pro.,SAP 2000,NISA		

Course Objectives

To give the students an understanding on effective use of a suitable design/analysis software package.

Syllabus

During the course of the second semester each student is expected to do a mini project. The student can execute this project by effective use of a suitable design/analysis software package. This may be as far as possible, a software studied as part of the curriculum or any other suitable package. In any case, at the end of the mini project the student should be well versed with the different aspects of the software. Each student must keep a project notebook, which shall be checked periodically throughout the semester, as part of evaluation. At the end of the training student shall submit a report in the prescribed format to the department.

Course Outcome

After the successful completion of the mini project, the students should be capable of conducting the analysis and design of structures and be well versed in the software package chosen.

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE6072	Structural Engineering Design Studio	0-0-2-1	2015
Pre-requisites	Nil		

Course Objectives

To instruct the students on

- Practical training related to structural engineering.
- Ability to solve stress analysis problems.
- Structural analysis & design software SAP2000& ANSYS

Syllabus

Linear Static Analysis of Continuous Beams, Portal Frames, Truss (2D and 3D), Multistoried Building.Loading : Dead Load, Live Load, Wind Load (IS: 875 Part 1 / Part 2 / Part 3), Earth Quake Load (IS: 1893 Part 1) and its Combinations as per codal Provisions

Linear Static Analysis of Continuous Beams, Portal Frames, Truss (2D and 3D), Plates (Plane Stress and Plane Strain)Linear dynamic analysis of Continuous Beams, Portal Frames

Course Outcome

- To understand the concepts and principles involved in structural engineering
- To equip the students to perform experimental work for project and thesis

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE7111	Advanced Metal Structures	3-0-0-3	2015
Pre-requisites	Nil		

Course Objectives

- To make students to learn principles of Plastic analysis and design of steel structures
- Design of different components of industrial building and to detail these structures including the connection design.
- To understand the design of steel concrete composite elements.

Syllabus

Basics of plastic analysis, plastic moment capacity, beams portal frames-plastic design. Estimation of deflection. Connections, Design of bolted and welded connection – both simple and moment connections. Analysis and design of industrial buildings, loads – wind load, purlin, bracings etc. Basics of pre engineered buildings. Introduction to composite materials – shear connection, steel concrete composite member designs

Course Outcome

On successful completion of the course the student will be able to design steel industrial buildings including the connection design. The student will acquire skill in the area of plastic analysis of basic steel structures and in the design of steel-concrete composite structural elements

Textbooks

1. Design of steel structures, N Subbramanian, Oxford University Press, 2008

References

1. R.P. Johnson, "Composite Structures of Steel & Concrete", Blackwell Scientific publications, UK, 1994.
2. S.K. Duggal "Limit State Design of Steel Structures" McGraw Hill Education Private Ltd., New Delhi.
3. Gaylord& Gaylord "Design of Steel Structures", Tata McGraw Hill, Education Edition 2012.
4. IS 800: 2007, IS 875: 1987

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I **Theorems of Plastic Analysis and Design:** General methods of		25

Analysis - non-linearity - Plastic method of analysis – moment redistribution – static, kinematic and uniqueness theorems-effect of axial and shear force on plastic moment capacity – Analysis of single and two bay portal frames – requirements of plastic design- advantages – Plastic design of Continuous beams and portal frames-estimation of deflection..	12	
Module II **Design of Connections:** Bolted Connections- Load Transfer Mechanism – Failure of Bolted Joints – Type of Connections Design of Fillet Welds - Design of Groove welds - Design of Intermittent fillet welds- Failure of Welds. Design of frame connections – simple and moment connections, beam to beam and beam to column – un-stiffened, stiffened seat connections, -- both welded and bolted.	12	25
Module III **Analysis and Design of Industrial Buildings:** Layout – sway and non sway frames – braced and rigid frames – Loads - dead, live and wind loads - wind pressure on roofs and walls - design of angular roof truss, tubular truss - design of purlins for roofs, built up purlins, knee braced trusses and stanchions -design of bracings. Introduction to Pre-engineered buildings (basics only)	10	25
Module IV **Steel-Concrete Composite Design**: Introduction to composite design – shear connectors – types of shear connectors – degrees of shear connections – partial and full shear connections – composite sections under positive bending – negative bending – propped conditions – un-propped conditions.	8	25
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE7211	Analysis Of Composite Structures	3-0-0-3	2015
Pre-requisites	Nil		

Course Objectives

The main objective of this course is to introduce the concept of composite laminates and equip them to analyse simple structures made of laminated composites. Also to make them understand about the theories underlying the analysis of laminated composite structures.

Syllabus

Introduction to laminated compositesand its manufacture. Various macromechanical and micro mechanical theories developed to analyse these structures. Failure analysis of the laminated composite. Analysis of laminated composite plates.

Course Outcome

The student will be able to understand the basics of laminated composites, its behaviour and will be able to do projects involving laminated composites structures.

Textbooks

1. Mechanics of Composite Materials by Autar.K.Kaw, Second Edition (2005), Taylor and Francis Press.
2. Mechanics of Laminated Plates and Shells by J.N.Reddy,CRC Press

References

1. Principles of Composite Material Mechanics by Ronald F.Gibson
2. Practical Analysis of Composite Laminates by J.N.Reddy, 1995, CRC Press.
3. Structural Analysis of Laminated Anisotropic Plates by James Whitney, 1995, CRC Press.
4. Mechanics of Composite Material and Structures by M.Mukhopadhyay, Universities Press
5. Mechanics of Composite Materials by R.M.Jones, CRC Press.

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I Introduction--Classification and Characteristics of Composite Materials, Basic Terminology, Uses of Fibrous Composites,	8	25

Application of composites, manufacture, advantages and limitations, Lamina and Laminate. Introduction to Micro mechanics, constituent materials and properties..		
Module II Laminate Analysis- Stress strain relations for lamina and laminate, Transformation of Elastic Constants, Classical Lamination Theory, Extensional, Bending and Coupling Stiffness, Different Configurations and Corresponding Stiffness, Shear Deformation Theories.	11	25
Module III Failure of Laminates- Various failure theories- Maximum Stress theory, Maximum Strain theory, Tsai-Hill Theory, Tsai- Wu Theory, Comparison of failure theories.Interlaminar failure of laminates	11	25
Module IV Behaviour and Analysis of Laminated Plates Subjected to Bending, Buckling and Vibrations using Classical Lamination Theory.	12	25
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE7311	Structural Optimization	3-0-0-3	2015
Pre-requisites	Nil		

Course Objectives

To impart knowledge to the students on

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

Syllabus

Single Variable Unconstrained Optimisation Techniques – Optimality Criteria;Multi Variable Unconstrained Optimisation Techniques Constrained Optimisation Techniques;Classical methods –Linear programming problem: Standard form, Simplex method; Indirect methods – Direct methods - Specialized Optimisation techniques – Dynamic programming, Geometric programming, Genetic Algorithms.

Course Outcome

On the successful completion of the course students are expected to

- Understand various optimization methods
- Understand capabilities of optimization programmes
- Understand , Analyse various techniques and apply them for real time applications

Textbooks

1. Rao S. S., "Engineering Optimisation – Theory and Practice", New Age International.
2. Deb, K., "Optimisation for Engineering Design – Algorithms and examples", Prentice Hall.

References

1. Arora J S. "Introduction to Optimum Design", McGraw Hill
2. Rajeev S and Krishnamoorthy C. S., "Discrete Optimisation of Structures using Genetic Algorithms", Journal of Structural Engineering, Vol. 118, No. 5, 1992, 1223–

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I Introduction –Problem formulation with examples;Single Variable		

Unconstrained Optimisation Techniques – Optimality Criteria;Bracketing methods– Unrestricted search, Exhaustive search;Region Elimination methods:–Interval Halving methods, Dichotomous search, Fibonacci method, Golden section method;Interpolation methods–Quadratic Interpolation method, Cubic Interpolation method;Gradient Based methods– Newton–Raphson method, Secant method, Bisection method.	12	25
Module II Multi Variable Unconstrained Optimisation Techniques – Optimality Criteria; Unidirectional Search ; Direct Search methods – Random search, Grid search, Univariate method, Hooke's and Jeeves' pattern search method, Powell's conjugate direction method, Simplex method; Gradient based methods–Cauchy's (Steepest descent) method, Conjugate gradient (Fletcher–Reeves) method, Newton's method, Variable metric (DFP)method, BFGS method..	10	25
Module III Constrained OptimisationTechniques;Classical methods – Direct substitution method, Constrained variation method, method of Lagrange multipliers, Kuhn–Tucker conditions. Linear programming problem: Standard form, Simplex method; Indirect methods –Elimination of constraints, Transformation techniques, and Penalty function method;Direct methods – Zoutendijk's method of feasible direction, Rosen's gradient Projection method.	10	25
Module IV Specialized Optimisation techniques – Dynamic programming, Geometric programming, Genetic Algorithms.	10	25
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE7121	Concrete Material Science	3-0-0-3	2015
Pre-requisites	**Nil**		

Course Objectives

- To have an understanding of the manufacture of concrete.
- To analyse the behaviour of concrete subjected to loads
- To have an understanding of mix design of concrete
- To understand various forms of concrete

Syllabus

Manufacture of concrete, rheological behaviour of concrete, mix design of concrete, durability of concrete, special concretes

Course Outcome

On successful completion of the course the student will have in-depth knowledge about constituents of concrete and manufacture procedure. The student will have thorough understanding about the mix design of concrete and its behaviour when subjected to various loads

Textbooks

1. Neville, A.M. and Brooks, J.J.," CONCRETE TECHNOLOGY", ELBS .1990.
2. Powers, T.C., "THE PROPERTIES OF FRESH CONCRETE".JOHN WILEY & SONS, INC. 1968.

References

1. Newman, K., "CONCRETE SYSTEMS in COMPOSITE MATERIALS".EDT BY L.Holliday. Elsevier Publishing Company. 1966.
2. Neville, A.M., "PROPERTIES OF CONCRETE", PITMAN. 1983
3. Newman, John &Choo, Ban Sang. "ADVANCED CONCRETE TECHNOLOGY - Constituent Materials" Elsevier 2003.
4. Newman, John &Choo, Ban Sang. "ADVANCED CONCRETE TECHNOLOGY - Concrete Properties" Elsevier 2003.
5. Wesche, K., "FLY ASH IN CONCRETE Properties and Performance." E & FN SPON 1991
6. Popovics.S., "FUNDAMENTALS OF PORTLAND CEMENT CONCRETE: A Quantitative Approach VOL 1 FRESH CONCRETE" JOHN WILEY & SONS.1982.

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I Materials - Concrete materials –Cement-Production, composition, and		

properties; cement chemistry- Types of cements; special cements-Aggregates- Mineralogy; properties, tests and standards-Chemical and mineral admixtures-Water reducers, air entrainers, set controllers, specialty admixtures - structure properties, and effects on concrete properties- supplementary cementing materials and pozzolans- Fly ash, blast furnace slag, silica fume, and metakaolin - their production, properties, and effects on concrete properties-Other mineral additives - reactive and inert-Reinforcements and admixtures. Behaviour of Concrete - Modern trends in concrete manufacture and placement techniques - Rheological behaviour of fresh concrete and hardened concrete - Resistance to static and dynamic loads.	12	25
Module II Mix Design -Basic principles– Specifications - Design of concrete mixes by IS code method - ACI method - Road Note No:4 method-new approaches based on rheology and particle packing	9	25
Module III Compressive strength and parameters affecting it-Tensile strength - direct and indirect; Modulus of elasticity and Poisson's ratio-Stress strain response of concrete-Testing of Concrete - Non-destructive testing and quality control – Durability -Introduction to durability; relation between durability and permeability- Chemical attack of concrete; corrosion of steel rebars; other durability issues-Corrosion protection and fire resistant.Creep and relaxation - parameters affecting; Shrinkage of concrete - types and significance-Parameters affecting shrinkage; measurement of creep and shrinkage**.**	11	25
Module IV Special Concretes-Pre-cast concrete -Under water concrete – Pump concrete - Polymer concrete - Composites and fibre reinforced concrete.Properties and applications of: High strength - high performance concrete, reactive powder concrete-Lightweight, heavyweight, and mass concrete; fibre reinforced concrete; self-compacting concrete; shotcrete; other special concretes.	10	25
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE7221	Engineering Fracture Mechanics	3-0-0-3	2015
Pre-requisites	Nil		

Course Objectives

To impart knowledge to the students Fracture Mechanics and its applications to Structural Engineering problems**.**

Syllabus

Significance of fracture mechanics, Griffith energy balance approach- Fracture toughness, Influence of material behaviour, I, II & III modes, Mixed mode problems. Linear Elastic Fracture Mechanics (LEFM) Elastic stress field approach. Crack tip plasticity: Irwin plastic zone size, Energy Balance Approach: Griffith energy balance approach, LEFM Testing: Plane strain and plane stress fracture toughness testing, Elastic plastic fracture mechanics (EPFM):, J–integral, Crackopening displacement (COD) approach, COD design curve, Relation between J and COD, Fatigue Crack Growth: Description of fatigue crack growth using stress intensity factor, Effects of stress ratio and crack tip plasticity – crack closure, Mixed mode failure Initiation of initial crack propagation direction in ductile materials under plane stress conditions-Product of principal stresses.

Course Outcome

On the successful completion of the course students are expected tounderstand fracture mechanics which has wide applications in Structural Engineering.

Textbooks

1. Ewalds, H.L. &Wanhill, R.J.H., "Fracture Mechanics" – Edward Arnold
2. Ed L. Elfgren and S.P. Shah, "Analysis of Concrete Structure by Fracture Mechanics", Proc of Rilem Workshop, Chapman and Hall, London.

References

1. David Broek, "Elementary Engineering Fracture Mechanics", Sijthoff and Noordhaff Alphen Aan Den Rijn, The Netherlands.

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I **Introduction:** Significance of fracture mechanics, Griffith energy balance approach, Irwin's modification to the Griffith theory, Stress intensity approach, Crack tip plasticity, Fracture toughness, sub–critical		

crack growth, Influence of material behaviour, I, II & III modes, Mixed mode problems. **Linear Elastic Fracture Mechanics (LEFM):** Elastic stress field approach, Mode I elasticstress field equations, Expressions for stresses and strains in the crack tip region, Finitespecimen width, Superposition of stress intensity factors (SIF), SIF solutions for wellknown problems such as centre cracked plate, single edge notched plate and embedded elliptical cracks	12	25
Module II **Crack tip plasticity:** Irwin plastic zone size, Dugdale approach, Shape of plastic zone, State of stress in the crack tip region, Influence of stress state on fracture behaviour. **Energy Balance Approach:** Griffith energy balance approach, Relations for practical use,Determination of SIF from compliance, Slow stable crack growth and R–curve concept,Description of crack resistance. **LEFM Testing:** Plane strain and plane stress fracture toughness testing, Determination of R–curves, Effects of yield strength and specimen thickness on fracture toughness, Practical use of fracture toughness and R–curve data.	12	25
Module III **Elastic plastic fracture mechanics (EPFM):** Development of EPFM, J–integral, Crackopening displacement (COD) approach, COD design curve, Relation between J and COD, Tearing modulus concept, Standard JIc test and COD test. **Fatigue Crack Growth:** Description of fatigue crack growth using stress intensity factor, Effects of stress ratio and crack tip plasticity – crack closure, Prediction of fatigue crackgrowth under constant amplitude and variable amplitude loading, Fatigue crack growth from notches – the short crack problem	8	25
Module IV **Mixed mode fialure:** Introduction to crack initiation and propagation in material which are brittle or ductile, Factor envelope for material under mixed mode stress intensity factors, Test results for various materials.		

Initiation of initial crack propagation direction in ductile materials under plane stress conditions. Angled crack problem. Elasto-plastic boundary around a cracked tip. A discussion on various criteria to determine the initial crack propagation direction. like total strain energy density, dilatational strain energy density, Distortional strain energy density, Product of principal stresses, The various criteria related to the above. The application of above criteria along the Elasto-plastic boundary, the influence of crack angle on the crack propagation direction.	10	25
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE7321	Forensic Engineering	3-0-0-3	2015
Pre-requisites	Nil		

Course Objectives

To impart knowledge to the students forensic engineering and its applications to Structural Engineering problems

Syllabus

Forensic Engineering –Structural Health Monitoring Failure Analysis Decision Criteria - Failure of Structures- Environmental Problems and Natural Hazards. Causes of deterioration in concrete and steel structures. Diagnosis and assessment of deterioration, ,non destructive tests-Methods of repair of cracks, Modern Techniques of Retrofitting. Structural health monitoring approaches - Sensors, Fiber-optic sensors Wireless smart sensors Vibration-Bridge SHM applications-Forensics Case Studies – Applications of NDT with Analytical and Destructive Methods.

Course Outcome

On the successful completion of the course students are expected tounderstand forensic engineering which has wide applications in Structural Engineering

Textbooks

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

References

1. Jacob Field and Kennenth L Carper, Structural Failures, Wiley Europe.

Course Plan

Contents	Contact Hours	Sem. Exam Marks
Module I Forensic Engineering –Structural Health Monitoring Evaluation of Deterioration in Service Post-Failure Analysis Decision Criteria for Evaluation/Repair/Rehabilitation. Condition Assessment of Existing Structures 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.	14	25

Environmental Problems and Natural Hazards. Causes of deterioration in concrete and steel structures. Preventive measures, maintenance and inspection.		
Module II Diagnosis and assessment of deterioration, visual inspection, non destructive tests, ultrasonic pulse velocity method, rebound hammer method, pull out tests, Bremer test, Windsor probe test, crack detection techniques, etc.	6	25
Module III Methods of repair of cracks, repairing spalling and disintegration, repairing concrete floors and pavements. Repairing of corrosion damage of reinforced concrete. Modern Techniques of Retrofitting. Strengthening by pre-stressing. Repair of steel structures.	10	25
Module IV Structural health monitoring approaches - Sensors, data acquisition, and signal processing Fiber-optic sensors Wireless smart sensors Vibration-based structural health monitoring (SHM) Bridge SHM applications Forensics Case Studies – Applications of NDT with Analytical and Destructive Methods	12	25
End Semester Exam		

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE7031	Seminar II	0-0-2-2	2015
Pre-requisites	Nil		

Course Objectives

Syllabus

Students have to register for the seminar and select a topic in consultation with any faculty Member offering courses for the programme. The paper should be on a recent advancement/trend in the field of structural engineering. A detailed write-up on the topic of the seminar is to be prepared in the prescribed format given by the Department. The seminar shall be of 30 minutes duration and a committee with the Head of the department as the chairman and two faculty members from the department as members shall evaluate the seminar based on the coverage of the topic, presentation and ability to answer the questions put forward by the committee.

Course Outcome

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE7041	Project (Phase 1)	0-0-8-6	2015
Pre-requisites	Nil		

Course Objectives

Syllabus

Normally students are expected to do the project within the college. However they are permitted to do the project in an industry or in a government research institute under a qualified supervisor from that organization. Progress of the project work is to be evaluated at the end of the third semester. For this a committee headed by the head of the department with two other faculty members in the area of the project, of which one shall be the project supervisor. If the project is done outside the college, (provision is available for them only in the fourth semester), the external supervisor associated with the student will also be a member of the committee. Final evaluation of the project will be taken up only on completion of the project in the fourth semester. This shall be done by a committee constituted for the purpose by the principal of the college. The concerned head of the department shall be the chairman of this committee. It shall have two senior faculty members from the same department, project supervisor and the external supervisor, if any, of the student and an external expert either from an academic/R&D organization or from Industry as members. Final project grading shall take into account the progress evaluation done in the third semester and the project evaluation in the fourth semester. If the quantum of work done by the candidate is found to be unsatisfactory, the committee may extend the duration of the project up to one more semester, giving reasons for this in writing to the student. Normally further extension will not be granted and there shall be no provision to register again for the project.

M.Tech projects should be socially relevant and research oriented ones. Each student is expected to do an individual project. The project work is carried out in two phases – Phase I in III semester and Phase II in IV semester.Project work is to be evaluated both in the third and the fourth semesters. Based on these evaluations the grade is finalised in the fourth semester.

Project evaluation weights shall be as follows:-

For convenience the marks are allotted as follows.

Total marks for the Project: 150

In the 3rd Semester:- Marks:50

Project Progress evaluation:

Progress evaluation by the Project Supervisor : 20 Marks

Presentation and evaluation by the committee : 30 Marks

Course Outcome

On completion of the project (Phase 1) the student is expected to conduct preliminary work and review previous literatures on a relevant and research oriented topic to be continued in the following semester.

Course No.	Course Title	L-T-P-Credits	Year of Introduction
06CE7012	Project (Phase 2)	0-0-21-12	2015
Pre-requisites			

Course Objectives

Syllabus

Phase II of the project work shall be in continuation of Phase I only. At the completion of a project the student will submit a project report, which will be evaluated (end semester assessment) by duly appointed examiner(s). This evaluation will be based on the project report and a viva voce examination on the project. The method of assessment for Phase II is as given:

In the 4th Semester:- Marks:100

Project evaluation by the supervisor/s : 30 Marks

Evaluation by the External expert : 30 Marks

Presentation & evaluation by the Committee : 40 Marks

Course Outcome

At the successful completion of a project, the student will be well versed in the work and should submit a report of the work done.

KERALA TECHNOLOGICAL UNIVERSITY

SCHEME AND SYLLABUS

FOR

M. Tech. DEGREE PROGRAMME

IN

MECHANICAL ENGINEERING

WITH SPECIALIZATION

COMPUTER INTEGRATED MANUFACTURING

CLUSTER 05 (ERNAKULAM II)

KERALA TECHNOLOGICAL UNIVERSITY

CET Campus, Thiruvananthapuram

Kerala, India -695016

(2015 ADMISSION ONWARDS)

KERALA TECHNOLOGICAL UNIVERSITY
SCHEME AND SYLLABUS FOR M. Tech. DEGREE PROGRAMME
Branch: MECHANICAL ENGINEERING
Specialization: Computer Integrated Manufacturing
Semester 1 (Credits: 21)

Exam Slot	Course No:	Name	L- T - P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
A	05ME 6301	Advanced Engineering Materials and Processing	3-1-0	40	60	3	4
B	05ME 6303	Computer Aided Process Planning and Control	3-1-0	40	60	3	4
C	05ME 6305	Computer Aided Design in Manufacturing	3-1-0	40	60	3	4
D	05ME 6307	Automation and Control Systems	3-0-0	40	60	3	3
E	05ME 631X	Elective-I	3-0-0	40	60	3	3
	05ME 6377	Research Methodology	0-2-0	100	0	0	2
	05ME 6391	Computer Integrated Manufacturing Laboratory – I	0-0-2	100	0	0	1
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Elective I

05ME 6311	Metrology and Computer Aided Inspection
05ME 6313	Quality Engineering and Management
05ME 6315	Rapid Prototyping

Semester 2 (Credits: 21)

Exam Slot	Course No:	Name	L- T - P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
A	05ME 6302	Computer Aided Manufacturing	3-1-0	40	60	3	4
B	05ME 6304	Industrial Automation	3-0-0	40	60	3	3
C	05ME 6306	Flexible Manufacturing Systems	3-0-0	40	60	3	3
D	05ME 632X	Elective-II	3-0-0	40	60	3	3
E	05ME 633X	Elective-III	3-0-0	40	60	3	3
	05ME 6366	Seminar-I	0-0-2	100	0	0	2
	05ME 6388	Mini Project	0-0-4	100	0	0	2
	05ME 6392	Computer Integrated Manufacturing	0-0-2	100	0	0	1

		Laboratory - II					

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Elective II

05ME 6322	Supply Chain Management
05ME 6324	Composite Material Technology
05ME 6326	Simulation of Manufacturing Systems

Elective III

05ME 6332	Industrial Robotics
05ME 6334	Precision and Micromachining
05ME 6336	Micro and Nano Manufacturing

Semester 3 (Credits: 14)

A	05ME 734X	Elective-IV	3-0-0	40	60	3	3
B	05ME 735X	Elective-V	3-0-0	40	60	3	3
	05ME 7367	Seminar-II	0-0-2	100	0	0	2
	05ME 7387	Project (Phase 1)	0-0-12	50	0	0	6

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Elective IV

05ME 7341	Production Scheduling
05ME 7343	Design for manufacturing and Assembly
05ME 7345	Lean Manufacturing

Elective V

05ME7351	Sustainable Manufacturing
05ME7353	Finite Element Method
05ME7355	Artificial Intelligence

Semester 4 (Credits: 12)

Exam Slot	Course No:	Name	L- T - P	Internal Marks	End Semester Exam	Credits
	05ME 7388	Project (Phase 2)	0-0-21	70	30	12

12

Total: 68

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05ME 6301	ADVANCED ENGINEERING MATERIALS AND PROCESSING	4-0-0-4	2015

COURSE OBJECTIVES

1. To analyze the structure and properties of intermatallics, maraging steel and super alloys.
2. To enable students to be more aware of the properties of advanced engineering materials such as composites and biomaterials and select the materials for various applications.

COURSE OUTCOMES

Upon completion of this course work, students should be

1. Familiar with a selection of advanced engineering materials and related processing techniques.
2. Aware of the scientific and technological aspects of these materials and processes.
3. Able to integrate the scientific and engineering principles underlying the four major elements: structure, properties, processing and performance related to material systems appropriate to the field.

MODULE	COURSE CONTENT (36 hrs)	HRS
I	Atomic structure, crystallography, imperfections, modes of plastic deformation, Frank and Read source, need of alloying, The Iron–Iron Carbide (Fe–Fe3C) phase diagram, heat treatment, strengthening mechanisms (Review only) Intermetallics: property prediction, phase diagrams, Electron (or Hume - Rothery) compounds and Laves phase, AB_2 structures. Maraging steel: History of maraging steel development - reaction in austenite - reaction in martensite - austenite to martensite transformation – effect of aging time - effects of maraging with cobalt, cobalt free, molybdenum and other alloying elements - variation of mechanical	9

	properties: yield strength, hardness and fatigue - effect of precipitate size - fracture toughness and weldability, hardness variation in welded zone - manufacturing steps of rings- applications - special advantages and limitations - comparison of production sequence with high tensile steel. High temperature super alloys: Characteristics of high-temperature materials- instances of superalloy component failures, gas turbine engine requirement- selection of materials for high-temperature applications,Larson–Miller approach for creep performance – justification for Nickel as a high-temperature material	
II	Physical metallurgy of nickel and its alloys: Composition–microstructure relationships in nickel alloys, FCC, gamma prime, gamma double prime phase, TCP phases, carbide and boride phases, grain-boundary carbides - Defects in Ni and its alloys - vacancies, shockley partial dislocations, superdislocations, stacking fault and antiphase boundary. Strengthening effects in nickel alloys: strengthening by particles of the gamma prime phase, temperature dependence of strengthening, yielding effect in gamma prime alloys - creep behavior of nickel alloys: nickel and creep strengthening in nickel alloys by solid-solution strengthening and precipitation hardening. Molybdenum: Ferromolybdenum -production of molybdenum – properties - effect of molybdenum alloying on hot strength, corrosion resistance, and toughness – applications - TZM, TZC. Niobium: Production of niobium - niobium alloys - niobium in steel making Ni alloys characteristics and applications Biomaterials: - Requirements for biomaterials-Dental materials: Cavity fillers etc -The structure of bone and bone fracture-Replacement joints-Reconstructive surgery-Biomaterials for heart repair Modern physical	9

	metallurgy and materials engineering.	
III	Titanium: Basic Properties, Crystal Structure, Elastic Properties, Deformation Modes - binary phase diagram classification based on alloying elements-Basic Hardening Mechanisms: Alpha Phase, Beta Phase - Sponge Production- effect of forging temperature and forging pressure - closed die forgings - pickling of titanium - scrap recycling - closed die forging - problems in machining Titanium - shear bands - Heat treatment and microstructure obtainable - welding of titanium and defects. Detailed discussions on Vacuum induction melting (VIM) - Conditions for freckle formation - - Vacuum arc remelting (VAR), Control, and structure developed, melt-related defects -electroslagremelting (ESR), electrode quality melt-related defects - triple melting, super alloy cleanliness. Ceramics: AX, AmXp, AmBmXp type crystal structures – imperfections in ceramics, stoichiometric defect reactions – stress strain behavior – applications.	10
IV	Composites: Introduction to composites, constituent materials and reinforcing fibers -properties and characteristics glass, carbon, aramid, ceramic, silicon carbide, boron fibers - discontinuous and continuous reinforcements for metal-matrix composites -metallic matrices: aluminum alloys; low-density, high-modulus alloys; high-temperature aluminum; titanium alloys - ceramic matrices - carbon matrices - interfaces and interphases - interphase thermodynamics -surface modification strategies - interphase effects on fiber-matrix adhesion - interphase and fiber-matrix adhesion effects on composite mechanical properties	8
END SEMESTER EXAM (ALL Modules)		

REFERENCES:

1. Callister William. D., “Material science and engineering”, John Wiley.
2. Westbrook J. H., “Intermetallic compounds”, John Wiley.
3. American Society for Metals, “Source book of Maraging Steels”.
4. Richard K. Wilson (Editor), “Maraging steels - recent development and applications”, TMS Publication.
5. Roger C. Reed, “The Superalloys Fundamentals and Applications”, Cambridge university press.
6. Matthew J. Donachie, Stephen J. Donachie, Superalloys, “A Technical Guide”, ASM International.
7. Krishnan K Chawla, “Composite Materials: Science and Engineering”, Springer.
8. ASM hand book volume 21 -composites
9. Thermodynamics & Heat transfer, YunusCengel.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05ME 6303	COMPUTER AIDED PROCESS PLANNING AND CONTROL	4-0-0-4	2015

COURSE OBJECTIVES

Upon completion of this course the student will be able to

1. Understand what is process planning and CAPP, know the various steps involved in CAPP, classify the various methods of CAPP, and understand the feature recognition in CAPP.
2. Understand the components of manufacturing systems.
3. Understand various process planning systems and implementation of various intelligent systems in CAPP.

COURSE OUTCOMES

1. Fundamental understanding of computer aided process planning systems.
2. Understanding the structures, basic components of manufacturing systems.
3. Understanding fundamental of intelligent systems in CAPP.

MODULE	COURSE CONTENT (36 hrs)	HRS
I	**INTRODUCTION:** The role of Process Planning in Manufacturing Cycle - Process Planning and Production Planning – Technology and Methods,Process Planning and Design, Concurrent Engineering, Aggregate Production Planning- Production planning defined -Short-term production planning -Multiple-objective production planning, Product mix analysis, Lot-size analysis - MRP and machine loading, Long-term production planning, Production forecasting. Production Scheduling - Scope of production scheduling operations .	9
INTERNAL TEST 1 (Module 1)		
II	**PART DESIGN REPRESENTATION:** Technical Drawings, Geometric Tolerances, Tolerancing in Production,	9

	Process Capability and Process selection,Experience-Based Planning, Components of a manufacturing system, Group Technology, Parts Classification and Coding, Features of Parts Classification and Coding Systems, OPITZ system, MICLASS system, Production Flow Analysis, Cellular Manufacturing, Application Considerations in Group Technology,	
INTERNAL TEST 2 (Module 2)		
III	**COMPUTER AIDED PROCESS PLANNING SYSTEMS:** Computer-Aided Process Planning, Retrieval CAPP Systems, Generative CAPP Systems, Structure of a Process Planning Software, Operation of a Typical Computer Aided Process Planning Software, Implementation Considerations of a Process planning system, Process Planning Systems, CAM-I CAPP, MIPLAN and MULTICAPP, Scope and problems of process planning - Process design, Operation design. Optimum routing analysis, Line balancing - Layout Planning and Design. Scope and problems of layout planning - Systematic layout planning (SLP)	10
IV	**INTELLIGENT PROCESS PLANNING:** Intelligent Manufacturing and Manufacturing Intelligence, Computational Intelligence, Artificial Neural Networks, Evolutionary Computation, Group Technology in Intelligent Manufacturing, Intelligent Process Planning: Intelligent CAPP, Application of GA to Computer-Aided Process Planning, The Implementation of ANN in CAPP System, The Use of Case-Based Reasoning in CAPP, Multi-Agent-Based CAPP.	8
END SEMESTER EXAM (ALL Modules)		

REFERENCES:

1. Gideon Halevi, "Process and Operation Planning" Revised Edition of The Principles of Process Planning: A Logical Approach, Kluwer Academic Publishers, 2003.
2. Groover M. P, "Automation, production systems and computer integrated

manufacturing", Prentice Hall India (P) Ltd., 2002.

3. Radhakrishnan P., Subramanyan S., Raju V., "CAD/CAM/CIM", 3rd edition, New Age International, 2008.
4. Sadhu Singh, "Computer Aided Design and Manufacturing", 5th edition, khanna publishers, 2010.
5. Rao P. N., "CAD/CAM: Principles and Applications", Tata McGraw Hill, 2004.
6. Zude Zhou, Huaiqing Wang, Ping Lou, "Manufacturing Intelligence for Industrial Engineering: Methods for System Self-Organization, Learning, and Adaptation", Engineering Science Reference, 2010.
7. A. K Gupta, S. K. Arora, "Industrial automation and robotics", Laxmi Publications, 2009.
8. R. Panneerselvam, " Production and Operations management", Prentice-Hall Of India Pvt. Limited, 2006

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05ME 6305	COMPUTER AIDED DESIGN IN MANUFACTURING	3-0-0-3	2015

COURSE OBJECTIVES

1. To provide an overview of the CAD systems
2. To discuss computer graphics and graphics transformations involved in CAD.
3. To introduce the concepts of geometric modeling and parameter design.
4. To provide an introduction to Finite Element Analysis.

COURSE OUTCOMES

1. Understand the use of computer graphics and geometric modelling techniques in CAD.
2. Understand the use of Finite Element Analysis in CAD applications.

MODULE	COURSE CONTENT (36 hrs)	HRS

I	Overview of CAD systems: Conventional and computer aided design processes – advantages and disadvantage – CAD hardware and software – analytical and graphics packages – networking of CAD systems. Computer graphics and graphics transformation: Image processing – transport of graphics data – graphic standards – display and viewing – transformations – customizing graphics softwares.	9
II	Geometric modeling: Wire frame, surface and solid modeling – applications and advantages –Boolean operations – half-spaces – filleting of edges of solids – boundary representations – constructive solid geometry – sweep representation	9
III	Parametric design and object representation: Types of co-ordinate system – parametric design – definition and advantages – parametric representation of analytic and synthetic curves – parametric representation of surfaces and solids – manipulations. Mechanical assembly – mass property calculation.	10
IV	Introduction to finite element analysis: Basic steps in finite element problems formulation – element type and characteristics – element shapes – co-ordinate systems – 1D link elements and beam elements – shape functions – stiffness matrices – direct stiffness method – 2 D elements – axisymmetric elements – plane stress problem – higher order elements.	8
END SEMESTER EXAM (ALL Modules)		

REFERENCES:

1. New man &Sproull, Principles of interactive graphics, McGraw Hill.
2. C. S. Krishnamoorthy and S. Rajeev, Computer aided design, Narosa Publishing House, 1991
3. Ibrahim Zeid, CAD/CAM theory and practice, McGraw Hill Inc, 1991

4. Vera B. Anand, Computer graphics and geometric modelling for engineers, John Wiley & Sons Inc., 1993
5. Sandhu Singh, Computer aided design and manufacturing, Khanna Publishers, 1998
6. User's Manuals for Ansys, Adams, Pro/Engineer, Cadds 5 and Autocadsoftwares.
7. R. D. Cook, Concepts and applications of finite element analysis
8. Daryl L. Logan, A first course in the finite element method
9. David V. Hutton, Fundamentals of finite element analysis
10. David F. Rogers and J. Alan Adams, Mathematical elements for computer graphics, Second Edition, McGraw Hill, 1990

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05ME 6307	AUTOMATION AND CONTROL SYSTEMS	3-0-0-3	2015

COURSE OBJECTIVES

Upon completion of this course the student will be able to accomplish the following Competencies

1. Explain the General function of Industrial Automation, list basic Devices in Automated systems.
2. Students will understand the automation strategies in manufacturing plants.
3. Identify Safety in Industrial Automation, and types of industrial sensors

COURSE OUTCOMES

4. Fundamental understanding of dynamical behavior of processes and systems, advanced automation function.
5. Understanding the structures, basic components and terminology of control systems, the difference between open-loop and closed-loop control.

6. Understanding fundamentals of automated assembly lines.

MODULE	COURSE CONTENT (36 hrs)	HRS
I	**Automation: Introduction to automation**: definition, types of automation, strategies merits and criticism – manufacturing plants and operations – automation strategies – basic elements of automated system – advanced automation functions – levels of automations – automated production lines – economic and social issues .	9
II	**Production automation:** Industrial control systems – process layout for automation –discrete manufacturing industries – continuous and discrete control systems – overview of computer process control – fundamentals of automated assembly, parts feeding devices – production flow analysis: general terminology and analysis, analysis of transfer lines without storage, partial automation.	9
III	**Hardware Components for Automation and Process Control:** Sensors-Actuators-Electric Motors, Other types of actuators-Analog to digital convertors-Digital to analog Convertors-Input/output devices for discrete data- Contact input/output interfaces, Pulse counters and generators.	10
IV	**Control systems:** Servomechanisms – digital computer control – controller components – hydraulic systems – pneumatic systems – stepper motor-transfer functions – block diagram algebra-– signal flow graphs-Feedback and non-feedback systems .	8

REFERENCES:

1. Groover M. P, "Automation, production systems and computer integrated manufacturing", Prentice Hall India (P) Ltd., 2002
2. Gopal M., "Control systems principles and design", TMH, New Delhi
3. Nagrath I. J. and Gopal M., "Control system engineering", New Age International, New Delhi
4. Shinsky, "Process control system", PHI, 2000
5. Troitskey A., "Principles of automation and automated production", Mir Publishers, 1976

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05ME 6311	METROLOGY AND COMPUTER AIDED INSPECTION	3-0-0-3	2015

COURSE OBJECTIVES

1. To familiarize the basic concepts of metrology, use of statistics in metrology and types of errors in precision measurements.
2. To acquaint the students with the metrology of gears and methods of measurement in testing of machine tools and measurement of gears.
3. To discuss Computer Aided Inspection (CAI) techniques.

COURSE OUTCOMES

Upon completion of this course work, students should have:

1. Have up to date knowledge about Metrology and Inspection and their applications in industries.
2. Understand the role of computers in metrology.

MODULE	COURSE CONTENT (36 hrs)	HRS

I	Type of errors:-catastrophic errors, alignment errors, combined sine and cosine errors, alignment of spherical end gauges; optical principles of projector, microscope, telescope, collimator, autocollimator and optical flat etc ; errors due to ambient conditions and errors due to elastic deformation; effects of supports; scale, reading, measuring errors; compound errors. Mathematical concepts in metrology: - statistical concepts, limiting mean, range, variance and standard deviation, normal distribution, confidence interval and limits, precision and accuracy, statistical analysis of measurement data and control chart techniques. Pneumatic comparators: - general design features, air gauge circuits, air gauge tooling, amplification selection, air gauge mastering, automatic gauging for inspection, machine control and assembly.	9
II	Measurement of gears:-involute curve, involute function, standard proportions, helical gears, under cutting in gear teeth and addendum modification, dual flank test, single flank test -tooth thickness measurement:-tooth thickness at a pitch line, constant chord, base tangent method, measurement of over rollers - gear pitch measurement: - tooth to pitch measurement, cumulative pitch error measurement – testing involute form – allowable errors in spur gear.	9
III	Machine tool testing:- lathe tests:- spindle axis parallel to bed, cross slide perpendicular to spindle axis, accuracy of pitch of lead screw etc – milling machine tests:- table surface parallel to guide ways, centre tee-slot parallel to table movement and square with spindle axis, cross travel of table parallel to spindle axis etc – radial drill tests:- saddle and arm movements parallel to base plate, spindle and feed movement square with base plate, other machines and methods – testing of measuring instruments:- plate square testing, angle between centre lines of holes, spines, gear tooth measurement, testing of try square, checking micrometer measuring faces,	10

	calibration of micrometer screw, checking of an autocollimator, optical square, calibration of polygon and circular table.	
IV	Laser metrology – applications of lasers in precision measurements - Co-ordinate measuring machine – contact and non-contact cmm – causes of errors – accuracy specifications – contact and non-contact probes - Calibration of CMM – measuring scales – Moiré fringes in linear grating – advantages and applications of CMM - Machine vision system – image formation – binary and grayscale image – image histogram – histogram operations – pixel point processing and pixel group processing – image sharpening and smoothing – edge detection and enhancement.	8

REFERENCES:

1. ASME, Hand book of industrial metrology
2. Hume, “Metrology”, McDonald
3. Robert J. Hocken, Paulo H. Pereira, “Coordinate measuring machines and systems”, Second Edition, CRC
4. Sharp, “Metrology”, ELBS
5. Taher, “Metrology”, ELBS

Ted Busch, “Fundamentals of dimensional metrology”, Third Edition, Delmar Publishers

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05ME 6313	QUALITY ENGINEERING AND MANAGEMENT	3-0-0-3	2015

COURSE OBJECTIVES

1. To introduce the philosophy and core values of quality management.
2. To develop an understanding of quality management principles, frameworks, tools and techniques for effective real life applications in industry
3. To study different methods for improving quality.

COURSE OUTCOMES

Upon successful completion of the module students will be able to:

7. Develop an understanding on quality management philosophies and frameworks
8. Develop in-depth knowledge on various tools and techniques of quality management
9. Learn the applications of quality tools and techniques in both manufacturing and service

industry

MODULE	COURSE CONTENT (36 hrs)	HRS
	Quality: Defining quality – philosophies of quality 'gurus'- dimensions of quality - measures of quality – cost of quality – direct costs & indirect costs – 'defectives' and its significance - traditional model and emerging model of 'cost-of-quality.' Continuous process improvement: PDSA cycle – problem solving methodology	9
II	Statistical process control: Statistical tools - control charts and use of probability distributions, process capability. Acceptance sampling: Lot-by-lot acceptance sampling by attributes – fundamental concepts, statistical aspects: operating characteristic curve, producer's risk and consumer's risk, AQL, LQ, AOQ, ASN, ATI – sampling plan design.	9
III	Taguchi methods: Loss functions – signal-to-noise ratio - process optimization and robust product design using orthogonal arrays,parametric and tolerance design. Quality function deployment: Concept - house of quality – QFD process.	10
IV	Total quality management (TQM): Definition - basic concepts – strategies. Six sigma methodology: Basic concepts – DMAIC problem solving technique. Quality system and standards: An overview of ISO 9000 and ISO 14000 series of standards	8

REFERENCES:

1. Dale H. Besterfield, "Quality control", Person Education, New Delhi, 2006.
2. Dale H. Besterfield, Carol Besterfield, Glen H. Besterfield& Mary Besterfield, "Total quality management", Person Education, New Delhi, 2008.

3. R. Subburaj, “ISO 9000: Path to TQM”, Allied Publishers Limited, New Delhi, 1997
4. Bank J., “The essence of total quality management”, Prentice Hall
5. Dale B. G., “Managing quality”, Prentice Hall
6. A.V. Feigenbaum, “Total quality control”, McGraw Hill
7. G. L. Taguchi and Syed et. al., “Quality engineering production systems”, McGraw Hill
8. Zaidi, “SPC - concepts, methodology and tools”, Prentice Hall
9. Perry L Johnson, “ISO 9000”, McGraw Hill

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05ME 6315	RAPID PROTOTYPING	1-1-0-2	2015

COURSE OBJECTIVES:

This subject provides students with

1. An understanding of the various rapid prototyping and rapid tooling technologies;
2. The knowledge to select appropriate technologies for product development purposes.
3. Students will study topics fundamental to rapid prototyping and automated fabrication, including the generation of suitable CAD models, current rapid prototyping fabrication technologies, their underlying material science, the use of secondary processing, and the impact of these technologies on society.

COURSE OUTCOMES:

Upon completion of the subject, students should be able to

1. Apply the basic principles of rapid prototyping (RP) and rapid tooling (RT), technologies to product development;
2. Decipher the limitations of RP and RT technologies for product development;
3. Realise the application of RP and RT technologies for product development.

MODULE	COURSE CONTENT (36 hrs)	HRS

I	Importance of being rapid – Roles of the Prototype-Process chain-data processing for rapid prototype (RP): CAD model preparation and data interfacing for RP –Classification of rapid Prototyping Systems- stereo lithography (SL): Principle, SL process, photo polymerization of SL resins. Rapid freeze prototyping- Solid Ground Curing-advantage ,disadvantage and applications.	9
II	Selective laser sintering (SLS): principle, indirect and direct SLS, - selective laser cladding (SLC) – Laser engineered net shaping (LENS), Electron beam melting (EBM), 3D printing and desktop processes.- advantage, disadvantage and applications.	9
III	Fused deposition modeling (FDM) — laminated object manufacturing- Multi jet modeling (MJM) - Shape Deposition Manufacturing –advantage, disadvantage and applications -vacuum casting.	10
IV	Rapid tooling (RT): Classification of RT –Direct and indirect RT-Soft and Hard Tooling – applications of RP: - heterogeneous objects, MEMS and other small objects, medicine and art.	8

REFERENCES:

1. PatrikVenuvinod, Weiyuyin Ma, "Rapid prototyping", Kluwer Academic Publishers
2. T. A. Grimm & Associates, "Users guide to rapid prototyping", Society of Manufacturing Engineers (SME)
3. Frank W. Liou, "Rapid prototyping & engineering applications", CRC Press
4. Ali K. Kamarani, "Rapid Prototyping theory & practice", Manufacturing System Engineering Series, Springer Verlag
5. J. A. McDonalds, C. J. Ryall, "Rapid prototyping - case book", Wiley Eastern
6. C. E. Bocking, AEW Rennie, "Rapid & virtual prototyping and applications", Wiley Eastern

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05ME 6377	RESEARCH METHODOLOGY	0-0-2-1	2015

COURSE OBJECTIVES

1. To generate awareness about the importance, types and stages of research.
2. To introduce the methods for data collection, analysis, interpretation and presentation of the results.

COURSE OUTCOMES

The students will be able to understand

1. The significance of different types of research and its various stages
2. The different methods of data collection
3. Different methods for analyzing data and interpreting the results.
4. The proper way of reporting and presenting the outcome.

MODULE	COURSE CONTENT (36 hrs)	HRS

I	Research: Meaning & objectives – types of research - identification, selection and formulation of research problem - research design - review of literature. Data collection & presentation: Primary & secondary data - collection methods. Basic statistical measures: Measures of central tendency, variation and skewness.	9
II	Probability:Definition – discrete and continuous probability distributions: binomial, poison, uniform, exponential and normal distributions. Sampling technique: Sampling methods, sampling distribution of mean, variance and proportion, confidence interval estimation, determination of sample size.	9
III	Testing of hypothesis: Fundamentals of hypothesis testing – procedure of hypothesis testing - testing of mean, proportion and variance: one-tailed and two-tailed tests – chi-square test for checking independence of categorized data - goodness of fit test. Test for correlation and regression.	10
IV	Non - parametric tests: One sample tests - sign test, chi-square test, Kolmogorov-Smirnov test, run test for randomness – two sample tests: sign test, median test, Mann-Whitney U test – K-samples tests: median tests, Kruskal-Wallis test. Interpretation and report writing: Meaning of interpretation, techniques of interpretations - types of report, layout of research report.	8
END SEMESTER EXAM (ALL Modules)		

REFERENCES:

1. Panneerselvam, R., "Research methodology", Prentice Hall of India, New Delhi, 2011
2. Kothary, C. R., "Research methodology: methods and techniques", New Age International, New Delhi, 2008
3. Goddard, W. and Melville, S., "Research methodology – an introduction", Juta& Co. Ltd., Lansdowne, 2007
4. Miller and Freund, "Probability and statistics for engineers", Prentice Hall of India

Private Limited, New Delhi

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05ME 6391	COMPUTER INTEGRATED MANUFACTURING LABORATORY I	3-0-0-0	2015

COURSE OBJECTIVES

- To train students in various computer aided modelling techniques using CAD softwares.
- To mould students to be an expert in the field of finite element analysis and also able to undertake problem identification, formulation and solution.
- To assist and support the design, manufacture and testing of products and components for design oriented projects.
- To emphasize the applications of DOE in the field of computer integrated manufacturing.

List of Exercises / Experiments

1. 3D solid modeling and assembly using any parametric software.
2. Synthesis of simple mechanisms using any parametric software.
3. Finite Element Analysis (FEA) :-
    - Pre-processing (solid modeling, meshing, analysis setup)solver and
    - post processing (graphical display and report)

    (Exercises include Simple Beam, Plane Stress, Strain, ax-symmetric, 3D Solids).
4. Manufacturing system simulation using software.

5. Design of experiments and analysis of data using software like SPSS, MiniTabetc

(Analysis of mean and ANOVA Application of software)

COURSE OUTCOME:

- The students shall be able to model 3-D CAD renderings.
- Students shall be able to apply FEA for solving problems in various areas.
- The students should have the ability to conduct design of experiments and execute the same to an appropriate professional standard.

REFERENCES:

1. Arbor text, PTC Authorized training manual (PL-830A-01), PTC University, Parametric Training Corporation, 2010.
2. K J bathe, Finite Element Procedures, Prentice Hall, 2007.
3. Abaqus 6.13, Documentation, DassaultSystèms, 2013.
4. Jacob Fish, Ted Belytschko, A First Course in Finite Elements (Paperback), Wiley, 2007.
5. Douglas C. Montgomery, Design and Analysis of Experiments: International Student Version (English) 8th Edition, Wiley.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05ME 6302	COMPUTER AIDED MANUFACTURING	4-0-0-4	2015

COURSE OBJECTIVES

After the successful completion of this course, students will

1. gain a basic understanding of computer numerical control (CNC) machining processes and operations using a combination of G-codes, milling and turning equipment
2. be able to create drawings using commercial solid modeling CAD software
3. be able to program NC codes manually
4. be able to generate NC codes using commercial CAM package
5. have known the current status of CAD/CAM systems in industry

COURSE OUTCOMES

Upon completion of the subject, students should be able to

1. Demonstrate a basic understanding of machining fundamentals including speed and feed calculations, tooling systems, and work-holding systems for CNC milling and turning equipment
2. Demonstrate a basic understanding of numerical controlled (NC) programming strategies
3. Demonstrate an ability to set-up, program, and operate CNC milling and turning equipment and to generate NC code using G-codes to machine parts to specifications.

MODULE	COURSE CONTENT (36 hrs)	HRS
I	**Introduction and design features of CNC machines:** Working principles of typical CNC lathes, turning centre, machining centre, CNC grinders, CNC gear cutting machines, wire cut EDM, turret punch press, CNC press brakes etc. Selection of CNC machine tools. Structure, drive kinematics, gear box, main drive, feed drive, selection of timing belts and pulleys, spindle bearings arrangement and installation. Re-circulating ball screws,	9

	linear motion guide ways, tool magazines, ATC, APC, chip conveyors, tool turrets, pneumatic and hydraulic control systems.	
INTERNAL TEST 1 (Module 1)		
II	**Control systems and interfacing:** Open loop and closed loop systems, microprocessor based CNC systems, block diagram of a typical CNC system, description of hardware and software interpolation systems, standard and optional features of a CNC control system, comparison of different control systems. Feedback devices with a CNC system, spindle encoder.	9
INTERNAL TEST 2 (Module 2)		
III	**Part programming of a CNC lathe:** Process planning, tooling,preset and qualified tools, typical tools for turning and machining centers. Axes definition, machine and work piece datum, turret datum, absolute and incremental programming, tape codes , ISO and EIA codes, G and M functions, tool offset information, soft jaws, tool nose radius compensation, long turning cycle, facing cycle, constant cutting velocity, threading cycle, peck drilling cycle, part programming examples.	10
IV	**Manual part programming of a machining centre:** Co-ordinate systems, cutter diameter compensation, fixed cycles, drilling cycle, tapping cycle, boring cycle, fine boring cycle, back boring cycle, area clearance programs, macros, parametric programming, part programming examples. CAD/CAM based NC programming, features of typical CAM packages.	8
END SEMESTER EXAM (ALL Modules)		

REFERENCES:

1. James Madison, “CNC machining hand book”, Industrial Press Inc., 1996
2. Steve Krar, Arthur Gill, “CNC technology and programming”, McGraw-Hill, 1990
3. Berry Leathan - Jones, “Introduction to computer numerical control”, Pitman, London, 1987

4. Hans B. Kief, T. Fredericx Waters, “Computer numerical control”, MacMillan / McGraw-Hill, 1992
5. Bernard Hodgers, “CNC part programming work book”, City and Guids / Macmillan, 1994.
6. David Gribbs, “An introduction to CNC machining”, Cassell, 1987
7. Sadasivan, T. A. and Sarathy, D., “Cutting tools for productive machining”, Widia (India) Ltd., 1999
8. Radhakrishnan, P., “Computer numerical control machines”, New Central Book Agency, 1992
9. Peter Smid, “CNC programming hand book”, Industrial Press Inc., 2000

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05ME 6304	INDUSTRIAL AUTOMATION	3-0-0-3	2015

COURSE OBJECTIVES

This course Provides comprehensive introduction to fluid power including both hydraulics and pneumatics.

COURSE OUTCOMES

On completion of this course the students will be able to acquire knowledge of the applications of fluid power in various engineering fields work with PLC and understand its application in industry.

MODULE	COURSE CONTENT (36 hrs)	HRS
I	**HYDRAULIC SYSTEMS** Introduction to fluid power system - Hydraulic fluids - functions, types, properties, selection and application. Construction, operation, characteristics and graphical symbols of hydraulic components- pumps, actuators/motors, valves, switches filters, seals, fittings and other accessories	9
INTERNAL TEST 1 (Module 1)		
II	**PNEUMATIC SYSTEMS** Introduction to pneumatic system - Construction, operation, characteristics and symbols of pneumatic components. Air treatment - principles and components. Sensors- types - Characteristics and applications - Introduction to fluidics and MPL.	9
INTERNAL TEST 2 (Module 2)		

III	**HYDRAULIC AND PNEUMATIC CIRCUITS:**Reciprocating circuits, pressure dependant circuits, speed control circuits, pilot operated circuits, simple sequencing circuits, synchronizing circuits, circuits using accumulator, time delay circuits, logic circuits, cascading circuits, feedback control circuits.	10
IV	**PROGRAMMABLE LOGIC CONTROLLER** Development of hydraulic / pneumatic circuits applied to machine tools, presses, material handling systems, automotive systems - packaging industries manufacturing automation. Programmable logic controller-Basic PLC structure, Input / Output processing- Ladder programming. Instruction lists- Latching and internal relays, sequencing, Timers and counters, Shift registers, Master and Jump Control.	8
END SEMESTER EXAM (ALL Modules)		

REFERENCES

1. Anthony Esposito, Fluid Power with applications, Prentice Hall International, 1997
2. Majumdar S. R., Oil Hydraulics, Tata McGraw Hill, 2002
3. W. bolton, Mechatronics, Pearson education Publication
4. Werner Deppert / Kurt Stoll, Pneumatic Application, Vogel verlag, 1986
5. John Pippenger, Tyler Hicks, Industrial Hydraulics, McGraw Hill International Edition, 1980
6. Andrew Parr, Hydraulics and pneumatics, Jaico Publishing House, 2003
7. FESTO, Fundamentals of Pneumatics, Vol I, II and III
8. Hehn Anton, H., Fluid Power Trouble Shooting, Marcel Dekker Inc., NewYork, 1984

9. Thomson, Introduction to Fluid power, Prentcie Hall, 2004

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05ME 6306	FLEXIBLE MANUFACTURING SYSTEMS	3-0-0-3	2015

COURSE OBJECTIVES

1. To provide an understanding of the concepts of flexible manufacturing systems, their components and operational decisions required for controlling such systems.
2. To specify the types of quantitative analysis that may be used with regard to FMS.
3. To study the fundamental concepts and programming of a Programmable Logic Controller (PLC).

COURSE OUTCOMES

Upon completion of this course work, students should be able to:

1. Perform modeling, design and simulation of flexible manufacturing systems.
2. Gain insight about the research areas related to FMS and real-time shop floor control.

MODULE	COURSE CONTENT (36 hrs)	HRS
I	Introduction to FMS: Definition of FMS – types and configuration concepts – types of flexibility. Functions of FMS host computer – FMS host and area controller function distribution. Development and implementation of FMS: Planning phases – integration – system configuration – FMS layouts – simulation – FMS project development steps. Project management – equipment development – host system development – planning - hardware and software development.	9
INTERNAL TEST 1 (Module 1)		
II	Pioneering integrated systems – different flexible systems: molins, chalmersetc – different pallets and fixtures for prismatic and turned parts – prismatic parts machines. Planning and scheduling of FMS: Quantitative Analysis of FMS –	9

	Bottleneck Model – Terminology and symbols, FMS Operational parameters, System performance measures –Extended Bottleneck model-Sizing the FMS - problems.	

INTERNAL TEST 2 (Module 2)		
III	Distributed numerical control: DNC system – communication between DNC computer and machine control unit – hierarchical processing of data in DNC system – features of DNC system specific to FMS. Automated material handling: Functions - types – quantitative analysis of material handling equipments. Design of conveyors and AGV systems. Automated storage: Storage system performance – AS/RS – carousel storage system – WIP storage – interfacing handling and storage with manufacturing.	10
IV	Programmable logic controllers in FMS: Role of PLCs in Manufacturing and Assembly operations in a CIM environment – PLC Input instructions, Outputs. PLC Timer and Counter functions – Creating relay logic diagrams and screen patterns for various operations in FMS from their process control descriptions. Data base in FMS: Manufacturing data systems and data flow-CAD and CAM considerations for FMS – data base systems. Design of automated assembly systems - FMS case studies in aerospace machining, sheet metal fabrication applications - Toyota production system - The Rover LM-500 FMS – The HNH (HattersleyMewmanHender) FMS etc.	8
END SEMESTER EXAM (ALL Modules)		

REFERENCES:

1. Parrish D. J., "Flexible manufacturing", Butterworth – Heinemann Ltd, 1990
2. Groover M. P., "Automation, production systems and computer integrated manufacturing", Prentice Hall India (P) Ltd., 2002
3. Shivanand H. K., Benal M. M and Koti V, "Flexible manufacturing system", New Age International (P) Limited. Publishers, 2006
4. Kusiak A., "Intelligent manufacturing systems", Prentice Hall, Englewood Cliffs, NJ,

1990

5. Joseph Talavage and Roger G. Hannan, Flexible Manufacturing Systems in practice, Marcel Dekker, Inc. New York, 1988.
6. Considine D. M. &Considine G. D., "Standard handbook of industrial automation", Chapman and Hall, London, 1986
7. Viswanadhan N. and Narahari Y., "Performance modeling of automated manufacturing systems", Prentice Hall India (P) Ltd., 1992
8. John W. Webb and Ronald A. Reis "Programmable Logic Controllers", Prentice Hall India (P) Ltd., 2006.
9. Ranky P. G., "The design and operation of FMS", IFS Pub, U. K, 1998

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05ME 6322	SUPPLY CHAIN MANAGEMENT	3-0-0-3	2015

COURSE OBJECTIVES

1. To introduce the major elements of supply chain and the need for supply chain management.
2. To study the role of forecasting and inventory management in supply chain.
3. To discuss sourcing, transportation and logistics decisions in supply chain management.

COURSE OUTCOMES

1. Students will be able to understand how supply chain strategy can provide a competitive edge for organizations
2. Students will learn about the importance of supply chain management and how to apply decision making techniques in an integrated supply chain environment.

MODULE	COURSE CONTENT (36 hrs)	HRS
I	Introduction to supply chain management: Supply chain basics, decision phases in supply chain, supply chain flows, supply chain efficiency and responsiveness, supply chain integration, process view of a supply chain, uncertainties in supply chain, key issues in supply chain management, drivers of supply chain performance. Supply chain coordination, bullwhip effect, developing relationships in the supply chain, resolving conflicts in supply chain relationships, role of information technology in supply chain	9
INTERNAL TEST 1 (Module 1)		
II	Demand forecasting in supply chain: Role of forecasting in supply chain, components of a forecast, forecasting methods, estimating level, trend and seasonal factors, Holt's model, Winter's model, measures of forecast error. Role of aggregate planning in supply chain: Aggregate planning strategies, managing supply and demand in supply chain.	9
INTERNAL TEST 2 (Module 2)		

III	Supply chain inventory: Role of cycle inventory in supply chain, economies of scale, lot sizing for a single product, lot sizing for multiple products, quantity discounts, trade promotions, price discrimination. Role of safety stock in supply chain, determining appropriate level of safety inventory, inventory replenishment policies, measures of product availability.	10
IV	Sourcing decisions in supply chain: Supplier selection and contracts, design collaboration, making sourcing decisions in practice. Transportation decisions: Role of transportation in supply chain, factors affecting transportation decisions. Routing and scheduling in transportation. Logistics: Definition, logistics and SCM, international considerations, inbound logistics, internal logistics and outbound logistics. Reverse logistics, green supply chain.	8
END SEMESTER EXAM (ALL Modules)		

REFERENCES:

1. Sunil Chopra and Peter Meindl, "Supply chain management - strategy planning and operation", PHI
2. Handfield R. B., Nichols Jr. E. L., "Introduction to supply chain management", Pearson Education
3. Raghuram R. and Rangaraj N., "Logistics and supply chain management", Macmillan, 2001
4. Simchi-Levi, D., Kaminsky, P., and Simchi-Levi, E., "Designing & managing the supply chain: concepts, strategies & case studies." 2nd Edition, Tata McGraw-Hill, 2003
5. Agarwal D. K., "A text book of logistics and supply chain management", Macmillan, 2003
6. Srinivasan, G., "Quantitative models in operations and supply chain management", PHI

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05ME 6324	COMPOSITE MATERIAL TECHNOLOGY	3-0-0-3	2015

COURSE OBJECTIVES:

- To provide knowledge of various manufacturing methods of different composite materials, their properties, and their applications.
- To understand machining characteristics of various composite materials.

COURSE OUTCOME:

At the end of this course the student will be able to select appropriate composite materials for specific applications.

MODULE	COURSE CONTENT (36 hrs)	HRS
I	Introduction – Fibre reinforcements – Fabrication, properties and applications of Glass fibres, Boron fibres, Carbon fibres, Aramid fibres, Ceramic fibres – Whiskers – Comparison of fibres: particulate and whisker reinforcements – Matrix materials – Polymers, Metals, Ceramics and their properties.	9
	INTERNAL TEST 1 (Module 1)	
II	**Polymer matrix composites** – Processing of PMCs – Thermoset matrix composites: Hand layup, spray, filamentwinding, pultruion, resin transfer moulding, auctoclave moulding – Thermoplastic matrix composites :Film stacking, diaphragm forming, thermoplastic tape laying, Injection moulding – Interfaces in PMCs:Glass fibre/polymer interface, Aramid fibre/polymer interface – Structure, applications and mechanicalproperties of PMCs – Recycling of PMCs	9
	INTERNAL TEST 2 (Module 2)	
III	**Metal matrix composites** – Types, Metallic matrices: Aluminium, Titanium, Magnesium, copper Alloys –Processingof MMCs: Solid state,	10

	Liquid state, Vapour state ,In-situ – Interface/Interphase in MMCs – Interfacialbonding in MMCs – Mechanical properties, coefficient of thermal expansion, environmental effects,moisture effects – Applications of MMCs – Recycling of MMCs.	
IV	**Ceramic matrix composites:** Introduction – Types – Toughening Mechanism- Processing of CMCs: Cold pressing, sintering, reaction bonding, liquid infiltration, lanxide process – In-situ chemical reaction techniques: Chemical vapour deposition, Chemical vapour impregnation, Sol-gel, C-C Composites. Interface in CMCs. Mechanical Properties and Applications of CMCs – Fatigue behaviors and S-N curves of particle and whisker reinforced CMCs – Hybrid composites – Thermal fatigue – Creep. **Machining of composites-** Traditional (turning, milling, drilling, abrasive machining) and non-traditional (abrasive waterjetmachining, electric discharge machining, ultrasonic, laser–assisted) machining of Composites.	8
END SEMESTER EXAM (All Modules)		

REFERENCES:

1. Autar K. Kaw, "Mechanics of Composite Materials'', CRC press.
2. Chawla K.K., "Composite Materials: Science and Engineering", Springer, New York.
3. Jahanmir S., Ramulu, M. and Koshy, P., "Machining of Ceramics and Composites", Marcel Dekker Inc, New York, 1999.
4. Mallick P.K., "Fiber Reinforced Composites: Materials, Manufacturing and Design", CRC Press, New Delhi.
5. Sheikh-Ahmad J.Y., "Machining of Polymer Composites", Springer.
6. Hull D. and Clyne T.W., "An Introduction to Composite Materials", Cambridge University Press.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05ME 6326	SIMULATION OF MANUFACTURING SYSTEMS	3-0-0-3	2015

COURSE OBJECTIVES

1. Expose the students to Discrete-Event Simulation as a design and analysis tool, problem solving tool, risk analysis tool, and decision-making tool in manufacturing environment.
2. Know how to conduct a successful simulation using software such as Matlab

COURSE OUTCOMES:

After completing the course students should be able to:

1. understand the nature of discrete-event simulation and the types of simulation models
2. understand the broad applicability of discrete-event simulation to solve complex manufacturing systems problems
3. learn the essential steps of the simulation methodology
4. learn analytical techniques for interpreting input data and output results pertinent to simulation models
5. learn to use Simulation Software Tool to build credible valid simulation models, design and run simulation experiments, and critically evaluate decision-support simulation results
6. gain insight into system behavior by measuring the performance characteristics of proposed new manufacturing system or the impact of proposed changes for existing manufacturing system.

MODULE	COURSE CONTENT (36 hrs)	HRS
I	**System concept:** Systems and system environment, components of a system, discrete and continuous systems, systems approach to problem solving, types of system study, system analysis, system design and system postulation, system modeling, types of models. **System simulation:** Technique of simulation, comparison of simulation and analytical methods, types of system simulation, steps in simulation study, Monte Carlo simulation. **Concepts in discrete event simulation:** Event scheduling/time advance algorithm, modeling world views, simulation programming tasks,	9

	comparison and selection of simulation languages.	
INTERNAL TEST 1 (Module 1)		
II	**Random number generation:** Techniques for generating random numbers, linear congruential method, test for random numbers, frequency tests, run tests, tests for autocorrelation, gap test, and Poker test. **Random variate generation:** Inverse transformation technique, exponential, uniform, weibull, triangular, empirical-discrete and continuous distributions. Convolution method, acceptance - rejection technique. **Input modeling for simulation:** Data collection, identifying the distribution with data, parameter estimation, goodness of fit test, Chi square, Klomogrov and Smirnov tests, selecting input model when data are not available.	9
INTERNAL TEST 2 (Module 2)		
III	**Verification and validation of simulation models:** Verification of simulation models, calibration and validation of models, face validity, validation of model assumption, validating input-output transformation, input-output validation using historical input data. **Output analysis for a single model:** Measures of performance and their estimation, point estimation, interval estimation, output analysis for terminating simulations and steady state simulations.	10
IV	**Simulation modeling and analysis of manufacturing systems:** Objectives, performance measures, issues in simulation of manufacturing systems, simulation software for manufacturing applications, simulation of job shop manufacturing systems, simulation modeling and analysis of single server and single queue systems, inventory systems and pert networks.	8
END SEMESTER EXAM (All Modules)		

REFERENCES:

1. Banks, J., Carson, J. S., Nelson, B. L., and Nicol, D. M., "Discrete-event system simulation", Third Edition, Pearson Education, Inc., 2001
2. Gordon G., "System simulation", Prentice Hall Ltd. 1991
3. Deo, N., "System simulation with digital computer", Prentice Hall of India, 1997
4. Askin R. G. and Standridge, C. R., "Modeling and analysis of manufacturing systems", John Wiley & Sons, 1993.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05ME 6332	INDUSTRIAL ROBOTICS	3-0-0-3	2015

COURSE OBJECTIVES:

1. To be familiar with the automation and brief history of robot and applications.
2. To give the student familiarities with the kinematics of robots.
3. □o give knowledge about robot end effectors and their design.
4. To learn about Robot Programming methods & Languages of robot.
5. To give knowledge about various Sensors and their applications in robots.

COURSE OUTCOMES:

1. Students will be equipped with the automation and importance of robotics in today and future goods production.
2. Students will be familiarized with the kinematic motions of robot.
3. Students will have good knowledge about robot end effectors and their design concepts.
4. Students will be equipped with the Programming methods & various Languages of robots.
5. Students will be equipped with the principles of various Sensors and their applications in Robots.

MODULE	COURSE CONTENT (36 hrs)	HRS
I	**FUNDAMENTAL CONCEPTS OF ROBOTICS** History, present status and future trends, robotics and automation, laws of robotics, robot definition, robotics systems and robot anatomy, specification of robots. Resolution, repeatability and accuracy of a manipulator.	9
	INTERNAL TEST 1 (Module 1)	
II	**ROBOT DRIVE MECHANISMS** Power transmission systems and control robot drive mechanisms, mechanical transmission method, rotary-to-rotary motion conversion, rotary-to-linear motion conversion, end effectors- types, gripping problem,	9

	remote-centered compliance devices - control of actuators in robotic mechanisms. Sensors for robotic applications: devices - non-optical-position sensors - optical position sensors - velocity sensors - proximity sensors: - contact and non-contact type - touch and slip sensors - force and torque sensors - AI and robotics	
INTERNAL TEST 2 (Module 2)		
III	**COMPUTER VISION FOR ROBOTICS SYSTEMS** Robot vision systems - imaging components - image representation - hardware aspects - picture coding - object recognition and categorization - visual inspection - software considerations - applications - commercial - robotic vision systems. **COMPUTER CONSIDERATIONS FOR ROBOTIC SYSTEMS:** Computer architecture for robots, hardware, computational elements in robotic applications - robot programming - sample programs - path planning - robot's computer system.	10
IV	**TRANSFORMATIONS, APPLICATIONS:** Homogeneous co-ordinates, co-ordinate reference frames, homogeneous transformations for the manipulator, the forward and inverse problem of manipulator kinematics, motion generation, manipulator dynamics, Jacobian in terms of D. H. matrices controller architecture. Robot programming of commercial robots - robot design and process specifications - motor selection in the design of a robotic joint - robot cell layouts - economic and social aspects of robotics, Capabilities of robots-robotics applications - obstacle avoidance - robotics in India - the future of robotics.	8
END SEMESTER EXAM (All Modules)		
REFERENCES:		

1. S.K Saha, “Introduction to Robotics”, McGraw Hill Education, 2008
2. Mikell P Groover, Mitchell Weiss, Roger N Nagel, Nicholas G Odrey, “Industrial Robotics”, McGraw Hill Book Co, NY, 2008.
3. Deb S R, "Robotics Technology and Flexible Automation", Tata McGraw Hill Book Co., 2004.
4. Fu KS, Gomaler R C and Lee C S G., "Robotics: Control Sensing, Vision, Intelligence", McGraw Hill Book Co., 1987.
5. Shuman Y No, "Handbook of Industrial Robotics", John Wiley and Sons, New York, 1985.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05ME 6334	PRECISION AND MICROMACHINING	3-0-0-3	2015

COURSE OBJECTIVES

1. To discuss the principles of micromachining.
2. To introduce the basic concepts in laser beam machining.
3. To study the various advanced finishing processes and their applications.

COURSE OUTCOMES

On successful completion of this course, students will be able to:

1. Gain an insight into the various aspects of laser beam machining.
2. Have a good understanding of the theories of cutting and chip formation in micro and nano engineering.
3. Acquire knowledge in the mechanism of material removal and machinability of materials in advanced finishing processes.

MODULE		HRS
I	Laser beam machining: Lasers basics - integration of laser system for cutting operation - principles of laser material removal – detailed discussion on process analysis, absorbed laser power at the cut front, exothermic heat in reactive laser cutting - characteristics of cut front, temperature at cut front, melt film thickness, melt flow velocity, mobility of cut front- characteristics of cut surface, striation, thermal dynamic instability, hydrodynamic instability - heat-affected zone - processing parameters, cutting speed, laser beam, polarization of beam, wavelength of laser beam, pulsed laser beam etc, gas nozzle etc - workpiece aspects for laser beam machining, workpiece thickness, workpiece materials.	9
II	Mechanical micromachining: microfluidic systems - theory of micromachining; micromilling force analysis, initial chip curl modeling, burr formation in micromachining - micromachining tool design - high	9

	speed air turbine spindles- mechanical design of high-speed rotors, basic geometry of the rotor, rotor with fillet surfaces.	
III	Nanomachining: Introduction, nanometric machining, theoretical basis of nanomachining, cutting force and energy, cutting temperature, chip formation and surface generation, minimum undeformed chip thickness, critical cutting edge radius, properties of workpiece materials, comparison of nanometric machining and conventional machining- implementation - single point diamond turning.	10
IV	Advanced finishing processes (AFPs), abrasive flow machining (AFM), magnetic abrasive finishing (MAF), elastic emission machining (EEM), ion beam machining (IBM), microhoning , superfinishing and chemical mechanical polishing (CMP). Micromachining by photonic beams- excimer laser- model construction of laser dragging, numerical simulation of dragged profile. Micromanufacturing for document security: Optically variable device - ODV foil microstructures- generic OVD microstructures- nano CODES.	8
END SEMESTER EXAM (All Modules)		

REFERENCES:

1. Paulo Davim J, "Nontraditional machining processes", ISBN 978-1-4471-5179-1, Springer-Verlag, London, 2013.
2. Hong Hocheng and Hung-Yin Tsai, "Advanced analysis of nontraditional machining", Springer.
3. NitaigourPremchandMahalik, "Micromanufacturing and nanotechnology"
4. Joseph McGeough, "Micromachining of engineering materials mechanical engineering", ISBN: 0-8247-0644-7.
5. M. Kahrizi, "Micromachining techniquess for fabrication of micro, nano structures".
6. Mark J. Jackson, "Micro and nanomanufacturing", Springer.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05ME 6336	MICRO AND NANO MANUFATURING	3-0-0-3	2015

COURSE OBJECTIVES

1. To discuss the various manufacturing processes of MEMS and semiconductor devices.
2. To study size-effects and material/interface behaviour at the micro-/nano scale.
3. To study the structure, properties and applications of carbon based nanostructures.

COURSE OUTCOMES

1. A good understanding of the fundamentals associated with manufacturing at the micro and nano scale.
2. In depth knowledge of micro and nano structures and their processing methods and techniques.

MODULE		HRS
I	Characterizing etching processes in bulk micromachining - microfabrication of MEMS and semiconductor devices -basics of microfabrication, integrated circuit fabrication etc - crystallography and its effects, silicon as substrate and structural material, stress and strain, - crystal plane effects on etching, wet etching process, reaction phenomena, anisotropic etching, isotropic etch curves, masking for anisotropic etchants, etching control, fusion bonding of silicon on an insulator, deep reactive ion etching, fabrication of a cantilever probe, manufacture, microprocessors etc and applications- problems with etching in bulk micromachining.	9
II	Photolithography: Principle of the soft lithography and applications - principle of microcontact printing and applications - characterizing the surface micromachining process, isolation layer, sacrificial layer, structural material, selective etching – properties, stress, stress measurement, stiction - wafer bonding: anodic and fusion, bonding. Micro and nanotechnology: Applications for space micropropulsion - subsystems and devices for miniaturised spacecraftsmicropropulsion: microbolomete, micro FEEP,	9

	integrated cold-gas microthruster, microturbogas, pyrotechnic actuator and microvalveetc - propulsion systems: solid propellant, ADCS etc.	
III	Carbon nanotube production and applications: Basis of nanotechnology - structure and properties of carbon nanotubes- production of carbon nanotube: chemical vapour deposition, arc discharge, laser ablation, mechanisms of growth, purification of carbon nanotube – applications: electrical transport of carbon nanotubes for FET, Computers, nanodevices for biomedical, X-ray equipment, nanomechanic actuator and artificial muscles, fuel cells, membrane electrode assembly, mechanical and electrical reinforcement of bipolar plates, hydrogen storage etc.	10
IV	Carbon based nanostructures: - Structure of carbon nanotubes, Y-shaped, double helical, bamboo, hierarchical morphology - structure of fullerenes - structure of carbon nanoballsstructure of carbon nanofibers - porous carbon - properties of carbon nanostructures – synthesis - 15 potential applications of nanostructures - composite materials - nanotechnology for fuel cell applications: nanoparticles in heterogeneous catalysis, O2 electroreduction reaction on carbonsupportedPt catalysts, carbon nanotubes as catalyst supports.	8
END SEMESTER EXAM (All Modules)		

REFERENCES:

1. NitaigourPremchandMahalik, “Micromanufacturing and nanotechnology”, Springer.
2. M. Kahrizi, “Micromachining techniquess for fabrication of micro, nano structures”.
3. Mark J. Jackson, “Micro and nanomanufacturing”, Springer
4. Jeremy Ramsden, “Micro &nano technologies”, Elsevier.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05ME 6366	**SEMINAR I**	**0-0-2-2**	**2015**

Each student shall prepare a seminar paper on any topic of interest related to the core/elective courses being undergone in the second semester of the M. Tech. programme. He/she shall get the paper approved by the Programme Coordinator/Faculty Members in the concerned area of specialization and shall present it in the class in the presence of Faculty in-charge of seminar class. Every student shall participate in the seminar. Grade will be awarded on the basis of the student's paper, presentation and his/her participation in the seminar.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05ME 6388	MINI PROJECT	0-0-2-2	2015

The mini project is designed to develop practical ability and knowledge about practical tools/techniques in order to solve the actual problems related to the industry, academic institutions or similar area. Students can take up any application level/system level project pertaining to a relevant domain. Projects can be chosen either from the list provided by the faculty or in the field of interest of the student. For external projects, students should obtain prior permission after submitting the details to the guide and synopsis of the work. The project guide should have a minimum qualification of ME/M.Tech in relevant field of work. At the end of each phase, presentation and demonstration of the project should be conducted, which will be evaluated by a panel of examiners. A detailed project report duly approved by the guide in the prescribed format should be submitted by the student for final evaluation. Publishing the work in Conference Proceedings/ Journals with National/ International status with the consent of the guide will carry an additional weightage in the review process.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05ME 6392	COMPUTER INTEGRATED MANUFACTURING LABORATORY II	0-0-2-1	2015

COURSE OBJECTIVES:

- To provide high quality laboratory experience for post graduate students in areas of manufacturing automation and computer assisted and computer controlled manufacturing.
- To familiarize students with the interdisciplinary nature of the course and embellish their experience in the field of instrumentation.
- To equip students with the current tools for design & manufacturing.
- To expertise students in the field of reverse engineering and PLC programming.

List of Exercises / Experiments

1. Programming of CNC lathe using software.
2. Programming of machining centre using software.
3. Automation using pneumatics
4. Automation using power hydraulics
5. Automation using PLCs for pneumatic control
6. Study of process control simulator.
7. PLC programming and implementation.
8. Transducer interface with PC.
9. Stepper motor and servo motor interface with PC.
10. Process capability evaluation based on inspection data.

COURSE OUTCOME:

Students who successfully complete this course will have enhanced knowledge in computer integrated manufacturing systems and better understanding of various aspects of CAM systems. They will know to use modern technologies in their academic and future life.

REFERENCES:

1. Arbor text, PTC Authorized Training Manual (pl-830a-01), PTC University, Parametric Training Corporation, 2010.
2. L.A. Bryan, Programmable Controllers Theory and Implementation, second edition, Industrial Text Publication.
3. Kevin Otto, Product Design: Techniques in Reverse Engineering and New Product Development (english) 1st Edition, Pearson.
4. Bruno Siciliano, OussamaKhatib, Springer Handbook of Robotics, Springer, 2008.
5. Margolis, Arduino Cookbook, Oreilly, 2012.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05ME 7341	PRODUCTION SCHEDULING	3-0-0-3	2015

COURSE OBJECTIVES

1. To introduce theory and algorithms for scheduling several tasks over time
2. To provide an understanding of measures of performance, single machine scheduling and flowshop scheduling
3. To study line balancing algorithms and project scheduling techniques

COURSE OUTCOMES

Students should be able to:

1. Apply the concepts of sequencing and scheduling on the factory floor
2. Have knowledge about the fundamental research topics in the field of production scheduling

MODULE		HRS
I	Introduction to scheduling – objectives in scheduling - processing characteristics and constraints – performance measures. Single machine scheduling – sequencing theorems - SPT rule to minimize mean flow time, EDD rule to maximum lateness – branch and bound technique to minimize mean tardiness – assignment model. Parallel processors – minimization of makespan, mean weighted flowtime - McNaughton's algorithm, heuristic procedures.	9
II	Flow shop scheduling – Extension of Johnsons's rule for 3 machine problem – branch and bound technique – Palmer's heuristic. Job shop scheduling – introduction to dispatching rules – SPT, FCFS, MWKR, MOPNR, LWKR, RANDOM – two jobs and m machines scheduling - Giffler and Thomson algorithm.	9
III	Mass production management - basic idea of assembly line balancing - optimization of number of stations with given production rate -	10

	minimization of cycle time with fixed number of stations. Line balancing algorithms – largest candidate rule, Kilbridge and Wester, rank positional weight method, COMSOAL.	
IV	Project scheduling – project network – AOA and AON - Gantt chart – critical path scheduling – probabilistic method for project scheduling – deployment of resources – activity time/cost trade-off analysis, resource leveling and resource allocation.	8
END SEMESTER EXAM (All Modules)		

REFERENCES:

1. R. Paneerselvam, "Production and operations management", Prentice-Hall, New Delhi, 2005
2. Roberta S. Russell and Bernard W. Taylor III, "Operations management", Pearson Education, Delhi, 2003
3. Kenneth R. Baker, "Introduction to sequencing and scheduling", John Wiley and Sons, 1974
4. Michael Pinedoo, "Scheduling: theory, algorithms and systems", Prentice Hall, New Delhi, 1995.
5. Wild, R., "Mass production management", John Wiley and Sons, New York.

05ME 7343	COURSE NAME	L-T-P-C	YEAR
05ME 7343	**DESIGN FOR MANUFACTURING AND ASSEMBLY**	**3-0-0-3**	**2015**

COURSE OBJECTIVES:-

1. To introduce the concept and application for design for manufacturing and assembly to practicing designers and manufacturing engineers as well as design students
2. To discuss various fundamentals of assembly and design recommendations for product development
3. The student will be able to reduce a company's production costs by analyzing and eliminating the factors that greatly affect the time, cost, and quality of manufacturing, assembly and service processes.
4. Utilize effective analysis, brainstorming, and trade-off techniques for redesigning assemblies and subassemblies.

COURSE OUTCOMES:-

1. Understanding various types of materials, its classification, suitable materials for product design and various methods of material selection, various mechanical properties of material.
2. Understanding various casting design, machining design, designing of formed .

1.

MODULE		HRS
I	**Process capability and tolerances:** Process capability, mean, process capability metrics, Cp, Cpk, cost aspects, feature tolerances, geometric tolerances - ISO standards - surface finish, review of relationship between attainable tolerance grades and different machining and sheet metal processes. Cumulative effect of tolerances - worst case method, root sum square method, dimensions following truncated normal distributions, Monte Carlo Simulation.	9

	Selective assembly: Interchangeable past manufacture and selective assembly, deciding the number of groups - Model-I: Group tolerances of mating parts equal; Model-II: total and group tolerances of shaft equal. Control of axial play - introducing secondary machining operations, laminated shims, examples.	
II	**Datum systems and fixture design:** Degrees of freedom, grouped datum systems - different types, two and three mutually perpendicular grouped datum planes; grouped datum system with spigot and recess, pin and hole; grouped datum system with spigot and recess pair and tongue - slot pair - computation of translational and rotational accuracy, geometric analysis and applications. **True position theory:** Comparison between co-ordinate and convention method of feature location, tolerancing and true position tolerancing, virtual size concept, floating and fixed fasteners, projected tolerance zone, zero true position tolerance, functional gauges, paper layout gauging, compound assembly, examples.	9
III	**Form design of castings, weldments and sheet metal components:** Redesign of castings based on parting line considerations, minimising core requirements, redesigning cast members using weldments, form design aspects of sheet metal components. **Tolerance charting technique:** Operation sequence for typical shaft type of components. Preparation of process drawings for different operations, tolerance worksheets and centrality analysis, examples.	10
IV	**Redesign for manufacture:** Design features to facilitate machining: datum features - functional and manufacturing. Component design - machining considerations, redesign for manufacture, examples. **DFMA tools:** Computer aided DFMA, Poke Yoka principles, axiomatic design method, quality function deployment, design for six sigma, lean	8

	manufacturing, waste identification and elimination, value stream mapping, sensor interface for fool-proof system design.	
END SEMESTER EXAM (All Modules)		

REFERENCES:

1. Harry Peck, "Designing for manufacture", Pitman Publications, 1983
2. Matousek, "Engineering design - a systematic approach", Blackie and Son Ltd., London, 1974
3. Micheal Wader, "Lean tools: a pocket guide to implementing lean practices", Productivity and Quality Publishing Pvt Ltd., 2002
4. Spotts M. F., "Dimensioning and tolerance for quantity production", Prentice Hall Inc., 1983
5. Oliver R. Wade, "Tolerance control in design and manufacturing", Industrial Press Inc., New York, 1967
6. James G. Bralla, "Hand book of product design for manufacturing", McGraw Hill, 1983
7. Trucks H. E., "Design for economic production", Society of Manufacturing Engineers, Michigan, Second Edition, 1987
8. Poka - Yoke, "Improving product quality by preventing defects", Productivity Press, 1992
9. Basem Said El-Haik, "Axiomatic quality", John Wiley and Sons, 2005

05ME 7343	COURSE NAME	L-T-P-C	YEAR
05ME 7345	**LEAN MANUFACTURING**	**3-0-0-3**	**2015**

COURSE OBJECTIVES:

Upon completion of this course the student will be able

1. To design a globally competitive manufacturing organisation using lean manufacturing principles.
2. To develop the skills to implement lean manufacturing in industry and manage the change process to achieve continuous improvement of efficiency and productivity.

COURSE OUTCOMES:

After successful completion of this course the students will

1. Identify and understand the key requirements and concepts in lean manufacturing and to initiate a continuous improvement change program in a manufacturing organization
2. Apply the tools in lean manufacturing to analyse a manufacturing system and plan for its improvements.
3. Manage the manufacturing system to achieve six sigma quality and sustainability.

MODULE		HRS
I	**Lean manufacturing:** Basics, principles & elements **Small-lot production:** Lot-size basics; lot sizing; lot-size reduction; facilitating small lot size. **Setup-Time reduction:** Setup reduction methodology; techniques for setup-reduction; setup reduction projects.	9
II	**Pull production systems:** Pull systems and push systems; conditions for pull production systems; how to achieve pull production; mechanisms for signal and control. **Workcells and cellular manufacturing:** Cell layout and capacity measures; design of workcells; worker assignment; implementation issues.	9

III	**Scheduling for smooth flow:** Production leveling; level scheduling in pull production; master production scheduling. **Synchronising and balancing process:** Synchronisation; bottleneck scheduling; balancing; adapting to schedule changes	10
IV	**Planning and control in pull production:** Centralised planning and control system; decentralised planning and control system; adapting MRP-based production planning and control system to pull production **Maintaining and improving equipment:** Equipment maintenance; equipment effectiveness; total productive maintenance.	8
END SEMESTER EXAM (All Modules)		

REFERENCES:

1. Harold J. Steudel and Paul Desruelle, "Manufacturing in the nineties – how to become a lean, world - class competitor", Van Norstrand Reinhold, New York, 1992
2. John Nicholas, "Competitive manufacturing management - continuos improvement, lean production, and customer-focused qualities", McGraw Hill International Edition, 1998
3. Ronald G. Askin& Jeffrey B. Goldberg, "Design and analysis of lean production systems", John Wiley & Sons, 2003

05ME 7343	COURSE NAME	L-T-P-C	YEAR
05ME 7351	**SUSTAINABLE MANUFACTURING**	**3-0-0-3**	**2015**

COURSE OBJECTIVES:

To introduce students to the realm of sustainable engineering and inculcate in them the modern trends and challenges in the area of manufacturing related to the concepts of sustainability and environmental problems related to manufacturing, green engineering, etc.

COURSE OUTCOMES:

1. The importance of sustainable engineering will be thoroughly understood by students on the completion of the syllabus.
2. As the members of engineering community, students will be motivated to think about sustainability in various stages of manufacturing and their responsibility levels in the conservation of environment are expected to be enhanced, while achieving the organizational goals.

MODULE		HRS
I	**SUSTAINABLE MANUFACTURING AND EMS:** Sustainable Manufacturing –Evolution of Sustainable Manufacturing - Product Design for Sustainability – introduction to ISO 14000 series standards - Concepts of ISO 14001 - requirements of ISO 14001 – Environmental Management System – frame work and benefits - Environmentally Conscious Manufacturing.	9
II	**GREEN MANUFACTURING**: Drivers of green production within business - Role of green production in competitive strategy - Motivations and Barriers to Green Manufacturing - Strategies for Green Manufacturing -Zero Emission Strategy - Environmental Impact of Manufacturing - The Development of Eco Labelling Schemes – guiding principles.	9

III	**RECYCLING & LIFE CYCLE ASSESSMENT:** Industrial Ecology - key concepts - System Tools to Support Industrial Ecology –Life Cycle Design Methods-Life Cycle Assessment (LCA)– components and use – planning for LCA- Reclamation and Recycling of steel - postconsumer and pre consumer recycled material.	10
IV	**ENVIRONMENTAL ATTRIBUTES OF MANUFACTURING:** Environment process characterization- Manufacturing process inventory- input & outputs of casting, plastic processing, machining operations, forming operations, surface treatment and joining. Environmentally responsible manufacturing –general techniques. Environmental Footprint Analysis - Carbon and water footprint analysis - need to reducethe carbon footprint of manufacturing operations –Value stream mapping-Application of Value Stream Mapping to Eliminate Waste.	8
END SEMESTER EXAM (All Modules)		

REFERENCES:

1. Madu, C.N., "Handbook of Environmentally Conscious Manufacturing", Kluwer Academic Publisher, 2001.
2. Gupta, S.M. and Lambert, A.J.D., "Environment Conscious Manufacturing", CRC Press, 2008.
3. Swamidass, P.M., "Encyclopedia of Production and Manufacturing Management", Kluwer Academic Publisher, 2000.
4. Kutz, M.," Environmentally Conscious Mechanical Design", John Wiley & Sons, 2007.
5. Davim, J.P., "Sustainable Manufacturing", John Wiley & Sons, 2010.
6. Green manufacturing fundamentals and application, edited by David A. Dornfeld, springer publication, (2012)

05ME 7343	COURSE NAME	L-T-P-C	YEAR
05ME 7353	**FINITE ELEMENT METHOD**	**3-0-0-3**	**2015**

COURSE OBJECTIVES:

Upon completion of this course the student will be able to accomplish the following competencies

1. To provide the fundamental concepts of the theory of the finite element method.
2. To enable the students to formulate the design problems into FEM.
3. To introduce basic aspects of finite element technology, including domain discretization, polynomial interpolation, application of boundary conditions, assembly of global arrays, and solution of the resulting algebraic systems.
4. Develop finite element formulation of engineering problems from a variety of application area including stress, heat transfer and vibration analysis

COURSE OUTCOMES:

On completion of this course the student will

1. Understanding the fundamental theory of the FEA method;

2. Develop the ability to generate the governing FE equations for systems governed by partial differential equations;

3. Understand the use of the basic finite elements for structural applications using truss, beam, frame, and plane elements; and

4. Understand the application and use of the FE method for heat transfer problems.

MODULE		HRS
I	Basic concepts of FEM – a general procedure for finite element analysis, brief history of finite element method, linear spring as a finite element, elastic bar, spar/link/truss element. Strain energy, Castigliano's first theorem, minimum potential energy.	9
II	Truss structures: The direct stiffness method – Nodal equilibrium equation, element transformation and direct assembly of global stiffness matrix, boundary conditions, constraint forces, element strain and stress, three dimensional trusses.	9

	Flexure - elements – elementary beam theory, flexure element, flexure element stiffness matrix and element load vector, work equivalence for distributed loads, flexure element with axial loading.	
III	Method of weighted residuals – introduction, method of weighted residuals, the Galerikin finite element method, application of Galerikin's method to structural elements - spar element, beam element. Interpolation function for general element formation – compatibility and completeness requirements, polynomial forms- one dimensional elements, triangular elements, rectangular elements, three dimensional elements, isoperimetric formulations, axisymmetric elements, numerical integration: Gaussian quadrature.	10
IV	Applications in solid mechanics – plane stress, plane strain – rectangular element, isoparametric formulation of plane quadrilateral element, axisymmetric stress analysis, general three dimensional stress – finite clement formulations, strain and stress computations, practical considerations. Torsion – boundary condition, torque. Introduction to FEM software.	8
END SEMESTER EXAM (All Modules)		

REFERENCES:

1. David V Hutton, "Fundamentals of finite element analysis", McGraw Hill
2. Daryl L. Logan, "First course in finite element method", Cengage Learning, Singapore.
3. J. N. Reddy, "An introduction to the finite element method", McGraw Hill
4. C. Zienkiwiez, "The finite element method", McGraw Hill, New York.
5. K. H. Huebner, "The finite element method of engineers", John Wiley & Sons, New York.

   L. J. Segerlind, "Applied finite element analysis", John Wily & Sons, New York.

05ME 7343	COURSE NAME	L-T-P-C	YEAR
05ME 7355	**ARTIFICIAL INTELLIGENCE**	**3-0-0-3**	**2015**

COURSE OBJECTIVES:

1. To introduce the fundamental concepts of artificial intelligence;
2. To equip students with the knowledge and skills in logic programming;
3. To explore the different paradigms in knowledge representation and reasoning;
4. To understand the contemporary techniques in machine learning;
5. To evaluate the effectiveness of hybridization of different artificial intelligence techniques.

COURSE OUTCOMES:

After completing the course students should be able to:

1. Understand the history, development and various applications of artificial intelligence;
2. Familiarize with propositional and predicate logic and their roles in logic programming;
3. Learn the knowledge representation and reasoning techniques in rule-based systems, case-based systems, and model-based systems;
4. Appreciate how uncertainty is being tackled in the knowledge representation and reasoning process, in particular, techniques based on probability theory and possibility theory ;
5. Master the skills and techniques in machine learning, such as decision tree induction, artificial neural networks, and genetic algorithm;

   Apply and integrate various artificial intelligence techniques in intelligent system development as well as understand the importance of maintaining intelligent systems.

MODULE		HRS
I	**Human and machine intelligence:** Concepts of fifth generation computing, programming in AI environment, developing artificial intelligence system, natural language processing, neural networks. **Introduction to fuzzy logic:** Basic concepts in fuzzy set theory – operations of fuzzy sets – fuzzy relational equations – propositional,	9

	predicate logic – inference – fuzzy logic principles – fuzzy inference – fuzzy rule based systems – fuzzification and defuzzification – types.	
II	**Fuzzy logic applications:** Fuzzy logic controllers – principles – various industrial applications of fuzzy logic control – adaptive fuzzy systems – fuzzy decision making – fuzzy classification – fuzzy pattern recognition – image processing applications – fuzzy optimization. **Introduction to artificial neural networks:** Fundamentals of neural networks – neural network architectures – learning methods – taxonomy of neural network architectures – standard back propagation algorithms – selection of various parameters – variations.	9
III	Associative memory – exponential bidirectional associative memory – adaptive resonance theory – introduction – adaptive resonance theory 1 – adaptive resonance theory 2 – applications – Kohenself organizing maps – counter propagation networks – industrial applications. **Expert system development:** Definition, choice of domain, collection of knowledge base, selection of inference mechanism, case studies of expert system development in design and manufacturing.	10
IV	**Industrial application of AI and expert systems:** Robotic vision systems, image processing techniques, application to object recognition and inspection, automatic speech recognition. **Recent advances:** Fundamentals of genetic algorithms – hybrid systems – meta heuristic techniques like simulated annealing,tabu search, ant colony optimization, perpetual self organizing, artificial immune systems – applications in design and manufacturing.	8
END SEMESTER EXAM (All Modules)		

REFERENCES:

1. Robert Levine et al, "A comprehensive guide to AI and expert systems", McGraw Hill

Inc, 1986

2. Henry C. Mishkoff, “Understanding AI”, BPB Publication, New Delhi, 1986
3. Peter Jackson, “Introduction to expert systems”, First Indian Reprint, 2000, Addison Wesley
4. Stuart Russell and Peter Norvig, “Artificial intelligence: a modern approach”, Prentice Hall, 1995
5. Elaine Rich et al., “Artificial intelligence”, McGraw Hill, 1995
6. Winston P H, “Artificial intelligence”, Addison Wesley, Massachusetts, Third Edition, 1992

05ME 7343	**COURSE NAME**	**L-T-P-C**	**YEAR**
05ME 7367	SEMINAR II	**0-0-2-2**	**2015**
Each student shall prepare a seminar paper on any topic of interest related to the core/elective courses being undergone in the second semester of the M. Tech. programme. He/she shall get the paper approved by the Programme Coordinator/Faculty Members in the concerned area of specialization and shall present it in the class in the presence of Faculty in-charge of seminar class. Every student shall participate in the seminar. Grade will be awarded on the basis of the student's paper, presentation and his/her participation in the seminar. .			

05ME 7343	**COURSE NAME**	**L-T-P-C**	**YEAR**
05ME 7387	PROJECT PHASE I	**0-0-8-6**	**2015**

The project (phase I) shall consist of research work done by the candidate or a comprehensive and critical review of any recent development in the subject of specialization or a detailed report of project work consisting of experimentation/numerical work, design and or development work that the candidate has executed.

In phase I of the project it is expected that the student should decide a topic of thesis, which is useful in the field or practical life. It is expected that students should refer national and international journals, proceedings of national and international seminars. Emphasis should be given to the introduction to the topic, literature review, and scope of the proposed work along with some preliminary work/experimentation carried out on the thesis topic.

Student should submit phase I project report in two copies covering the content discussed above and highlighting the features of work to be carried out in part I of the project. Student should follow standard practice of thesis writing.

The candidate will deliver a talk on the topic and the assessment will be made on the basic of the term work and talks there on by a panel of internal examiners one of which will be the internal guide. These examiners should give suggestions in writing to the student to be incorporated in project work phase II.

05ME 7343	**COURSE NAME**	**L-T-P-C**	**YEAR**
05ME 7388	PROJECT PHASE II	**0-0-21-12**	**2015**
In the fourth semester the student has continue project work and after successfully finishing the work, he / she has to submit a detailed bounded thesis report. The work carried out should lead to a publication in a National / International Journal or Conference. They should have submitted the paper before M. Tech. evaluation and specific weightage should be given to accepted papers in reputed journals or conferences.			

KERALA TECHNOLOGICAL UNIVERSITY

SCHEME AND SYLLABUS

FOR

M. Tech. DEGREE PROGRAMME

IN

COMPUTER SCIENCE AND ENGINEERING

WITH SPECIALIZATION

CYBER SECURITY

CLUSTER 05 (ERNAKULAM II)

KERALA TECHNOLOGICAL UNIVERSITY
CET Campus, Thiruvananthapuram
Kerala, India -695016

(2015 ADMISSION ONWARDS)

KERALA TECHNOLOGICAL UNIVERSITY

SCHEME AND SYLLABUS FOR M. Tech. DEGREE PROGRAMME

Branch: COMPUTER SCIENCE AND ENGINEERING

Specialization: CYBER SECURITY

SEMESTER – I

Exam Slot	***Course No***	***Subjects***	L-T-P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
A	05CS 6201	Mathematical Foundations For Cyber Security	3-1-0	40	60	3	4
B	05CS 6203	Advanced Data Structures and Algorithms	3-1-0	40	60	3	4
C	05CS 6205	Operating Systems And Security	3-1-0	40	60	3	4
D	05CS 6207	Cryptographic Protocols and Standards	2-1-0	40	60	3	3
E	05CS 621x	Elective I	2-1-0	40	60	3	3
	05CS 6277	Research methodology	1-1-0	100	0	0	2
	05CS 6291	Information Security Lab	0-0-2	100	0	0	1

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Elective – I	
Course No	**Subjects**
05CS 6211	Mobile Network Security
05CS 6213	Information Risk Management
05CS 6215	Data Mining and Machine Learning

SEMESTER – II

Exam Slot	*Course No*	*Subjects*	*L-T-P*	*Internal Marks*	*End Semester Exam*		*Credits*
					Marks	Duration (hrs)	
A	05CS 6202	Cyber Forensics	3-1-0	40	60	3	4
B	05CS 6204	Secure Coding	2-1-0	40	60	3	3
C	05CS 6206	Ethical Hacking	3-1-1	40	60	3	3
D	05CS 622x	Elective II	2-1-0	40	60	3	3
E	05CS 623x	Elective III	2-1-0	40	60	3	3
	05CS 6266	Seminar I	0-0-2	100	0	0	2
	05CS 6288	Mini Project	0-0-4	100	0	0	2
	05CS 6292	Ethical Hacking And Digital Forensic Tools Lab	0-0-2	100	0	0	1
							21

Elective – II	
Course No	**Subjects**
05CS 6222	Coding and Information Theory
05CS 6224	Design of Secured Architecture
05CS 6226	Digital Watermarking

Elective – III	
Course No	**Subjects**
05CS 6232	Cryptanalysis
05CS 6234	Distributed and Cloud Computing
05CS 6236	Storage management and Security

SEMESTER – III

Exam Slot	*Course No*	*Subjects*	*L-T-P*	*Internal Marks*	*End Semester Exam*		*Credits*
					Marks	Duration (hrs)	
A	05CS 724x	Elective IV	2-1-0	40	60	3	3
B	05CS 725x	Elective V	2-1-0	40	60	3	3
	05CS 7267	Seminar II	0-0-2	100	0	0	2
	05CS 7287	Project (Phase 1)	0-0-8	50	0	0	6

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Elective – IV	
Course No	**Subjects**
05CS 7241	Cloud Security
05CS 7243	Cyber Laws and Security Policies
05CS 7245	Biometric Security
Elective – V	
Course No	**Subjects**
05CS 7251	Internet Information and application security
05CS 7253	Database Security
05CS 7255	Dependable Distributed Systems

SEMESTER – IV

Exam Slot	*Course No*	*Subjects*	*L-T-P*	*Internal Marks*	*End Semester Exam*		*Credits*
					Marks	*Duration(hrs)*	
	05CS 7288	Project (Phase 2)	0-0-21	70	30	-	12

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Total :68

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05CS 6201	MATHEMATICAL FOUNDATIONS FOR CYBER SECURITY	3-1-0-4	2015

COURSE OBJECTIVES:

- Introduces basic concepts and knowledge in number theory, together with a wide variety of interesting applications of discrete mathematics.
- Train students to solve problems from algorithm design and analysis, coding theory etc and to apply techniques of number theory in cryptography.

COURSE OUTCOMES:

- Number theory is intended to introduce students to number theoretic problems and to different areas of number theory.
- Number theory has many applications especially to coding theory and cryptography.
- Understand the ideas of group, ring and an integral domain and be aware of examples of these structures in mathematics.

MODULE	COURSE CONTENT (56 hrs)	HRS
I	NUMBER THEORY: Introduction - Divisibility - Greatest common divisor - Prime numbers – Fundamental theorem of arithmetic - Mersenne primes - Fermat numbers - Euclidean algorithm - Fermat's theorem - Euler totient function - Euler's theoerem. Congruences: Definition - Basic properties of congruences - Residue classes - Chinese remainder theorem.	14
	INTERNAL TEST 1(Module 1)	
II	ALGEBRAIC STRUCTURES: Groups – Subgroup, Cyclic groups, group homomorphisms, Permutation groups, Cosets, Modulo groups - Primitive roots – Discrete logarithms. Rings – Sub rings, ideals and quotient rings, Integral domains. Rings of polynomials, factorization of polynomials over a field. Fields – Finite fields – GF (p^n), GF(2^n) - Classification - Structure of finite fields.	14
	INTERNAL TEST 2(Module 2)	
III	CODING THEORY: Introduction - Basic concepts: codes, minimum distance, equivalence of codes, Linear codes - Linear codes - Generator matrices and parity-check matrices - Syndrome decoding – Hamming codes - Hadamard Code - Goppa codes.	14
IV	STOCASTIC PROCESS and PSEUDORANDOM NUMBER GENERATION: Random Variables – discrete and continuous- central Limit Theorem-Stochastic Process- Markov Chain. Pseudorandom number	14

	generation: Introduction and examples - Indistinguishability of Probability Distributions - Next Bit Predictors - The Blum-Blum-Shub Generator – Security of the BBS Generator.	
END SEMESTER EXAM (ALL Modules)		

REFERENCES:

1. Ivan Niven, Herbert S. Zuckerman, and Hugh L. Montgomery, 'An introduction to the theory of numbers', John Wiley and Sons 2004.
2. Douglas Stinson, 'Cryptography – Theory and Practice', CRC Press, 2006.
3. Sheldon M Ross, "Introduction to Probability Models", Academic Press, 2003.
4. C.L. Liu, 'Elements of Discrete mathematics', McGraw Hill, 2008.
5. Fraleigh J. B., 'A first course in abstract algebra', Narosa, 1990.
6. Joseph A. Gallian, ''Contemporary Abstract Algebra', Narosa, 1998.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05CS 6203	ADVANCED DATA STRUCTURES AND ALGORITHMS	3-1-0-4	2015

COURSE OBJECTIVES:

- Familiarize with advanced data structures based trees and heaps.
- Learn to choose the appropriate data structure and algorithm design method for a specified application.
- Study approaches used to analyze and design algorithms and to appreciate the impact of algorithm design in practice.
- Learn different advanced algorithms in dynamic programming, flow network
- and computational geometry

COURSE OUTCOMES:

After completion of the course completion, the students will be able

- To compare different implementations of data structures and to recognize the advantages and disadvantages of the different implementations.
- To design, write, and analyze the performance of programs that handle structured data and perform more complex tasks, typical of larger software projects.
- To determine which algorithm or data structure to use in different scenarios.
- To demonstrate analytical comprehension of concepts such as abstract data , algorithms and efficiency analysis

MODULE	COURSE CONTENT (56 hrs)	HRS
I	Trees -Threaded Binary Trees, Selection Trees, Forests and binary search trees, Counting Binary Trees, Red-Black Trees, Splay Trees, Suffix Trees, Digital Search Trees, Tries- Binary Tries-patricia, Multiway Tries.	14
	INTERNAL TEST 1 (Module 1)	
II	Priority Queues - Single and Double Ended Priority Queues, Leftist Trees, Binomial Heaps, Fibonacci Heaps, Pairing Heaps, Symmetric Min-Max Heaps, Interval Heaps	14
	INTERNAL TEST 2 (Module 2)	
III	Analysis of Algorithms-review of algorithmic strategies, asymptotic analysis, solving recurrence relations through Substitution Method, Recursion Tree, and Master Method Dynamic Programming-Rod cutting-top down and bottom up approach, matrix chain multiplication-recursive solution, Longest common subsequence problem	14

IV	Maximum Flow-Flow Networks, Ford-Fulkerson method-analysis of Ford-Fulkerson, Edmonds-Karp algorithm, Maximum bipartite matching Computational Geometry- Line segment properties, Finding the convex hull **,** Finding the closest pair of points. Implementations using Python have to be conducted and evaluated for data structures and algorithms.	14
END SEMESTER EXAM (ALL Modules)		

REFERENCES:

1. Ellis Horowitz, SartajSahni, Susan Anderson Freed, Fundamentals of Data Structures in C, Second Edition, University Press, 2008
2. YedidyahLangsam, Moshe J. Augenstein, Aaron M. Tenenbaum, Data Structures using C and C++, Second Edition, PHI Learning Private Limited, 2010
3. Thomas Cormen, Charles, Ronald Rives, Introduction to algorithm,3rd edition, PHI Learning
4. Ellis Horowitz and SartajSahni, SanguthevarRajasekaran, Fundamentals of Computer Algorithms,Universities Press, 2nd Edition, Hyderabad .
5. Sara Baase& Allen Van Gelder , Computer Algorithms – Introduction to Design and Analysis, Pearson Education..
6. AnanyLevitin, Introduction to The Design & Analysis of Algorithms, Pearson Education, 2nd Edition, New Delhi, 2008.
7. Berman and Paul, Algorithms, Cenage Learning India Edition, New Delhi, 2008.
8. S.K.Basu , Design Methods And Analysis Of Algorithms ,PHI Learning Private Limited, New Delhi,2008.
9. Jon Kleinberg and Eva Tardos, Algorithm Design, Pearson Education, NewDelhi, 2006.
10. Hari Mohan Pandey, Design Analysis And Algorithms, University Science Press, 2008.
11. R. Panneerselvam, Design and Analysis of Algorithms, PHI Learning Private Limited, New Delhi, 2009.
12. UditAgarwal, Algorithms Design And Analysis, DhanapatRai& Co, New Delhi, 2009.
13. Aho, Hopcroft and ullman, The Design And Analysis of Computer Algorithms, Pearson Education, New Delhi, 2007.
14. S.E.Goodman and S. T. Hedetmiemi, Introduction To The Design And Analysis Of Algorithms, McGraw-Hill International Editions, Singapore 2000.
15. Richard Neapolitan, Kumarss N, Foundations of Algorithms, DC Hearth &company.
    Sanjay Dasgupta, Christos Papadimitriou, UmeshVazirani, Algorithms, Tata McGraw-Hill Edition.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05CS 6205	OPERATING SYSTEM AND SECURITY	3-1-0-4	2015

COURSE OBJECTIVES:

- Introduce students to the field of threads and vulnerabilities in OS and how to provide security in different OS.
- Focuses on the study of techniques of fundamentals of protection systems, Information flow and Security kernels. This course also deals with a couple of case studies.

COURSE OUTCOMES:

Upon completion, the student will be able to

- Understand the basic of securing an operating system.
- Understand the principles of trusted systems, Information flow integrity and securing commercial OS.
- Understand the security challenges with the help of case studies.

MODULE	COURSE CONTENT (42 hrs)	HRS
I	Introduction: Secure Os, Security Goals, Trust Model, Threat Model, Access Control. Fundamentals: Protection system, Lampson's Access Matrix, Mandatory protection system. Multics: Fundamentals, multics protection system models, multics reference model, multics security, multics vulnerability analysis.	11
	INTERNAL TEST 1 (Module 1)	
II	Security in ordinary operating system: UNIX security, windows security Verifiable security goals: Information flow, information flow secrecy, models, information flow integrity model, the challenges of trusted, process, covert channels.	11
	INTERNAL TEST 2 (Module 2)	
III	Security Kernels: The Security Kernels, secure communications, processor Scomp, Gemini secure OS, Securing commercial OS, Retrofitting security into a commercial OS, History Retrofitting commercial OS, Commercial era, microkernel era, UNIX era-IX, domainand type enforcement.	10
IV	Case study: Solaris Extensions Trusted extensions, access control, Solaris compatibility, trusted extensions, mediations process rights management, role based access control, trusted extensions, networking trusted extensions, multilevel services, trusted extensions administration. Case study: Building secure OS for Linux: Linux security modules, security enhanced Linux.	10

END SEMESTER EXAM (ALL Modules)
REFERENCES: 1. Trent Jaeger, Operating system security, Morgan & Claypool Publishers, 2008 2. Michael Palmer, Guide to Operating system Security Thomson 3. Andrew S Tanenbaum, Modern Operating systems, 3rd Edition 4. Secure Operating Systems. John Mitchell. Multics-Orange Book-Claremont 5. Reading: Nachenberg, Computer Virus-Antivirus Coevolution. Comm. ACM, 40(1), pp. 46-51, January 1997. 6. Paxson, Bro: A System for Detecting Network Intruders in Real-Time. Proc. 7th USENIX Security Symposium, San Antonio, TX, January 1998

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05CS 6207	CRYPTOGRAPHIC PROTOCOLS AND STANDARDS	3-1-0-3	2015

COURSE OBJECTIVES:

- To Enable Learner to understand various goals for designing a secure authentication and key establishment protocols.
- Analyze various existing protocols in terms of the goals.

COURSE OUTCOMES:

- Will able to design a key agreement or key transport or key establishment protocol satisfying various security goals.
- Will able to verify the security of a cryptographic protocol designed and analyzes the complexity of it.

MODULE	COURSE CONTENT (56 hrs)	HRS
I	Goals for authentication and Key Establishment: Basic Goals, Enhanced Goals, Goals concerning compromised Keys, Formal Verification of Protocols, Complexity Theoretic Proofs of Security.	14
	INTERNAL TEST 1 (Module 1)	
II	Protocols Using Shared Key Cryptography: Entity Authentication Protocols, Server-Less Key Establishment, Server-Based Key Establishment, Key Establishment Using Multiple Servers.	14
	INTERNAL TEST 2 (Module 2)	
III	Authentication and Key Transport Using Public Key Cryptography: Design Principles for Public Key Protocols, Entity Authentication Protocol, Key Transport Protocols. Key Agreement Protocols: Key Control, Unknown Key-Share Attacks, Classes of Key Agreement: Diffie-Hellman Key Agreement, MTI Protocols, Diffie-Hellman-Based Protocols with Basic Message Format and with Enhanced Message Format. ID based schemes: Okamoto's scheme, Gunther's scheme, Girault's scheme.	14
IV	Conference Key Protocols: Generalizing Diffie-Hellman Key Agreement, Conference Key Agreement Protocols, Identity-Based Conference Key Protocols, Conference Key Agreement without Diffie-Hellman, Conference Key Transport Protocols, Key Broadcasting Protocols	14

END SEMESTER EXAM (ALL Modules)

REFERENCES:

1. Collin Boyd and AnishMathuria, "Protocols for Authentication and Key Establishment", Springer; 2010.
2. Abhijith Das and C.E. VeniMadha van, "Public-key Cryptography, Theory and Practice", Pearson Education, 2009.
3. Alfred J. Menezes, Paul C. Van Oorschot and Scott A. Vanstone, "Handbook of Applied Cryptography", CRC Press, 1996.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05CS 6211	MOBILE NETWORK SECURITY	3-1-0-3	2015

COURSE OBJECTIVES:

The main objective of the course is to introduce the students to security and privacy problems in the realm of wireless networks

- Creates Understanding about the basics of wireless technologies and security.
- Gain in - depth knowledge on wireless and mobile network security and its relation to the new security based protocols
- Apply proactive and defensive measures to counter potential threats, attacks and intrusions
- Design secured wireless and mobile networks that optimize accessibility whilst minimizing vulnerability to security risks

COURSE OUTCOMES:

Upon completion, the student will be able to

- Identify and investigate in-depth both early and contemporary threats to mobile and wireless networks security.
- Apply proactive and defensive measures to deter and repel potential threats, attacks and intrusions.
- Develop a clear view of integrated security environments consisting of both similar and diverse wireless access technologies and security architectures.

MODULE	COURSE CONTENT (42 hrs)	HRS
I	Transmission Fundamentals: Antennas and Wave Propagation. Cellular Wireless networks, Third Generation Systems, 4G Long Term Evolutions, Signal Encoding Techniques, Spread Spectrum, Coding and Error Control, Multiple Access in Wireless Systems.	11
	INTERNAL TEST 1 (Module 1)	
II	Satellite Networks, Wireless System Operations and Standards, Wi-Max an Ultra Wide Band technologies, Mobile IP and Wireless Access Protocol. Wireless LAN Technology, Wi-Fi and IEEE 802.11 Wireless LAN Standard, Blue-tooth and IEEE 802.15 standard.	11
	INTERNAL TEST 2 (Module 2)	
III	Threats to Wireless networks, ESM, ECM and ECCM, Proliferation of device and technologies, Practical aspects, Wireless availability, Privacy Challenges, Risks: Denial of Service, Insertion Attacks, Interception and monitoring wireless traffic, MIS configuration, Wireless Attacks, Surveillance, War Driving, Client-to-Client Hacking, Rogue Access Points, Jamming and Denial of Service.	10

IV	Authentication, Encryption/Decryption in GSM, Securing the WLAN, WEP Introduction, RC4 Encryption, Data Analysis, IV Collision, Key Extraction, WEP Cracking, WPA/ WPA2, AES, Access Point-Based Security Measures, Third- Party Security Methods, Funk's Steel-Belted Radius, WLAN Protection Enhancements, Blue-tooth Security Implementation, Security in Wi- MAX, UWB security, Satellite network security.	10
END SEMESTER EXAM (ALL Modules)		

REFERENCES:

1 KavehPahlavan and PrashantKrishnamurthy,"Principles of Wireless Networks", Prentice -Hall, 2006.
2 Cyrus Peikari and Seth Fogie, "Maximum Wireless Security" Sams, 2002.
3 Hideki lmai, Mohammad GhulamRahman and KazukuniKobari "Wireless Communications Security", Universal Personal Communications of Artech House, 2006.
4 Stallings William, "Wireless Communications and Networks" Second Edition, Pearson Education Ltd, 2009.
5 Jon Edney and William A. Arbaugh, " Real 802.11 Security: Wi-Fi Protected Access and 802.11i" , Addison-Wesley Professional, 2003.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05CS 6213	INFORMATION RISK MANAGEMENT	3-1-0-3	2015

COURSE OBJECTIVES:

- To understand the processes and measures that is used to manage risk to business critical information in an increasingly challenging cyber security environment.
- Examine the way in which business and society make an assessment of, control and transfer risk.
- To engage students in active discovery of risk management principles.

COURSE OUTCOMES:

Upon completion, the student will be able to

- Understand the structured process that is used to manage the risk to information and data.
- Realize what a business must, should or could do to address its risks.
- Recognize the challenges unique to deploying the security measures.

MODULE	COURSE CONTENT (42 hrs)	HRS
I	Information Risk Management: Definitions and relationships among different security components - threat agent, threat, vulnerability, risk, asset, exposure and safeguards; Governance models such as COSO and COBIT, ISO 27000 series of standards for setting up security programs.	11
	INTERNAL TEST 1 (Module 1)	
II	Risk analysis and management, policies, standards, baselines, guidelines and procedures as applied to Security Management program, Information strategy objectives.	11
	INTERNAL TEST 2 (Module 2)	
III	Security awareness and training. Security Architecture and Design: review of architectural frameworks (such as Zachman and SABSA), concepts of Security Models (such as Bell-LaPadula, Biba and Brewer-Nash), vulnerabilities and threats to information systems (such as traditional on-premise systems, web based multi-tiered applications, distributed systems and cloud based services), application of countermeasures to mitigate against those threats and security products evaluation.	10
IV	Business Continuity and Disaster Recovery: Business Continuity Management (BCM) concepts, Business Impact Analysis, BC/DR Strategy development, backup and offsite facilities and types of drills and tests. An introduction to Operational Security and Physical security aspects.	10

END SEMESTER EXAM (ALL Modules)

REFERENCES:

1. Alan Calder and Steve G. Watkins, "Information Security Risk Management for IS027001 /IS027002", IT Governance Ltd, 2010.
2. Susan Snedaker, "Business Continuity and Disaster Recovery Planning for IT Professionals", Elsevier Science & Technology Books, 2007.
3. Harold F Tipton and Micki Krause, "Information Security Management Handbook", Volume 1, Sixth Edition, Auerbach Publications, 2003.
4. Andreas Von Grebmer, "Information and IT Risk Management in a Nutshell: A Pragmatic Approach to Information Security" Books on Demand, 2008.
5. Evan Wheeler, " Security Risk Management" ,Elsevier, 2011.
6. Ian Tibble,"Security De-Engineering: Solving the Problems in Information Risk Management", CRC Press, 2012.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05CS 6215	DATA MINING AND MACHINE LEARNING	3-1-0-3	2015

COURSE OBJECTIVES:

- Introduce students to the field of data mining and machine learning process.
- Focuses on the study of techniques of clustering, classification, association finding, feature selection and visualization to real world data and determining whether a real world problem has a data mining solution.

COURSE OUTCOMES:

Upon completion, the student will be able to

- Understand the basic data mining and machine learning algorithms.
- Apply supervised and unsupervised learning algorithms to prediction problems.
- Accurately evaluate the performance of algorithms, as well as formulate and test hypotheses.

MODULE	COURSE CONTENT (42 hrs)	HRS
I	Introduction- Data Mining, Machine Learning, Review of Cybersecurity Solutions. Classical Machine-Learning Paradigms for Data Mining - Fundamentals of Supervised Machine-Learning, Popular Unsupervised Machine-Learning Methods, Improvements on Machine-Learning Methods, Challenges in Data Mining, Challenges in Machine Learning	11
	INTERNAL TEST 1 (Module 1)	
II	Supervised Learning for Misuse/Signature Detection- Machine-Learning Applications in Misuse Detection- Rule-Based Signature Analysis, Artificial Neural Network, Support Vector Machine, Genetic Programming, Decision Tree and CART, Bayesian Network. Machine Learning for Anomaly Detection- Anomaly Detection, Machine Learning in Anomaly Detection Systems, Machine-Learning Applications in Anomaly Detection.	11
	INTERNAL TEST 2 (Module 2)	
III	Machine Learning for Hybrid Detection- Hybrid Detection, Machine Learning in Hybrid Intrusion Detection Systems, Machine-Learning Applications in Hybrid Intrusion Detection. Machine Learning for Scan Detection- Scan and Scan Detection, Machine Learning in Scan Detection, Machine-Learning Applications in Scan Detection, Other Scan Techniques, Machine Learning for Profiling Network Traffic- Network Traffic Profiling and Related Network Traffic Knowledge, Machine Learning and Network Traffic Profiling, Data-Mining and Machine-Learning Applications in Network Profiling.	10

IV	Privacy-Preserving Data Mining- Privacy Preservation Techniques in PPDM, Workflow of PPDM, Data-Mining and Machine-Learning Applications in PPDM- Privacy Preservation Association Rules, Privacy Preservation Decision Tree, Privacy Preservation Bayesian Network, Privacy Preservation KNN, Privacy Preservation k-Means Clustering. Emerging Challenges in Cyber security- Network Monitoring, Profiling, and Privacy Preservation, Challenges in Intrusion Detection.	10
END SEMESTER EXAM (ALL Modules)		

REFERENCES:

1. SumeetDua and Xian Du, “Data Mining and Machine Learning in Cyber security” CRC press, Auerbach Publications 2011.
2. Christopher Westphal,” Data Mining for Intelligence, Fraud & Criminal Detection: Advanced Analytics & Information Sharing Technologies” CRC Press, 2008.
3. Marcus A. Maloof, “Machine Learning and Data Mining for Computer Security: Methods and Applications” Springer Science & Business Media, 2006.
4. Jesus Mena,” Machine Learning Forensics for Law Enforcement, Security, and Intelligence”, CRC Press, 2011.
5. Ian H. Witten, Eibe Frank, Mark A. Hall,” Data Mining: Practical Machine Learning Tools and Techniques”, Elsevier, 2011.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05CS 6277	RESEARCH METHODOLOGY	1-1-0-2	2015

COURSE OBJECTIVES:

- Aware of the research process.
- Familiarize the tools and skills to investigate a research.
- Preparation of an effective report.

COURSE OUTCOMES:

- Able to do research in a systematic way.
- Effective use of appropriate tools for samples and data collection.
- Write research proposals and reports.

MODULE	COURSE CONTENT (28 hrs)	HRS
I	Introduction-Tools for Planning Research, Finding resources, internet research skills, Evaluating and citing resources, publishing research-literature review – problem definition Reproducible research-focus on the concepts and tools behind reporting modern data analyses in a reproducible manner. (Students are expected set up a GitHub account and/or take part in collaborative projects such as Mozilla Science Lab,Linux Foundation , Wikis or technical blogging)	7
	INTERNAL TEST 1 (Module 1)	
II	Sampling fundamentals -Types of sampling: probability and non-probability sampling. Sampling theory, sampling distribution and sample size determination. Tools and techniques of data collection: Questionnaire and schedule for field surveys, interview, observation, simulation, experimental and case study methods. Collection, recording, editing, coding and scaling of data. Scale classification and types. Measurement of validity, reliability and practicality.	7
	INTERNAL TEST 2 (Module 2)	
III	Descriptive and inferential statistics - Data analysis and interpretation – testing of hypothesis, testing of population mean, variance and proportion –Z test – t test – F test - chi square test.– standard error of the estimate. Testing goodness of fit. Brief introduction to non parametric tests, factor analysis, discriminant analysis and path analysis (description only).	7
IV	Meaning of interpretation and inference: importance and care for interpreting results. Presentation of reports: structure and style. Parts of a research report. Guidelines for writing	7

	research papers and reports –. Ethics in research. Use of computers and internet in research. Familiarization with Online tools for computer science researchers **Case Study:** Familiarize Latex software for report preparation. Students have to take up a case study on particular samples and conclude with some hypothesis. A report of the same has to be submitted by the student at the end of this course.	
END SEMESTER EXAM (ALL Modules)		

REFERENCES:

1. C. R. Kothari, Research Methodology, Methods and techniques (New Age International Publishers, New Delhi, 2004).
2. R. Panneerseklvam, Research Methodology (Prentice Hall of India, New Delhi, 2011).
3. Ranjit Kumar, Research Methodology, A step by step approach (Pearson Publishers, New Delhi, 2005.
4. Management Research Methodology : K. N. Krishnaswami, AppaIyer and M Mathirajan, Pearson Education, Delhi, 2010
5. Hand Book of Research Methodology : M N Borse, SreeNivas Publications, Jaipur, 2004
6. Business Research Methods: William G Zikmund, South – Western Ltd, 2003
7. Research Methods in Social Science: P K Majumdar, Viva Books Pvt Ltd, New Delhi, 2005
8. Analyzing Quantitative Data: Norman Blaikie, SAGE Publications , London, 2003

Web References:

Module 1

http://help.library.ubc.ca/evaluating-and-citing-sources/evaluating-information-sources/
http://www.vtstutorials.ac.uk/detective/
http://connectedresearchers.com/online-tools-for-researchers/
https://www.ucl.ac.uk/isd/services/research-it/research-software/infrastructure/github/signup
https://www.mozillascience.org/training
https://www.ucl.ac.uk/isd/services/research-it
http://researchkit.org/
https://www.cs.ubc.ca/our-department/facilities/reading-room/research-publications/research-tools

Module 4

http://www.i-studentglobal.com/study-programmes/science-engineering-computing-technology/50-essential-online-tools-for-every-computer-science-student

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05CS 6291	INFORMATION SECURITY LAB	0-0-2-1	2015

COURSE OBJECTIVES:

- The main objective this practical session is that students will get the exposure to various tools and programming methods using in information security.

COURSE OUTCOMES:

By the completion of this laboratory session Student

- Will gain the knowledge on perl and Shell scripting languages to implement various security attacks.
- Will get the ideas in various ways to trace an attacker.
- Will get the practical exposure to software firewall, port monitoring etc….

The following programs should be implemented preferably on platform Windows/Linux through perl, shell scripting language and other standard utilities available with LINUX systems. :-

1. Write a perl script to concatenate ten messages and transmit to remote server
    a. Using arrays
    b. Without using arrays.
2. Write a perl script to implement following functions:
    a. Stack functions
    b. File functions
    c. File text functions
    d. Directory functions
    e. Shift, unshift, Splice functions.
3. Write a Perl script to secure windows operating systems and web browser by disabling Hardware and software units.
4. Write a perl script to implement Mail bombing and trace the hacker.
5. Write a shell script to crack LINUX login passwords and trace it when breaking is happened.
6. Working with Sniffers for monitoring network communication (Ethereal)
7. Understanding of cryptographic algorithms and implementation of the same in C or C++.
8. Using open SSL for web server - browser communication
9. Using GNU PGP
10. Performance evaluation of various cryptographic algorithms
11. Using IP TABLES on Linux and setting the filtering rules
12. Configuring S/MIME for e-mail communication

13. Understanding the buffer overflow and format string attacks
14. Using NMAP for ports monitoring
15. Implementation of proxy based security protocols in C or C++ with features like confidentiality, integrity and authentication

FOLLOWING ARE SOME OF THE WEB LINKS, WHICH HELP TO SOLVE

THE ABOVE ASSIGNMENTS:

- http://linuxcommand.org/man_pages/openssl1.html
- http://www.openssl.org/docs/apps/openssl.html
- http://www.queen.clara.net/pgp/art3.html
- http://www.ccs.ornl.gov/~hongo/main/resources/contrib/gpg-howto/gpg-howto.html
- https://netfiles.uiuc.edu/ehowes/www/gpg/gpg-com-0.htm
- http://www.ethereal.com/docs/user-guide/

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05CS 6202	CYBER FORENSICS	3-1-0-4	2015

COURSE OBJECTIVES:

The main objective of the course is to introduce the students to bring awareness in crimes and tracing the attackers.

- Define digital forensics from electronic media.
- Describe how to prepare for digital evidence investigations and explain the differences between law enforcement agency and corporate investigations.
- Explain the importance of maintaining professional conduct

COURSE OUTCOMES:

Upon completion, the student will be able to

- Utilize a systematic approach to computer investigations.
- Utilize various forensic tools to collect digital evidence.
- Perform digital forensics analysis upon networks and network devices.
- Perform web based investigations.

MODULE	COURSE CONTENT (42 hrs)	HRS
I	Cyber forensics Introduction to Cyber forensics, Type of Computer Forensics Technology- Type of Vendor and Computer Forensics Services. Information Security Investigations, Corporate Cyber Forensics, Scientific method in forensic analysis, investigating large scale Data breach cases, Analyzing Malicious software.	11
	INTERNAL TEST 1 (Module 1)	
II	Digital Evidence in Criminal Investigations. The Analog and Digital World, Training and Education in digital evidence, the digital crime scene, Investigating Cybercrime, Duties Support Functions and Competencies. Computer Forensics Evidence and Capture- Data Recovery-Evidence collection and Data Seizure-Duplication and preservation of Digital Evidence-Computer image verification and Authentication	11
	INTERNAL TEST 2 (Module 2)	
III	Investigating Network Intrusions and Cyber Crime, Network Forensics and Investigating logs, Investigating network Traffic, Investigating Web attacks, Router Forensics. Computer Forensics Analysis- Discovery of Electronic Evidence- Identification of data- Reconstructing Past events-networks	10

IV	Countermeasure: Information warfare- Surveillance tool for Information warfare of the future-Advanced Computer Forensics. Cyber forensics tools and case studies.	10
END SEMESTER EXAM (ALL Modules)		

REFERENCES:

1. Understanding Cryptography: A Textbook for Students and Practitioners: Christofpaar, Jan Pelzl.
2. Live Hacking: The Ultimate Guide to Hacking Techniques & Countermeasures for Ethical Hackers & IT Security Experts Ali Jahangiri
3. Handbook of Digital and Multimedia Forensic Evidence [Paperback] John J. Barbara
4. Computer Forensics: Investigating Network Intrusions and Cyber Crime (Ec-Council Press Series: Computer Forensics)
5. Cyber Forensics: Understanding Information Security Investigations (Springer's Forensic Laboratory Science Series) by Jennifer Bayuk
6. Information warfare : Information warfare and security: (ACM Press) by Dorothy
   Elizabeth Robling Denning
7. Cyberwar and Information Warfare : Springer's by Daniel Ventre
8. Computer forensics: computer crime scene investigation, Volume 1 (Charles River Media, 2008) By John R. Vacca

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05CS 6204	SECURE CODING	3-1-0-3	2015

COURSE OBJECTIVES:

- Students shall understand vulnerabilities in coding, identify, and remediate them.

COURSE OUTCOMES:

Upon completion, the student will be able

- To utilize a systematic approach to secure coding java and web applications.

MODULE	COURSE CONTENT (42 hrs)	HRS
I	Introduction, Security concepts, Security Architecture - Principles, coding in C and C++, Strings - String Characteristics, Common String Manipulation Errors, String Vulnerabilities, Process Memory Organization, Stack Smashing, Code Injection, Arc Injection, Notable Vulnerabilities. Pointer Subterfuge - Data Locations, Function Pointers, Data Pointers, Modifying the Instruction Pointer, Global Offset Table, The .dtors Section , Virtual Pointers, The atexit() and on_exit() Functions, The longjmp() Function, Exception Handling.	11
	INTERNAL TEST 1 (Module 1)	
II	Dynamic Memory Management - Common Dynamic Memory Management Errors, Doug Lea's Memory Allocator, RtlHeap, Integer Security - Integers, Integer Conversions, Integer Error Conditions, Integer Operations, Vulnerabilities, Nonexceptional Integer Logic Errors, Notable Vulnerabilities in Dynamic Memory Management and Integer Security	11
	INTERNAL TEST 2 (Module 2)	
III	Formatted Output - Variadic Functions, Formatted Output Functions, Exploiting Formatted Output Functions, Stack Randomization. File I/O - Concurrency, Time of Check, Time of Use, Files as Locks and File Locking, File System Exploits.	10
IV	Web Application, SQL Injection, Web Server–Related Vulnerabilities (XSS, XSRF, and Response Splitting), Web Client–Related Vulnerabilities (XSS), Use of Magic URLs, Predictable Cookies, and Hidden Form Fields:- Overview, CWE References, Affected Languages, Explain, Spotting the Pattern, Code Review, Testing Techniques, Redemption Steps.	10

END SEMESTER EXAM (ALL Modules)
References: 1. Robert C. Seaford, "Secure Coding in C and C++", Addison-Wesley Professional, 2005. 2. Mark G. Graff, Kenneth R. van Wyk, "Secure Coding: Principles & Practices" O'Reilly, 2003 3. Michael Howard, David LeBlanc, and John Viega, "24 DEADLY SINS OF SOFTWARE SECURITY" McGraw-Hill Companies, 2010. 4. James A. Whittaker and Herbert H. Thompson, "How to Break Software Security", Addison Wesley, 2003. 5. John C. Mitchell and Krzysztof Apt, "Concepts in Programming Languages", Cambridge University Press, 2001.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05CS 6206	ETHICAL HACKING	3-1-1-3	2015

COURSE OBJECTIVES:

- To render all the techniques used for penetration testing for performing security auditing.
- To transform the internet security industry by infusing professionalism and efficiency.

COURSE OUTCOMES:

By the end of the course students will

- Learn various hacking methods.
- Perform system security vulnerability testing.
- Perform system vulnerability exploit attacks.
- Produce a security assessment report
- Learn various issues related to hacking.

MODULE	COURSE CONTENT (56 hrs)	HRS
I	Casing the Establishment - What is footprinting- Internet Footprinting. - Scanning-Enumeration - basic banner grabbing, Enumerating Common Network services. Securing permission - Securing file and folder permission. Using the encrypting file system. Securing registry permissions. Securing service- Managing service permission. Default services in windows 2000 and windows XP. Unix - The Quest for Root. Remote Access vs Local access. Remote access. Local access. After hacking root.	9
INTERNAL TEST 1 (Module 1)		
II	Dial-up ,PBX, Voicemail, and VPN hacking - Preparing to dial up. War-Dialing. Brude-Force Scripting PBX hacking. Voice mail hacking . VPN hacking. Network Devices – Discovery, Autonomous System Lookup. Public Newsgroups. Service Detection. Network Vulnerability. Detecting Layer 2 Media.	9
INTERNAL TEST 2 (Module 2)		
III	Wireless Hacking - Wireless Foot printing. Wireless Scanning and Enumeration. Gaining Access. Tools that exploiting WEP Weakness. Denial of Services Attacks. Firewalls- Firewalls landscape- Firewall Identification-Scanning Through firewalls- packet Filtering- Application Proxy Vulnerabilities . Denial of Service Attacks - Motivation of Dos Attackers. Types of DoS attacks. Generic Dos Attacks. Unix and Windows DoS	10

IV	Remote Control Insecurities - Discovering Remote Control Software. Connection. Weakness.VNC . Microsoft Terminal Server and Citrix ICA .Advanced Techniques Session Hijacking. Back Doors. Trojans. Cryptography . Subverting the systems Environment. Social Engineering. Web Hacking. Web server hacking web application hacking. Hacking the internet User - Malicious Mobile code, SSL fraud, E-mail Hacking, IRC hacking, Global Counter measures to Internet User Hacking.	8
END SEMESTER EXAM (ALL Modules)		

References:

1. Stuart McClure, Joel Scambray and Goerge Kurtz, “Hacking Exposed Network Security Secrets & Solutions”, Tata Mcgrawhill Publishers, 2010.
2. Bensmith, and Brian Komer, “Microsoft Windows Security Resource Kit”, Prentice Hall of India, 2010.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05CS 6222	CODING AND INFORMATION THEORY	3-1-0-3	2015

COURSE OBJECTIVES:

- Covers information theory and coding within the context of modern digital communications applications.
- To help students in quantify the notion of information in a mathematically and intuitively sound way.
- Explaining how this quantitative measure of information may be used in order to build efficient solutions to multitudinous engineering problems

COURSE OUTCOMES:

By the end of the course students will

- Learn various coding methods.
- Learn various error control methods.

MODULE	COURSE CONTENT (42 hrs)	HRS
I	Source Coding - Introduction to information theory, uncertainty and information, average mutual information and entropy, source coding theorem, Shannon-fano coding, Huffman coding, Arithmetic coding, Lempel-Ziv algorithm, run-length encoding and rate distortion function.	11
	INTERNAL TEST 1 (Module 1)	
II	Channel capacity and coding - channel models, channel capacity, channel coding, information capacity theorem, random selection of codes. Error control coding: linear block codes and their properties, decoding of linear block code, perfect codes, hamming codes, optimal linear codes and MDS codes.	11
	INTERNAL TEST 2 (Module 2)	
III	Cyclic codes - polynomials, division algorithm for polynomials, a method for generating cyclic codes, matrix description of cyclic codes, burst error correction, fire codes, golay codes, CRC codes, circuit implementation of cyclic codes. BCH codes: minimal polynomials, generator polynomial for BCH codes, decoding of BCH codes, Reed-Solomon codes and nested codes.	10

IV	Convolutional codes - tree codes and trellis codes, polynomial description of convolutional codes, distance notions for convolutional codes, generation function, matrix description of convolutional codes, viterbi decoding of convolutional codes, distance bounds for convolutional codes, turbo codes and turbo decoding. Trellis Coded Modulation - concept of coded modulation, mapping by set partitioning, ungerboeck's TCM design rules, TCM decoder, Performance evaluation for Additive White Gaussian Noise (AWGN) channel, TCM for fading channels.	10
END SEMESTER EXAM (ALL Modules)		

References:

1. Lin S. and D. J. Costello, "Error Control Coding — Fundamentals and Applications", Second Edition, Pearson Education Inc., NJ., USA, 2004
2. Shu Lin and Daniel J. Costello, "Error Control Coding", Second Edition, Prentice Hall, 1983.
3. Ranjan Bose, "Information Theory, Coding and Cryptography", Tata McGraw-Hill, 2003.
4. E. R. Berlekamp, "Algebraic Coding Theory", McGraw-Hill, New York, 1968.
5. R. E. Blahut, "Algebraic Codes for Data Transmission", Cambridge University Press Cambridge, UK, 2003.
6. Ranjan Bose, "Information theory, coding and cryptography", Tata McGraw Hill, 2002.
7. Viterbi, "Information theory and coding", McGraw Hill, 1982.
8. John G. Proakis, "Digital Communications", 2nd Edition, McGraw Hill, 1989.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05CS 6224	DESIGN OF SECURED ARCHITECTURES	3-1-0-3	2015

COURSE OBJECTIVES:

- Students shall gain an understanding of the techniques and architectural components used to provide a secure computing environment.

COURSE OUTCOMES:

Upon completion, the student will be able

- To know the strengths and weaknesses of different security design techniques.
- To specify a security solution to fulfill specific design requirements.

MODULE	COURSE CONTENT (36 hrs)	HRS
I	Architecture and Security - Architecture Reviews-Software Process-Reviews and the Software Development Cycle-Software Process and Architecture Models-Software Process and Security- Architecture Review of System-Security Assessments-Security Architecture Basics-Architecture Patterns in Security.	11
	INTERNAL TEST 1 (Module 1)	
II	Low-Level Architecture - Code Review-importance of code review- Buffer Overflow Exploits- Countermeasures against Buffer Overflow Attacks-patterns applicable- Security and Perl- Byte code Verification in Java-Good Coding Practices Lead to Secure Code- Cryptography- Trusted Code - Secure Communications	11
	INTERNAL TEST 2 (Module 2)	
III	Mid-Level Architecture - Middleware Security- Middleware and Security-The Assumption of Infallibility. High-Level Architecture - Security Components- Secure Single Sign-On- Public-Key Infrastructures-Firewalls- Intrusion Detection Systems-LDAP and X.500 Directories-Kerberos- Distributed Computing Environment-The Secure Shell, or SSH-The Distributed Sandbox- Security and Other Architectural Goals- Metrics for Non-Functional Goals-Force Diagrams around Security- High Availability- Robustness- Reconstruction of Events- Ease of Use-Maintainability, Adaptability, and Evolution- Scalability- Interoperability-Performance- Portability.	10

IV	Enterprise Security Architecture - Security as a Process-Security Data-Enterprise Security as a Data Management Problem- Tools for Data Management- David Isenberg and the "Stupid Network"-Extensible Markup Language- The XML Security Services Signaling Layer-XML and Security Standards- The Security Pattern Catalog Revisited-XML-Enabled Security Data-HGP: A Case Study in Data Management. Business Cases and Security: Building Business Cases for Security	10
END SEMESTER EXAM (ALL Modules)		

References:

1. Jay Ramachandran, "Designing Security Architecture Solutions", Wiley Computer Publishing, 2010.
2. Markus Schumacher, "Security Patterns: Integrating Security and Systems Engineering", Wiley Software Pattern Series, 2010.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05CS 6226	DIGITAL WATERMARKING	3-1-0-3	2015

COURSE OBJECTIVES:

- To make the students aware of the basic mathematical concept behind watermarking theory and its main applications.
- Provides the knowledge about the applications of watermarking techniques used and teaches about Watermark security and cryptographic methods used.

COURSE OUTCOMES:

Upon completion, the Students will be able to

- Understand and identify digital watermarking from other related fields.
- Explain different types of watermarking applications and watermarking frameworks.
- Design digital watermarking systems according to application domains.
- Analyze the different type of watermarking security issues.

MODULE	COURSE CONTENT (42 hrs)	HRS
I	Watermarking host signals: Image, Video, and Audio. Multimedia compression and decompression, Lossless compression, Models watermarking, Communication-based models of watermarking, Geometric models of watermarking, modeling watermark detection by correlation	11
	INTERNAL TEST 1 (Module 1)	
II	Basic message coding, Mapping message in message vectors, Error correction coding, Detecting multi-symbol watermarks, Watermarking with side information, Inform(embedding, Informed coding.	11
	INTERNAL TEST 2 (Module 2)	
III	Structured dirty-paper codes, Analyzing errors, Message errors, ROC curves, The effect of whitening on error rates, Analysis of normalized correlation, Using perceptual mode, Evaluating perceptual impact of watermarks.	10
IV	General forms of perceptual model, Perceptual adaptive watermarking, Robust watermarking, Watermark security, Watermark security and cryptography, Content authentication, Exact authentication, Selective, authentication, Localization, Restoration.	10

END SEMESTER EXAM (ALL Modules)
References: 1. Cox I., M. Miller, J. Bloom, J. Fridrich and T Kalker, "Digit Watermarking and Steganography", Second Edition, Morg Kaufmann Publishers, 2008. 2. E. Cole, R. Krutz, and J. Conley, Network Security Bible, Wiley-Dreamtech, 2005. 3. W. Stallings, Cryptography and Network Security Principles and practice, 3/e, Pearson Education Asia, 2003. 4. C. P. Pfleeger and S. L. Pfleeger, Security in Computing, 3/e, Pearson Education, 2003. 5. M. Bishop, Computer Security: Art and Science, Pearson Education, 2003.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05CS 6232	CRYPTANALYSIS	3-1-0-3	2015

COURSE OBJECTIVES:

- To enable learner to understand various risks, threats and vulnerabilities in a system.
- Also gives security awareness and countermeasures to mitigate various risks, threats and vulnerabilities in a system.

COURSE OUTCOMES:

- Will able to design and analyze the security architecture designed for any system.
- Will able to identify the security flows in any multi-tiered applications, distributed systems and cloud based services and mitigate it.

MODULE	COURSE CONTENT (36 hrs)	HRS
I	Cryptanalysis of classical ciphers: Vigenere cipher, Affine cipher, Hill-cipher Linear Shift Register Random Bit Generator: Berlekamp- Massey algorithm for the cryptanalysis of LFSR, Correlation attack on LFSR based stream ciphers, Cryptanalysis of ORYX, Fast algebraic attack.	11
INTERNAL TEST 1 (Module 1)		
II	Cryptanalysis of Block Ciphers: Man in the middle attack double DES, Linear and Differential cryptanalysis. Algorithmic Number Theory: Stein's binary greatest common divisor algorithm, Shanks Tonelli algorithm for square roots in Fp, Stein's greatest common divisor algorithm for polynomials.	11
INTERNAL TEST 2 (Module 2)		
III	Algorithms for DLP: Pollard Rho method for DLP, Shank's baby step Giant step algorithm for DLP Silver-Pohling-Hellman algorithm for DLP, Index calculus for DLP algorithms: Trial division, Fermat method, Legendre-congruence, Continued fraction method, Pollard Rho method, Elliptic curve method, Quadratic sieve.	10
IV	Lattice based Cryptanalysis. Direct attacks using lattice reduction, Coppersmith's attacks. Attacks on cryptographic hash functions: Birth day paradox, Birthday for paradox for multi collisions, Birthday paradox in two groups, Application of Birthday paradox in Hash functions, Multicollisions attack on hash functions.	10
END SEMESTER EXAM (ALL Modules)		

References:

1. Antoine Joux, "Algorithmic Cryptanalysis", Chapman & Hall/CRC Cryptography and Series, 2009.
2. Song Y Yang, "Number Theory for Computing", Second Edition,SpringerVerlag, 2010.
3. Gregory V. Bard, "Algebraic Cryptanalysis", Springer, 2009.
4. Hffstein, Jeffray, Pipher, Jill and Silverman, "An Introduction to Mathematical Cryptography",Springer, 2010.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05CS 6234	DISTRIBUTED AND CLOUD COMPUTING	3-1-0-3	2015

COURSE OBJECTIVES:

- To expose the fundamentals of distributed computer systems, explore and acquire a critical understanding about the fundamental concepts of Cloud computing and its technologies.
- Enable the learner to develop a firm grounding in the tools and principles of building distributed and cloud applications.

COURSE OUTCOMES:

Upon Completion the students will be able to

- Create models for distributed systems.
- To explain the basic information storage and retrieval concepts in a storage system.
- To understand the emerging area of cloud computing, also learn about the cloud infrastructure services like PAAS, SAAS, IAAS etc..

MODULE	COURSE CONTENT (42 hrs)	HRS
I	**Systems Modeling, Clustering and Virtualization-** Distributed System Models and Enabling Technologies, Computer Clusters for Scalable Parallel Computing, Virtual Machines and Virtualization of Clusters and Data centers. Foundations:Introduction to Cloud Computing, Migrating into a Cloud, Enriching the 'Integration as a Service' Paradigm for the Cloud Era, The Enterprise Cloud Computing Paradigm.	11
	INTERNAL TEST 1 (Module 1)	
II	**Infrastructure as a Service (IAAS) & Platform and Software as a Service (PAAS / SAAS):** Virtual machines provisioning and Migration services, On the Management of Virtual machines for Cloud Infrastructures, Enhancing Cloud Computing Environments using a cluster as a Service, Secure Distributed Data Storage in Cloud Computing. Aneka, Comet Cloud, T-Systems', Workflow Engine for Clouds, Understanding Scientific Applications for Cloud Environments.	11
	INTERNAL TEST 2 (Module 2)	
III	**Monitoring, Management and Applications:** An Architecture for Federated Cloud Computing, SLA Management in Cloud Computing, Performance Prediction for HPC on Clouds, Best Practices in Architecting Cloud Applications in the AWS cloud, Building Content Delivery networks using Clouds, Resource Cloud Mashups.	10
IV	**Governance and Case Studies:** Organizational Readiness and Change management in the Cloud age, Data Security in the Cloud, Legal Issues in Cloud computing, Achieving Production Readiness for Cloud Services.	10

END SEMESTER EXAM (ALL Modules)

Reference:

1. Cloud Computing: Principles and Paradigms by RajkumarBuyya, James Broberg and Andrzej M. Goscinski, Wiley, 2011.
2. Distributed and Cloud Computing, Kai Hwang, GeofferyC.Fox, Jack J.Dongarra, Elsevier, 2012.
3. Cloud Computing : A Practical Approach, Anthony T.Velte, Toby J.Velte, Robert Elsenpeter, Tata McGraw Hill, rp2011.
4. Enterprise Cloud Computing, GautamShroff, Cambridge University Press, 2010.
5. Cloud Computing: Implementation, Management and Security, John W. Rittinghouse, James F.Ransome, CRC Press, rp2012.
6. Cloud Application Architectures: Building Applications and Infrastructure in the Cloud, George Reese, O'Reilly, SPD, rp2011.
7. Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, Tim Mather, SubraKumaraswamy, ShahedLatif, O'Reilly, SPD, rp2011.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05CS 6236	STORAGE MANAGEMENT AND SECURITY	3-1-0-3	2015

COURSE OBJECTIVES:

- To enable students to understand, explore and acquire a critical understanding about managing information in storage system and effective security implementation on the corresponding platforms.

COURSE OUTCOMES:

- Introduce the students to various types of storage systems available and understand the importance of storage networking.
- To explain the basic information storage and retrieval concepts in a storage system.
- To understand the issues those are specific to efficient information retrieval.
- To implement security issues while storing and retrieving information.

MODULE	COURSE CONTENT (36 hrs)	HRS
I	Introduction, History: computing, networking, storage, Need for storage networking , SAN, NAS, SAN/NAS Convergence, Distributed Storage Systems, Mainframe/proprietary vs. open storage, Storage Industry Organizations and Major Vendors Market, Storage networking strategy (SAN/NAS) Technology	11
	INTERNAL TEST 1 (Module 1)	
II	Storage components, Data organization: File vs. Block, Object; Data store; Searchable models; Storage Devices (including fixed content storage devices), File Systems, Volume Managers, RAID systems, Caches, Prefetching. Error management: Disk Error Management, RAID Error Management, Distributed Systems Error Management	11
	INTERNAL TEST 2 (Module 2)	
III	Large Storage Systems: Google FS/Big Table, Cloud/Web - based systems (Amazon S3), FS+DB convergence, Programming models: Hadoop. Archival Systems: Content addressable storage, Backup: server less, LAN free, LAN Replication issues, Storage Security, Storage Management, Device Management, NAS Management, Virtualization, Virtualization solutions, SAN Management: Storage Provisioning, Storage Migration	10
IV	Securing the storage Infrastructure, Storage Security Framework, Risk Triad, Storage Security Domains, Security Implementation in Storage Networking. Managing the Storage Infrastructure, Monitoring the Storage Infrastructure, Storage Management Activities, Developing an Ideal Solution, Concepts in Practice.	10

END SEMESTER EXAM (ALL Modules)
References: 1. EMC Education Services “Information Storage and Management: Storing, Managing, and Protecting Digital Information” , John Wiley & Sons, 2010 2. John Chirillo, ScottBlaul“ Storage Security: Protecting SANs, NAS and DAS”, Wiley, 2003. 3. David Alexander, Amanda French, Dave Sutton “Information Security Management Principles” BCS, The Chartered Institute, 2008. 4. Gerald J. Kowalski, Mark T. Maybury“ Information Storage and Retrieval Systems: Theory and Implementation, Springer, 2000. 5. Foster Stockwell , “A history of information storage and retrieval” McFarland, 2001. 6. R. Kelly Rainer, Casey G. Cegielski , “Introduction to Information Systems: Enabling and Transforming Business, John Wiley & Sons, 2010.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05CS 6266	**SEMINAR- I**	**0-0-2-2**	**2015**

Each student should present a seminar on any topic related to the core/elective courses offered in the first semester of the M. Tech. Program. The selected topic should be based on the papers published in reputed international journals preferably IEEE/ACM. The selected paper should be approved by the Program Coordinator/Faculty member before presentation. The students should undertake a detailed study on the topic and submit a report at the end of the semester. Marks will be awarded based on the topic, presentation, participation in the seminar and the report.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05CS 6288	**MINI PROJECT**	**0-0-4-2**	**2015**

The mini project is designed to develop practical ability and knowledge in tools/techniques to solve problems related to the industry, academic institutions and computer science research. Students can take up any application level/system level project pertaining to a relevant domain, preferably based on papers from IEEE/ACM journals. Projects can be chosen either from the list provided by the faculty or in the field of interest of the student. The topic should be approved by the Programme Co-ordinator / Faculty member before carrying out the work. For external projects, students should obtain prior permission after submitting the details of the guide and synopsis of the work. The project guide should have a minimum qualification of ME/M.Tech in Computer Science or related fields. At the end of each phase, presentation and demonstration of the project should be conducted, which will be evaluated by a panel of examiners. A detailed project report duly approved by the guide in the prescribed format should be submitted for end semester assessment. Marks will be awarded based on the report and their performance during presentations and demonstrations. Publishing the work in Conference Proceedings/Journals with National/International status with the consent of the guide will carry an additional weightage in the evaluation process.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05CS 6292	ETHICAL HACKING AND DIGITAL FORENSIC TOOLS LAB	0-0-2-1	2015

Course Objectives:

- The main objective this practical session is that students will get the exposure to various hacking and forensic tools.

Course Outcomes:

By the completion of this laboratory session Student

- Will gain the knowledge to implement various security attacks.
- Will get the ideas in various ways to trace an attacker.
- Will get the practical exposure to forensic tools.

Part A: Ethical hacking

1. Working with Trojans, Backdoors and sniffer for monitoring network communication
2. Denial of Service and Session Hijacking using Tear Drop, DDOS attack.
3. Penetration Testing and justification of penetration testing through risk analysis
4. Password guessing and Password Cracking.
5. Malware – Keylogger, Trojans, Keylogger countermeasures
6. Understanding Data Packet Sniffers
7. Windows Hacking – NT LAN Manager, Secure 1 password recovery
8. Implementing Web Data Extractor and Web site watcher.
9. Email Tracking.
10. Configuring Software and Hardware firewall.
11. Firewalls, Packet Analyzers, Filtering methods.

Part B: Exposure on Digital Forensic tools

1. Backup the images file from RAM using Helix3pro tool and show the analysis.
2. Introduction to Santhoku Linux operating system and features extraction.
3. Using Santoku operating system generates the analysis document for any attacked file from by taking backup image from RAM.
4. Using Santoku operating system generates the attacker injected viewing java files.
5. Using Santoku operating system shows how attackers opened various Firefox URL‟s and pdf document JavaScript files and show the analysis.
6. Using Santoku operating System files show how an attacker connected to the various network inodes by the specific process.

7. Using exiftool (-k) generate the any picture hardware and software.
8. Using deft_6.1 tool recover the attacker browsing data from any computer.
9. Using Courier tool Extract a hacker secret bitmap image hidden data.
10. Using sg (Stegnography) cyber Forensic tool hide a message in a document or any file.
11. Using sg cyber Forensic tool unhide a message in a document or any file.
12. Using Helix3pro tool show how to extract deleted data file from hard disk or usb device.
13. Using Ghostnet tool hide a message into a picture or any image file.
14. Using kgbkey logger tool record or generate an document what a user working on system
15. Using pinpoint metaviewr tool extract a metadata from system or from image file.
16. Using Bulk Extractor tool extract information from windows file system.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05CS 7241	CLOUD SECURITY	3-1-0-3	2015

COURSE OBJECTIVES:

- To understand the Security aspects of cloud computing which have always been subjected to many criticisms.
- Explaining the importance for any security professional to possess an understanding of the cloud architecture and study the methods to secure the same.

COURSE OUTCOMES:

Upon completion, the student will be able to

- Understand the fundamentals of cloud computing and its architecture.
- Understand the requirements for an application to be deployed in a cloud.
- Become knowledgeable in the methods to secure cloud.
- Analyze the issues and challenges faced to secure information in a cloud.

MODULE	COURSE CONTENT (36 hrs)	HRS
I	**Cloud computing Fundamentals and Architecture**:- Essential characteristics, Architectural influences, Technological Influences, Operational influences, Outsourcing legal issues, BPO issues, IT server Management . Cloud architecture model – Cloud delivery model, SPI framework, SaaS, PaaS, Iaas, Deployment models –Public, community, Private, Hybrid Cloud. Alternative deployment models.	11
INTERNAL TEST 1 (Module 1)		
II	**Cloud software security fundamentals**: – Security objective, security service, Cloud security design principles, Secure cloud software requirements, Secure development practice, Approaches of cloud software requirements engineering, Security policy implementation, Secure cloud software testing, penetration testing, Disaster recovery, Cloud for BCP/DCP.	11

INTERNAL TEST 2 (Module 2)		
III	**Cloud Risk Issues and Challenges**:- CIA triad, Privacy and Compliance Risk, PCIDSS, Information privacy and privacy law, Common threats and vulnerabilities, Access control issues, service provider Risk. Security policy Implementation, Computer Security incident response team (CSIRT), Virtualization security Management- virtual threats, VM security recommendations, VM security techniques – hardening, securing VM remote access.	10
IV	**Cloud Security Architecture** :- General issues, Trusted cloud, Secure execution environments and communications, Micro architecture, Identity management, Access control, Autonomic security, protection, self-healing. Cloud life cycle issues – cloud standards, DMTF, ISO, ETSI, OASI, SNIA, OGF, OWASP, Incident response, Internet Engineering Task Force Incident- Handling Guidelines, Computer security and response team, Encryption and key management, VM Architecture, Key Protection, Hardware protection, VM life cycle.	10
END SEMESTER EXAM (ALL Modules)		

References

7. Ronald L. Krutz, Russell Dean Vines, Cloud Security, Wiley publication 2010.
8. Tim Mather, SubraKumaraswamy, ShahedLatif, Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, O'Reilly Media, Inc., 2009.
9. Toby Velte, Anthony Velte, Robert Elsenpeter, Cloud Computing, A Practical Approach, Tata McGraw-Hill Education, 2009.
10. GautamShroff, Enterprise Cloud Computing Technology Architecture Applications, Cambridge University Press, 2010.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05CS 7243	CYBER LAWS AND SECURITY POLICIES	3-1-0-3	2015

COURSE OBJECTIVES:

- To enable learner to understand, explore, and acquire a critical understanding cyber law.
- Develop competencies for dealing with frauds and deceptions (confidence tricks, scams) and other cyber crimes for example, child pornography etc.

COURSE OUTCOMES:

- Make Learner Conversant With The Social And Intellectual Property Issues Emerging From Cyberspace.
- Explore The Legal And Policy Developments In Various Countries To Regulate Cyberspace;
- Develop The Understanding Of Relationship Between Commerce And Cyberspace;
- Give Learners In Depth Knowledge Of Information Technology Act And Legal Frame Work Of Right To Privacy, Data Security And Data Protection.
- Make Study On Various Case Studies On Real Time Crimes.

MODULE	COURSE CONTENT (36 hrs)	HRS
I	**Introduction to Cyber Law Evolution of Computer Technology:** Emergence of Cyber space. Cyber Jurisprudence, Jurisprudence and law, Doctrinal approach, Consensual approach, Real Approach, Cyber Ethics, Cyber Jurisdiction, Hierarchy of courts, Civil and criminal jurisdictions, Cyberspace-Web space, Web hosting and web Development agreement, Legal and Technological Significance of domain Names, Internet as a tool for global access.	11
INTERNAL TEST 1 (Module 1)		
II	**Information technology Act** : Overview of IT Act, 2000, Amendments and Limitations of IT Act, Digital Signatures, Cryptographic Algorithm, Public Cryptography, Private Cryptography, Electronic Governance, Legal Recognition of Electronic Records, Legal Recognition of Digital Signature Certifying Authorities, Cyber Crime and Offences, Network Service Providers Liability, Cyber Regulations Appellate Tribunal, Penalties and Adjudication.	11
INTERNAL TEST 2 (Module 2)		
III	**Cyber law and related Legislation :** Patent Law, Trademark Law, Copyright, Software – Copyright or Patented, Domain Names and Copyright disputes, Electronic Data Base and its Protection, IT Act and Civil Procedure Code, IT Act and Criminal Procedural Code, Relevant	10

	Sections of Indian Evidence Act, Relevant Sections of Bankers Book Evidence Act, Relevant Sections of Indian Penal Code, Relevant Sections of Reserve Bank of India Act, Law Relating To Employees And Internet, Alternative Dispute Resolution , Online Dispute Resolution (ODR).	
IV	**Electronic Business and legal issues**: Evolution and development in E-commerce, paper vs paper less contracts E-Commerce models- B2B, B2C, E security. **Application area:** Business, taxation, electronic payments, supply chain, EDI, E-markets, Emerging Trends. **Case Study On Cyber Crimes:** Harassment Via E-Mails, Email Spoofing (Online A Method Of Sending E-Mail Using A False Name Or E-Mail Address To Make It Appear That The E-Mail Comes From Somebody Other Than The True Sender, Cyber Pornography (Exm.MMS),Cyber-Stalking.	10
END SEMESTER EXAM (ALL Modules)		

References:

1. K.Kumar," Cyber Laws: Intellectual property & E Commerce, Security",1st Edition, Dominant Publisher,2011.
2. Rodney D. Ryder, " Guide To Cyber Laws", Second Edition, Wadhwa And Company, New Delhi, 2007.
3. Information Security policy &implementation Issues, NIIT, PHI.
4. Vakul Sharma, "Handbook Of Cyber Laws" Macmillan India Ltd, 2nd Edition,PHI,2003.
5. Justice Yatindra Singh, " Cyber Laws", Universal Law Publishing, 1st Edition,New Delhi, 2003.
6. Sharma, S.R., "Dimensions Of Cyber Crime", Annual Publications Pvt. Ltd., 1st Edition, 2004.
7. Augastine, Paul T.," Cyber Crimes And Legal Issues", Crecent Publishing Corporation, 2007.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05CS 7245	BIOMETRIC SECURITY	3-1-0-3	2015

COURSE OBJECTIVES:

- To provide students with understanding of biometrics, biometric equipment and standards applied to security.

COURSE OUTCOMES:

- Demonstrate knowledge of the basic physical and biological science and engineering principles underlying biometric systems.
- Understand and analyze biometric systems at the component level and be able to analyze and design basic biometric system applications.
- Be able to work effectively in teams and express their work and ideas orally and in writing.
- Identify the sociological and acceptance issues associated with the design and implementation of biometric systems.
- Understand various Biometric security issues.

MODULE	COURSE CONTENT (36 hrs)	HRS
I	Biometrics- Introduction- benefits of biometrics over traditional authentication systems benefits of biometrics in identification systems- selecting a biometric for a system –Applications – Key biometric terms and processes - biometric matching methods -Accuracy in biometric systems.	11
	INTERNAL TEST 1 (Module 1)	
II	Physiological Biometric Technologies: Fingerprints - Technical description –characteristics - Competing technologies - strengths – weaknesses – deployment - Facial scan – Technical description - characteristics - weaknesses-deployment - Iris scan - Technical description – characteristics - strengths – weaknesses – deployment - Retina vascular pattern – Technical description – characteristics - strengths – weaknesses – deployment - Hand scan – Technical description-characteristics - strengths – weaknesses deployment – DNA biometrics.	11
	INTERNAL TEST 2 (Module 2)	

III	Behavioral Biometric Technologies: Handprint Biometrics - DNA Biometrics - signature and handwriting technology - Technical description – classification - keyboard / keystroke dynamics - Voice – data acquisition - feature extraction - characteristics - strengths – weaknesses- deployment.	10
IV	Multi biometrics: Multi biometrics and multi factor biometrics - two-factor authentication with passwords - tickets and tokens – executive decision - implementation plan. Case studies on Physiological, Behavioral and multifactor biometrics in identification systems.	10
END SEMESTER EXAM (ALL Modules)		

REFERENCES:

1. Samir Nanavathi, Michel Thieme, and Raj Nanavathi, "Biometrics -Identity verification in a network", Wiley Eastern, 2002.
2. John Chirillo and Scott Blaul," Implementing Biometric Security", Wiley Eastern Publications, 2005.
3. John Berger," Biometrics for Network Security", Prentice Hall, 2004.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05CS 7251	INTERNET INFORMATION AND APPLICATION SECURITY	3-1-0-3	2015

COURSE OBJECTIVES:

- To give exposure to various security threats to web applications/ servers and providing security to web servers.

COURSE OUTCOMES:

By the completion of this course, Student will

- Understand security concepts, security professional roles, and security resources in the context of systems and security development life cycle
- Understand the business need for security, threats, attacks, top ten security vulnerabilities, and secure software development
- Understand information security policies, standards and practices, the information security blueprint.
- Analyze and describe security requirements for typical web application scenario.

MODULE	COURSE CONTENT (36 hrs)	HRS
I	Web application security- Key Problem factors – Core defense mechanisms- Handlinguser access- handling user input- Handling attackers – web spidering – Discovering hidden content. Transmitting data via the client – Hidden form fields – HTTP cookies – URL parameters – Handling client-side data securely – Attacking authentication – design flaws in authentication mechanisms –securing authentication Attacking access controls – Common vulnerabilities – Securing access controls	11
INTERNAL TEST 1 (Module 1)		
II	Web server Hacking - Source code disclosure – Canonicalization attacks – Denial of service – Web application hacking – Web crawling Database Hacking – Database discovery – Database vulnerabilities	10

INTERNAL TEST 2 (Module 2)		
III	SQL Injection - How it happens - Dynamic string building - Insecure Database Configuration - finding SQL injection – Exploiting SQL injection – Common techniques – identifying the database – UNION statements – Preventing SQL injection Platform level defenses- Using run time protection - web application Firewalls – Using ModSecurity - Intercepting filters- Web server filters - application filters – securing the database – Locking down the application data – Locking down the Database server	11
IV	Mod Security - Blocking common attacks – HTTP finger printing – Blocking proxies requests – Cross-site scripting – Cross-site request forgeries – Shell command execution attempts – Null byte attacks – Source code revelation – Directory traversal attacks – Blog spam – Website defacement – Brute force attack – Directory indexing – Detecting the real IP address of an attacker	10
END SEMESTER EXAM (ALL Modules)		

References:

1. DafyddStuttard, Marcus Pinto, The Web Application Hacker's Handbook, 2nd Edition, Wiley Publishing, Inc.
2. Stuart McClure Joel, ScambRay, George Kurtz, Hacking Exposed 7: Network Security Secrets & Solutions, Seventh Edition, 2012, The McGraw-Hill Companies
3. Justin Clarke, SQL Injection Attacks and Defense, 2009, Syngress Publication Inc.
4. Magnus Mischel , ModSecurity 2.5, Packt Publishing

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05CS 7253	DATABASE SECURITY	3-1-0-3	2015

COURSE OBJECTIVES:

- The main objective of the course is cover topics related to database security and auditing.
- The main areas of study is on the key components of information assurance as it relates to database systems – confidentiality, integrity, and availability, and how these components can be managed and measured.

COURSE OUTCOMES:

Upon completion, the student will be able to

- Identify access control methods for secure database application development
- Analyze vulnerabilities in the database.
- Understand common attacks used against database confidentiality and explain how to defend against the attack.
- Apply security audit methods to database communication and design secure database schema.

MODULE	COURSE CONTENT (36 hrs)	HRS
I	Introduction to databases: database modeling, conceptual database design, overview of SQL and relational algebra, Access control mechanisms in general computing systems: Lampson's access control matrix. Mandatory access control.	10
	INTERNAL TEST 1 (Module 1)	
II	Authentication mechanisms in databases, DAC in databases: Griffiths and Wade, MAC mechanisms in databases: SeaView. RBAC in databases. Authentication and password security – Weak authentication options, Implementation options, Strong password selection method, Implement account lockout, Password profile.	11
	INTERNAL TEST 2 (Module 2)	

III	SQL Injection, Auditing in databases, Statistical inference in databases, Private information retrieval viewed as a database access problem. Privacy in data publishing, Virtual Private Databases, Security of outsourced databases.	10
IV	Securing database to database communication – Monitor and limit outbound communication, Protect link usernames and passwords – Secure replication mechanisms. Trojans- Types of DB Trojans, Monitor for changes to run as privileges, Traces and event monitors. Encrypting data-in transit, Encrypt data-at-rest. Database security auditing categories.	11

END SEMESTER EXAM (ALL Modules)

References:

1. Ron Ben Natan, "Implementing Database Security and Auditing", Elsevier, 2005.
2. Hassan A. Afyouni, "Database Security and Auditing: Protecting Data Integrity and Accessibility", Course Technology, 2005.
3. Michael Gertz and SushilJajodia, "Handbook of Database Security-Applications and Trends", Springer, 2008.
4. Database Security, Cengage Learning; 1 edition (July 12, 2011),AlfredBasta . Melissa Zgola
5. Data warehousing and data mining techniques for cyber security, Springer's By AnoopSingha.
6. Carlos Coronel, Steven A. Morris, Peter Rob, "Database Systems: Design, Implementation, and Management", Cengage Learning, 2011.
7. Vijay Atluri, John Hale, "Research Advances in Database and Information Systems Security", Springer, 2000.
8. PierangelaSamarati, Ravi Sandhu," Database Security X: Status and prospects, Volume 10",Springer, 1997.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05CS 7255	DEPENDABLE DISTRIBUTED SYSTEMS	3-1-0-3	2015

COURSE OBJECTIVES:

- To explore the state-of-the art principles, methods, and techniques for devising adaptive and dependable distributed systems.
- Also explains the importance of learning the working of computers in a banking system and creates an awareness of various Biometric systems, their performance and the issues related to the security

COURSE OUTCOMES:

Upon completion, the student will be able to

- Understand the Architectural and infrastructural principles for adaptive and dependable distributed systems.
- Understand the Approaches to improve the scalability of dependable and adaptive systems.
- Understand about the basic banking systems and the bookkeeping practices followed.
- Gain a broader knowledge and understand the different Biometric techniques.

MODULE	COURSE CONTENT (36 hrs)	HRS
I	Dependability concepts - Faults and Failures – Redundancy – Reliability – Availability – Safety – Security – Timeliness - Fault-classification - Fault-detection and location - Fault containment - Byzantine failures - Fault injection - Fault-tolerant techniques - Performability metrics. Fault-tolerance in real-time systems - Space-time tradeoff - Fault-tolerant techniques (N-version programming - Recovery block - Imprecise computation; (m,k)- deadline model) – Adaptive fault-tolerance - Fault detection and location in real-time systems. Security Engineering – Protocols - Hardware protection - Cryptography – Introduction – The	11

	Random Oracle model – Symmetric Crypto- primitives – modes of operations – Hash functions – Asymmetric crypto primitives.	
INTERNAL TEST 1 (Module 1)		
II	Distributed systems - Concurrency - fault tolerance and failure recovery – Naming. Multilevel Security – Security policy model – The Bell Lapadula security policy model – Examples of Multilevel secure system – Broader implementation of multilevel security system. Multilateral security – Introduction – Comparison of Chinese wall and the BMA model – Inference Control – The residual problem.	10
INTERNAL TEST 2 (Module 2)		
III	Banking and bookkeeping – Introduction – How computers systems works – Wholesale payment system – Automatic teller Machine – Monitoring systems – Introduction – Prepayment meters – Taximeters, Tachographs and trunk speed limits. Nuclear Command and control – Introduction – The kennedy memorandum – unconditionally secure authentication codes – shared control security – tamper resistance and PAL – Treaty verification. Security printing and seals – Introduction – History – Security printing – packaging and seals – systemic vulnerability – evaluation methodology.	11
IV	Bio metrics – Introduction – Handwritten signature – face recognition – fingerprints – Iris codes – Voice recognition. Emission Security – Introduction – Technical Surveillance and countermeasures – Passive Attacks – Active Attacks. Electronic and Information warfare – Introduction – Basics – Communication system – Surveillance and target acquisition – IFF system – Directed Energy Weapon – Information Warefare. Telecom Security – Introduction – Phone Breaking – Mobile phones – Network attack and defense - Protecting E-commerce systems- E – policy – Management issues – systems evaluation and assurance.	10
END SEMESTER EXAM (ALL Modules)		

References:

1. Ross J Anderson and Ross Anderson, “Security Engineering: A guide to building dependable distributed systems”, Wiley, 2001.
2. David Powell, “A generic fault-Tolerant architecture for Real-Time Dependable Systems”, Springer, 2001.
3. Hassan B Diab and Albert Y. Zomaya, “Dependable computing systems: Paradigm, Performance issues and Applications”, Wiley series on Parallel and Distributed Computing, 2000.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05CS 7267	**SEMINAR – II**	**0-0-2-2**	**2015**

Each student shall present a seminar on any topic related to their miniproject or thesis work of the M. Tech. Program. The selected topic should be based on the papers published in reputed international journals preferably IEEE/ACM. They should get the paper approved by the Program Co-ordinator/Faculty member in charge of the seminar and shall present it in the class. Every student shall participate in the seminar. The students should undertake a detailed study on the topic and submit a report at the end of the semester. Marks will be awarded based on the topic, presentation, participation in the seminar and the report submitted.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05CS 7287	**PROJECT PHASE I**	**0-0-8-6**	**2015**

In Master's thesis Phase-I, the students are expected to select an emerging research area in Computer Science or related fields, after conducting a detailed literature survey. A detailed design should be prepared based on the study, comparison, analysis and review of the research work and recent developments in the area. Recent National/International Conference Proceedings/Journals, preferably IEEE/ACM, should be referred for the selection of the topic.

Students should submit a copy of Phase-I thesis report covering the content discussed above and highlighting the features of work to be carried out in Phase-II of the thesis. Emphasis should be given for literature survey, scope and design of the proposed work along with the details of the preliminary work carried out on the thesis topic.

The candidate should present the current status of the thesis work and the assessment will be made on the basis of the work and the presentation, by a panel of examiners. This panel can be a committee headed by the head of the department with two other faculty members in the area of the project, of which one shall be the project supervisor .If the project is done outside the college, the external supervisor associated with the student will also be a member of the committee. The examiners should give their suggestions in writing to the students so that it should be incorporated in the Phase–II of the thesis.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
05CS 7288	**PROJECT PHASE II**	**0-0-21-12**	**2015**

In the fourth semester, the thesis work approved and evaluated in third semester should be continued and carried out to successful completion . A detailed thesis report should be submitted at the end of phase II. The work carried out should lead to a publication in a National / International Conference or Journal. The papers received acceptance before the M.Tech evaluation will carry specific weightage.

Final evaluation of the project will be taken up only on completion of the project. This shall be done by a committee constituted by the principal of the college for the purpose. The concerned head of the department shall be the chairman of this committee. It shall have two senior faculty members from the same department, project supervisor and external supervisor of the student, if any and an external expert either from an academic /R&D organization or from industry as members.