SYLLABUS
M.Tech- STRUCTURAL ENGINEERING

ADVANCED DESIGN OF RC STRUCTURES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – I

Subject Code	21CSE11	**CIE**	50
Number of Lecture Hours/Week	03	**SEE**	50
Total Number of Lecture Hours	52	**Exam Hours**	03

CREDITS – 03

Course objectives:

The objective of this course is to make students to learn principles of Structural Design, To design different types of structures and to detail the structures. To evaluate performance of thestructures

Modules	Teaching Hours	RBT Level
Module -1		
Yield line method of design of slabs. Introduction, fundamental concepts of yield line theory, location of yield lines for standard cases, internal force in yield lines, methods of yield line by equilibrium approach, yield line analysis of one way and two way rectangular slab, circular slab and rectangular slab supported on three sides. Yield line design of one way and two way rectangular slab.	**10 Hours**	**L_1, L_2, L_3, L_4, L_5**
Module -2		
Design of grid floors andDesignof flat slabs. Introduction, analysis and design of grid floors by approximate method. Design of flat slab	**10 Hours**	**L_1, L_2, L_3, L_4, L_5**
Module -3		
Design of continuous beams with redistribution of Moments Introduction, effective span and calculation of bending moment and shear force, redistribution of moments, design of continuous beam by limit state method, reinforcement detailing, Design principles of curved beams.	**10 Hours**	**L_1, L_2, L_3, L_4, L_5**
Module -4		
Design of silos, bunkers and Design principles of chimneys.	**10 Hours**	**L_1, L_2, L_4, L_5**
Module -5		
Introduction, formwork as a temporary structures, Requirements for formwork, selection of formwork,classification or types of formwork, Materials for formwork: Timber, Plywood, Steel, Aluminum, Plastic and other materials.	**12 Hours**	**L_1, $L_{2,L5}$**

Design concepts: loads on formwork, dead load or permanent load, imposed load, environmental load, the design basis (Assumption made in formwork design) estimating permissible stresses, maximum bending moment, shear force and deflection, numerical problems.		

Course outcomes:

On completion of this course, students are ableto:

- AchieveKnowledgeofdesignanddevelopmentofproblemsolvingskills.
- Understand the principles of StructuralDesign
- Design and develop analyticalskills.
- Summarize the principles of Structural Designand detailing
- Understands the concepts of formwork.

Question paper pattern:

- The question paper will have tenquestions.
- Each full question consists of 10marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under amodule.
- The students will have to answer 5 full questions, selecting one full question from each module.

REFERENCE BOOKS:

1. N Krishna raju "Design of advance R C structure" CBS publication, New delhi
2. A.K.Jain "Limit state method of design neemchand and bros roorkee
3. Park and pandey "Reinforced concrete" john witney and bros
4. B.C Punmia , Ashokkumar and Jain A K Jain – "Limit state design of reinforced concrete" laxmi publication new delhi
5. V. Ram Krishnan and P.D Arthm "Ultimate strength design of structural concrete" Wheeler books Allahabad
6. IS 456-2000, SP-16

COMPUTATIONAL STRUCTURAL MECHANICS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – I

Subject Code	21CSE12	**CIE**	50
Number of Lecture Hours/Week	03	**SEE**	50
Total Number of Lecture Hours	52	**Exam Hours**	03

CREDITS – 03

Course objectives:

The objective of this course is to make students to learn principles of Structural Analysis, To implement these principles through different methods andtoAnalysevarioustypesofstructures.Toevaluatetheforceanddisplacement parameters of thestructures.

Modules	Teaching Hours	RBT Level
Module -1		
Fundamental concepts: Static and Kinematic indeterminacy, Concepts of stiffness and flexibility. Energy concepts. Principle of minimum potential energy and minimum complementary energy. Development of element flexibility and element stiffness matrices for truss, beam and gridelements.	**12 Hours**	**L_1, L_2, L_4, L_5**
Module -2		
Analysis using Flexibility method: Force- transformation matrix using Flexibility method, Development of global flexibility matrix for continuous beams, plane trusses and rigid plane frames (having not more than six co-ordinates – 8x8flexibility matrix) Analysis of continuous beams, plane trusses and rigid plane frames by flexibility method (Only 2D)	**10 Hours**	**L_1, L_2, L_3 L_4, L_5**
Module -3		
Analysis using Stiffness Method: Displacement- transformation matrix using Stiffness Method, Development of global stiffness matrix for continuous beams, plane trusses and rigid plane frames (having not more than six co-ordinates – 8x8 stiffness matrix) Analysis of continuous beams, plane trusses and rigid plane frames by stiffness method (Only 2D)	**10 Hours**	**L_1, L_2, L_3 L_4, L_5**
Module -4		

Effects of temperature change and lack of fit: Related numerical problems by flexibility and stiffness method as in Module 2 and 3	**10 Hours**	**L_1, L_2, L_3 L_4, L_5**
Module -5		
Numarical techniques: Solution techniques including numerical problems for simultaneous equations, Gauss elimination and Cholesky method. Bandwidth minimization technique.	**10 Hours**	**L_1, L_2, L_4, L_5**

Course outcomes:

On completion of this course, students are ableto:

- Achieve Knowledge of design and development of problem solvingskills.
- Understand the principles of StructuralAnalysis
- Design and develop analyticalskills
- Summarize the Solutiontechniques
- Understand the concepts of structuralbehavior

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 10marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from eachmodule.

REFERENCE BOOKS:

1. Rajasekaran, "**Computational Structural Mechanics**", PHI, New Delhi 2001.
2. F.W.Beaufait et al., "**Computer methods of Structural Analysis"**, Prentice Hall,1970.
3. W.Weaver and J.H.Gere, "**Matrix Analysis of Framed Structures"**, Van Nastran,1980.
4. H.Karde Stuncer, "**Elementary Matrix Analysis of Structures"**, McGraw Hill1974.
5. A.K.Jain "**Advanced Structural Analysis with ComputerApplication"** Nemchand and Brothers, Roorkee, India.
6. M.F.Rubinstein "**Matrix Computer Methods of Structural Analysis**"Prentice – Hall.
7. C.S.Reddy "**Basic Structural Analysis**" Tata McGraw Hill – 1996
8. M.Mukhopadyaya "**Matrix Finite Element,Compute and Strength Analysis**" OxFord & IBW – 1984.
9. G.S.Pandit & S.P.Gupta "**Structural Analysis A Matrix Approach"** TataMcGraw Hill – 1981

ADVANCED DESIGN OF PRE-STRESSED CONCRETE STRUCTURES

[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – I

Subject Code	21CSE131	**CIE**	50
Number of Lecture Hours/Week	03	**SEE**	50
Total Number of Lecture Hours	52	**Exam Hours**	03

CREDITS – 03

Course objectives: This course will enable students to

1. Design pre-stressedelements
2. Understand the behavior of pre-stressedelements.
3. Understand the behavior of pre-stressedsections

Modules	Teaching Hours
Module -1	
Losses of Pre stress: General concepts of Pre-stress and pre stressing systems, pre-tensioning system, post tensioning system, load bearing concepts Loss of prestress in pre-tensioned and post- tensioned members due to various causes like elastic shortening of concrete, shrinkage of concrete, creep of concrete, relaxation of steel, slip in anchorage, bending of member and frictional loss.	**10 Hours**
Module -2	
Deflections of Prestressed Concrete Members: Importance of Control of Deflections, Factors Influencing Deflections, Short-term Deflections of Uncracked Members, Prediction of Long-time Deflections, Deflections of Cracked Members,and Requirements of Various Codes of Practice.	**10 Hours**
Module -3	
Flexural Strength of Pre stressed concrete section. Types of flexural failure Analysis of sections under axial load and for flexure, Indian code provisional for analysis of flexural strength. **Design of Sections for Shear**: Shear and Principal stresses, Improving shear resistance by different prestressing techniques- horizontal, sloping and vertical prestressing, Analysis of rectangular and I–beam, Design of shear reinforcement,Indian code provisions.	**10 Hours**
Module -4	

Transfer of Prestress in Pretensioned Members : Transmission of prestressing force by bond, Transmission length, Flexural bond stresses,IScodeprovisions,Anchoragezonestressesinpost Tensioned members, stress distribution in End block, Anchorage zone reinforcements.	**12 Hours**
Module -5	
Statically Indeterminate Structures: Advantages and disadvantages of continuous PSC beams, Primary and secondary moments,PandClines,Lineartransformation,concordantand Non-concordant cable profiles, Analysis of continuous beams.	**10 Hours**

Course outcomes:

After studying this course, students will be able to:

- Analyse , Design and detail PSCelements

Question paper pattern:

- The question paper will have Ten questions, each full question carrying 10marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from eachmodule.
- Each full question shall cover the topics under amodule.
- The students shall answer Five full questions selecting one full question from each module.
- Ifmorethanonequestionisansweredinmodules,bestanswerwillbeconsidered for the award of marks limiting one full question answer in each module.

REFERENCE BOOKS:

1. Krishna Raju, “Prestressed concrete”, Tata Mc Graw Hill Book – Co ., NewDelhi.
2. T.Y. Lin and Burn, “Design of prestress concrete structures”, John Wiley, NewYork.
3. S. Ramamrutham, “Prestressed concrete”, Dhanpat Rai & Sons,Delhi.
4. IS1343-2007

STRUCTURAL DYNAMICS

[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – I

Subject Code	21CSE132	**CIE**	50
Number of Lecture Hours/Week	03	**SEE**	50
Total Number of Lecture Hours	52	**Exam Hours**	03

CREDITS – 03

Course objectives:

The objective of this course is to make students to learn principles of Structural Dynamics, To implement these principles through different methods and to apply the same for free and forced vibration of structures. To evaluate the dynamic characteristics of thestructures

Modules	Teaching Hours	RBT Level
Module -1		
Introduction: Introduction to Dynamic problems in Civil Engineering, Concept of degrees of freedom, D'Alembert's principle, principle of virtual displacement and energy principles Dynamics of Single degree-of-freedom systems: Mathematical models of Single-degree-of-freedom systems system, Free vibration response of damped and undamped systems.	**12 Hours**	**L_1, L_2, L_5**
Module -2		
Response of Single-degree-of-freedom systems to harmonic loading (rotation unbalance, reciprocating unbalance) including support motion, vibration isolation, transmissibility, Numerical methods applied to Single-degree-of-freedom systems – Duhamel integral,	**10 Hours**	**L_3, L_4, L_5**
Module -3		
Two degrees of freedom system: free and forced vibration of undamped freedom system, viscous damping in free vibration, co-ordinate coupling, vibration absorber of two-degree of freedom system. Forced vibration of damped two degrees of freedom system.	**10 Hours**	**L_1, L_2, L_4, L_5**

Module -4		
Dynamics of Multi-degree freedom systems: multi-degree-of-freedom systems, Shear building concept, free vibration of undamped multi-degree-of-freedom systems – Natural frequencies and mode shapes – orthogonalitypropertyof modes.	**10 Hours**	**L_3, L_4, L_5**
Module -5		
Approximate methods: Rayleigh's method Dunkarley's method, Stodola's method. Dynamics of Continuous systems: Free longitudinal vibration of bars, flexural vibration of beams with different end conditions, lumped mass and consistence mass system.	**10 Hours**	**L_2, L_4**

Course outcomes:

On completion of this course, students are ableto:

- AchieveKnowledgeofdesignanddevelopmentofproblemsolvingskills.
- Understand the principles of StructuralDynamics
- Design and develop analyticalskills.
- Summarize the Solution techniques for dynamics of Multi-degree freedom systems
- Understand the concepts of damping instructures.

Question paper pattern:

- The question paper will have tenquestions.
- Each full question consists of 10marks.
- There will be 2 full questions (with a maximum of four sub questions) from eachmodule.
- Each full question will have sub questions covering all the topics under a module.
- Thestudentswillhavetoanswer5fullquestions,selectingonefull question from each module.

REFERENCE BOOKS:

- Dynamics of Structures – Theory andApplication to Earthquake Engineering"- 2nd ed., Anil K.Chopra, PearsonEducation.
- Earthquake Resistant Design of Building Structures, Vinod Hosur, WILEY(india)
- Vibrations, structural dynamics- M. Mukhopadhaya : OxfordIBH publishing co-pvt.ltd. New Delhi.
- Structural Dynamics- Mario Paz: CBSpublishers.
- Structural Dynamics- Clough &Penzien:TMH
- Vibration Problems in Engineering Timoshenko, S, Van-NostrandCo

DESIGN OF PRECAST AND COMPOSITE STRUCTURES [As per Choice Based Credit System (CBCS) scheme] SEMESTER – I			
Subject Code	21CSE133	**CIE**	50
Number of Lecture Hours/Week	03	**SEE**	50
Total Number of Lecture Hours	52	**Exam Hours**	03
CREDITS – 03			

Course objectives: This course will enable students to

1. Understand the concepts and techniques of precast construction and Select or design precast elements suitable for project specific requirements
2. Design precast systems to ensure integrity and safety of the structure and to avoid progressive collapse and Design composite floors and beam elements

Modules	Teaching Hours
Module -1	
Concepts , components, Structural Systems and Design of precast concrete floors Need and types of precast construction, Modular coordination, Precast elements- Floor, Beams, Columns and walls. Structural Systems and connections. **Design of precast Concrete Floors:**Theoretical andDesign Examples of Hollow core slabs,. Precast Concrete Planks, floor with composite toppings with and without props.	**10 Hours**
Module -2	
Design of precast reinforced and prestressed Concrete beams Theoretical andDesignExamples of ITB – Full section precast, SemiPrecast,proppedandunproppedconditions.DesignofRCNibs	**10 Hours**
Module -3	
Design of precast concrete columns and walls Design of braced and unbraced columns with corbels subjected to pattern and full loading. Design of Corbels, Design of RC walls subjected to Vertical, Horizontal loadsand moments, Design of vertical ties and horizontal joints.	**10 Hours**
Module -4	

Design of Precast Connections and Structural Integrity Beam bearing, Beam half Joint,Steel Inserts, Socket Connection, Structural integrity, Avoidance of progressive collapse, Design of Structural Ties.	**12 Hours**
Module -5	
Design of Steel Concrete Composite Floors and Beams Composite Floors: Profiled Sheeting with concrete topping, Design method, Bending and Shear Resistance of Composite Slabs, Serviceability Criteria, DesignExample **Composite Beams:** Elastic Behaviour, Ultimate Load behavior of Composite beams, Stresses and deflection in service and vibration, Design Example of Simply Supported beams.	**10 Hours**
Course outcomes: After studying this course, students will be able to:	
Graduate Attributes (as per NBA)	

Question paper pattern:

- The question paper will have Ten questions, each full question carrying 10marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from eachmodule.
- Each full question shall cover the topics under amodule.
- The students shall answer Five full questions selecting one full question from eachmodule.

If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in eachmodule.

REFERENCES:

1. Hass A.M. – Precast Concrete – Design and applications Applied Science,1983.
2. David Sheppard – "Plant cast, Precast and Prestressed concrete– McGraw Hill;1989
3. NBC – 2005 (Part I to Part VII) BIS Publications, New Delhi, IS 15910- 2011,IS 11447,IS5241 – I andIII
4. R.P.Johnson: Composite Structure of Steel and Concrete (Volume 1), Blackwell Scientific Publication (Second Edition), U.K.,1994.
5. IS: 11384-1985, Code of Practice for Composite Construction in Structural Steel andConcrete.

INSDAG Teaching Resource Chapter 21 to 27:www.steel-insdag.org

RELIABILITY ANALYSIS OF STRUCTURES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – I

Subject Code	21CSE134	**CIE**	50
Number of Lecture Hours/Week	03	**SEE**	50
Total Number of Lecture Hours	52	**Exam Hours**	03

CREDITS – 03

Course objectives:

The objective of this course is to make students to learn principles of reliability, To implement the Probability Concepts for the ReliabilityAnalysis.
To evaluate different methods of reliability analysis.

Modules	Teaching Hours	RBT Level
Module -1		
Preliminary Data Analysis: Graphical representation- Histogram, frequency polygon, Measures of central tendency- grouped and ungrouped data, measures of dispersion, measures of asymmetry. Curve fitting and Correlation: Fitting a straight line, curve of the form $y = ab^x$, and parabola, Coefficient ofcorrelation.	**10 Hours**	**L_1, L_2, L_3, L_4**
Module -2		
Probability Concepts: Random events-Sample space and events, Venn diagram and event space, Measures of probability-interpretation, probability axioms, addition rule, multiplication rule, conditional probability, probability tree diagram, statistical independence, total probability theorem and Baye's theorem	**10 Hours**	**L_1, L_2, L_4**
Module -3		
Random variables: Probability mass function, probability density function, Mathematical expectation, Chebyshev's theorem. Probability distributions: Discrete distributions- Binomial and poison distributions, Continuousdistributions- Normal, Log normal distributions.	**10 Hours**	**L_1, L_2, L_4**
Module -4		

Reliability Analysis: Measures of reliability-factor of safety, safety margin, reliability index, performance function and limiting state. Reliability Methods-First Order Second Moment Method (FOSM), Point Estimate Method (PEM), and Advanced First Order Second Moment Method (Hasofer-Lind'smethod)	**10 Hours**	**L_1, L_2, L_3, L_4**
Module -5		
System reliability: Influence of correlation coefficient, redundant and non-redundant systems- series, parallel and combined systems, Uncertainty in reliability assessments- Confidence limits, Bayesian revision of reliability. Simulation Techniques: Monte Carlo simulation- Statistical experiments, sample size and accuracy, Generation of randomnumbers- random numbers with standard uniform distribution, continuous random variables, discrete random variables	**12 Hours**	**L_1, L_2, L_4**

Course outcomes:

On completion of this course, students are ableto:

- AchieveKnowledgeofdesignanddevelopmentofproblemsolvingskills.
- Understand the principles ofreliability.
- Design and develop analyticalskills.
- Summarize the Probabilitydistributions
- Understands the concept of Systemreliability.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 10marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under amodule.
- The students will have to answer 5 full questions, selecting one full question from eachmodule.

REFERENCE BOOKS:

1. Ranganathan, R. (1999). "Structural Reliability Analysis and design"- Jaico publishing house, Mumbai,India.
2. Ang, A. H. S., and Tang, W. H. (1984). "Probability concepts in engineering planninganddesign"-Volume–I,JohnWileyandsons,Inc,NewYork.
3. Ang, A. H. S., and Tang, W. H. (1984). "Probability concepts in engineering planning and design"-Volume –II, John Wiley and sons, Inc, NewYork.
4. Milton, E. Harr (1987). "Reliability based design in civil engineering"- Mc Graw Hill bookCo.
5. Nathabdndu, T., Kottegoda, and Renzo Rosso (1998). Statistics, "Probability and reliability for Civil and Environmental Engineers"- Mc Graw Hill international edition,Singapore.
6. Achintya Haldar and Sankaran Mahadevan (2000). "Probability, Reliability and Statistical methods in Engineering design"- John Wiley and Sons.Inc.
7. Thoft-christensen, P., and Baker, M., J., (1982), "Structural reliability theory and its applications"- Springer-Verlag, Berlin,NewYork.
8. Thoft-christensen, P., and Murotsu, Y. (1988). "Application of structural systems reliability theory"- Springer-Verlag, Berlin,NewYork

DESIGN OF MASONRY STRUCTURES

[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – I

Subject Code	21CSE141	**CIE**	50
Number of Lecture Hours/Week	03	**SEE**	50
Total Number of Lecture Hours	52	**Exam Hours**	03

CREDITS – 03

Course objectives:

The objective of this course is to make students to learn performance of masonry structures, To design the masonry structures for earthquake resistance. To evaluate the strength and stability of the masonrystructures.

Modules	**Teaching Hours**	**RBT Level**
Module -1		

Introduction, Masonry units, materials and types: History of masonry Characteristics of Brick, stone, clay block, concrete block, stabilized mud block masonry units – strength, modulus of elasticity and water absorption. Masonry materials – Classification and properties of mortars, selection ofmortars.	**10 Hours**	**L_1, L_2**
Module -2		
Strength of Masonry in Compression: Behaviour of Masonry under compression, strength and elastic properties, influence of masonry unit and mortar characteristics, effect of masonry unit height on compressive strength, influence of masonry bonding patterns on strength, prediction of strength of masonry in Indian context, Failure theories of masonry under compression. Effects of slenderness and eccentricity, effect of rate of absorption, effect of curing, effect of ageing, workmanship on compressivestrength	**10 Hours**	**L_1, L_2, L_4**
Module -3		
Flexural and shear bond, flexural strength and shear strength: Bond between masonry unitand mortar, tests for determining flexural and shear bond strengths, factors affecting bond strength, effect of bond strength on compressive strength, orthotropic strength properties of masonry in flexure, shear strength of masonry, test procedures for evaluating flexural and shearstrength	**10 Hours**	**L_1, L_2, L_4**
Module -4		
Design of load bearing masonry buildings: Permissible compressive stress, stress reduction and shape reduction factors, increase in permissible stresses for eccentric vertical and lateral loads, permissible tensile and shear stresses, Effective height of walls and columns, opening in walls, effective length, effective thickness, slenderness ratio, eccentricity, load dispersion, arching action, lintels; Wall carrying axial load, eccentric load with different eccentricity ratios, wall with openings, freestanding wall; Design of load bearing masonry for buildings up to 3 to 8 storeys using BIS codal provisions	**12 Hours**	**L_1, L_2, L_3, L_4**
Module -5		

Earthquake resistant masonry buildings: Behaviour of masonry buildings during earthquakes, concepts and design procedure for earthquake resistant masonry, BIS codal provisions. Masonry arches, domes and vaults: Components and classification of masonry arches, domes and vaults, historical buildings, construction procedure	**10 Hours**	**L_1, L_2, L_4**

Course outcomes:

On completion of this course, students are ableto:

- AchieveKnowledgeofdesignanddevelopmentofproblemsolvingskills.
- Understand the principles of design and construction of masonry structures
- Design and develop analyticalskills.
- Summarize the masonryCharacteristics.
- Evaluatethestrengthandstabilityofthemasonrystructures.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 10marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under amodule.
- The students will have to answer 5 full questions, selecting one full question from eachmodule.

REFERENCE BOOKS:

1. Hendry A.W., "Structural masonry"- Macmillan Education Ltd.,2nd edition
2. SinhaB.P&DavisS.R.,"DesignofMasonrystructures"-E&FNSpon
3. DayaratnamP,"BrickandReinforcedBrickStructures"-Oxford&IBH
4. Curtin,"DesignofReinforcedandPrestressedMasonry"-ThomasTelford
5. Sven Sahlin, "Structural Masonry"-PrenticeHall
6. Jagadish K S, Venkatarama Reddy B V and Nanjunda Rao K S, "Alternative Building Materials and Technologies"-New Age International, New Delhi &Bangalore
7. IS 1905, BIS, NewDelhi.
8. SP20(S&T),NewDelhi

SPECIAL CONCRETE

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – I

Subject Code	21CSE142	**CIE**	50
Number of Lecture Hours/Week	03	**SEE**	50
Total Number of Lecture Hours	52	**Exam Hours**	03
CREDITS – 03			

Course objectives:

The objective of this course is to make students to learn principles of Concrete mix design, To differentiate between different types of concrete. To characterize the high Performanceconcrete.

Modules	Teaching Hours	RBT Level
Module -1		
Components of modern concrete and developments in the process and constituent materials: Role of constituents, Development incements and cement replacement materials, pozzolona, fly ash, silica fume, rice husk ash, recycled aggregates, chemical admixtures. Mix proportioning of Concrete: Principles andmethods.	**10 Hours**	**L_1, L_2, L_5**
Module -2		
Light Weight concrete: Introduction, classification, properties, strength and durability, mix proportioning and problems. High density concrete: Radiation shielding ability of concrete, materials for high density concrete, mix proportioning, properties in fresh and hardened state, placementmethods.	**10 Hours**	**L_1, L_2**
Module -3		
Ferro cement: Ferrocement materials, mechanical properties, cracking of ferrocement, strength and behaviour in tension, compression and flexure, ferrocement constructions, durability, andapplications. Self Compacting Concrete, Reactive powder concrete, and bacterialconcrete	**11 Hours**	**L_1, L_2, L_5**
Module -4		
Fibre reinforced concrete: Fibre materials, mix proportioning, distribution and orientation, interfacial bond, properties in fresh state, strength and behavior in tension, compression and flexure of steel fibre reinforced concrete, mechanicalproperties, crack arrest and toughening mechanism,applications.	**11 Hours**	**L_1, L_2, L_5**
Module -5		
High Performance concrete: constituents, mix proportioning, properties in fresh and hardened states, applications and limitations. Ready Mixed Concrete-QCI-RMCPC scheme requirements.	**10 Hours**	**L_1, L_2**

Course outcomes:

On completion of this course, students are ableto:

- Achieve Knowledge of design and development of problem solvingskills.
- Understand the principles of Concrete mixdesign
- Design and develop analyticalskills.
- Summarize the Light Weight concrete, Fibre reinforced concrete and High Performanceconcrete
- Understand the concepts of high Performanceconcrete

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 10marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under amodule.
- The students will have to answer 5 full questions, selecting one full question from eachmodule.

REFERENCES:

1. Neville A.M, "Properties of Concrete" Pearson Education Asia,2000
2. P. Kumar Mehta, Paul J.N. Monterio, CONCRETE:Microstructure, Properties and Materials", Tata McGrawHill
3. A.R.Santhakumar, (2007) "Concrete Technology"-Oxford University Press, New Delhi,2007
4. Gambhir "Concrete Technology"TMH.
5. Short A and Kinniburgh.W, "Light Weight Concrete"- Asia Publishing House,1983
6. Aitcin P.C. "High Performance Concrete"-E and FN, Spon London1998
7. Rixom.R. and Mailvaganam.N., "Chemical admixtures in concrete"- E and FN, Spon London1999
8. Rudnai.G.,"LightWeightconcrete"-Akademiaikiado,Budapest,1983
9. http://qcin.org/CAS/RMCPC/

ADVANCED DESIGN OF STEEL STRUCTURES [As per Choice Based Credit System (CBCS) scheme] SEMESTER – I			
Subject Code	21CSE143	IA Marks	50
Numberof Lecture Hours/Week	03	Exam Marks	50

Total Number of Lecture Hours	52	Exam Hours	03

CREDITS – 03

Course objectives: This course will enable students to

1. Understand the background to the design provisions for hot-rolled and cold-formed steel structures, including the main differences between them.
2. Proficiency in applying the provisions for design of columns,beams, beam-columns
3. Design structural sections for adequate fireresistance

Modules	Teaching Hours
Module -1	
Laterally Unrestrained Beams: Lateral Buckling of Beams, Factors affecting lateral stability, IS 800 code provisions, Design Approach. Lateral buckling strength of Cantilever beams, continuous beams, beams with continuous and discretelateralrestraints,Mono-symmetricandnon-uniform beams – Design Examples. Concepts of -Shear Center, Warping, Uniform and Non-Uniform torsion.	**12 Hours**
Module -2	
Beam- Columns in Frames: Behaviour of Short and Long Beam - Columns, Effects of Slenderness Ratio and Axial Force on Modes of Failure, Biaxial bending, Strength of Beam Columns, Sway and Non-Sway Frames, Strength and Stability of rigid jointed frames, Effective Length of Columns-, Methods in IS 800 – Examples	**10 Hours**
Module -3	
Steel Beams with Web Openings: Shape of the web openings, practical guide lines, and Force distribution and failure patterns, Analysis of beams with perforated thin and thick webs, Design of laterally restrained castellated beams for given sectional properties, Vierendeel girders (design for given analysis results)	**10 Hours**
Module -4	
Cold formed steel sections: Techniques and properties, Advantages, Typical profiles, Stiffened and unstiffened elements, Local buckling effects, effective section properties, IS 801& 811 code provisions- numerical examples, beam design, column design.	**10 Hours**
Module -5	

Fire resistance: Fire resistance level, Period of Structural Adequacy, Properties of steel with temperature, Limiting Steel temperature, Protected and unprotected members, Methods of fire protection, Fire resistance ratings- Numerical Examples.	**10 Hours**

Course outcomes:

After studying this course, students will be able to:

Graduate Attributes (as per NBA)

Question paper pattern:

- The question paper will have Ten questions, each full question carrying 10 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from eachmodule.
- Each full question shall cover the topics under amodule.
- The students shall answer Five full questions selecting one full question from eachmodule.

If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

REFERENCE BOOKS:

1. N. Subramanian, "Design of Steel Structures", Oxford,IBH
2. Duggal S.K, "Design of Steel Structures" TataMcGraw-Hill 3. IS 1031, 1032,1033
3. IS 800: 2007,
4. IS 811
5. INSDAG Teaching Resource Chapter 11 to 20:www.steel-insdag.org

DISASTER MITIGATIONANDMANAGEMENT

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – I

Subject Code	21CSE144	**CIE**	50
Number of Lecture Hours/Week	03	**SEE**	50

Total Number of Lecture Hours	52	**Exam Hours**	03
CREDITS – 03			

Course objectives:

- To introduce various environmental hazards anddisasters.
- To understand various concepts, principles to manage disaster.
- Toappraisevariousenvironmentalpoliciesandprogramsin Indiafordisaster management.

Modules	Teaching Hours	RBT Level
Module -1		
Environmentalhazards,EnvironmentalDisastersandEnvironmentalstress-Meaning and concepts. Vulnerability and disasterpreparedness.	**10 Hours**	**L_1, L_2, L_3, L_4**
Module -2		
NaturalhazardsandDisasters-VolcanicEruption,Earthquakes,Tsunamis, Landslides,Cyclones,Lightning,Hailstorms,Floods,Droughts,Coldwaves, Heat waves andFire. Man induced hazards & Disasters - Soil Erosion, Chemical hazards, Population Explosion.	**11 Hours**	**L_1, L_2, L_4**
Module -3		
EmergingapproachesinDisasterManagement-Preparinghazardzonation maps,Predictability/forecasting&warning,Preparingdisasterpreparedness plan, Land use zoning,Communication. Disaster resistant house construction, Population reduction in vulnerable areas, Awareness Rescue training for search & operation at national & regionallevelImmediaterelief,Assessmentsurveys,PoliticalAdministrative Aspect, Social Aspect, Economic Aspect, Environmental Aspect.	**10 Hours**	**L_1, L_2, L_4**
Module -4		
ProvisionofImmediatereliefmeasurestodisasteraffectedpeople,Prediction of Hazards & Disasters, Measures of adjustment to naturalhazards.	**11 Hours**	**L_1, L_2, L_3, L_4**
Module -5		

A regional survey of Land Subsidence, Coastal Disaster, Cyclonic Disaster & Disaster in Hills with particular reference to India. Ecological planningfor sustainability&sustainabledevelopmentinIndia, Sustainablerural development: A Remedy to Disasters, Role of Panchayats in Disaster mitigations, Environmental policies & programmes in India- Institutions & NationalCentersforNaturalDisasterreduction,EnvironmentalLegislations in India, Awareness, Conservation Movement, Education &training.	**10 Hours**	**L_1, L_2, L_4**

Course outcomes:*On completion of this course, students are ableto:*

- AchieveKnowledgeofdesignanddevelopmentofproblemsolvingskills.
- Understand the environmental hazards anddisasters.
- Design and develop analyticalskills.
- To understand various concepts, principles to manage disaster.
- Toappraisevariousenvironmentalpoliciesandprogramsin Indiafordisaster management.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 10marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under amodule.
- The students will have to answer 5 full questions, selecting one full question from eachmodule.

REFERENCE BOOKS:

1. R.B.Singh (Ed), Environmental Geography, Heritage Publishers New Delhi,1990.
2. Savinder Singh, Environmental Geography, Prayag Pustak Bhawan,1997.
3. Kates,B.I & White, G.F., The Environment as Hazards, Oxford, New York, 1978.
4. R.B.Singh(Ed),DisasterManagement,RawatPublication,NewDelhi,2000.
5. H.K. Gupta (Ed), Disaster Management, University Press, India,2003.
6. R.B. Singh, Space Technology for Disaster Mitigation in India (INCED), University of Tokyo,1994
7. Dr.Satender, Disaster Management in Hills, Concept Publishing Co.,New Delhi,2003.
8. R.K. Bhandani, An overview on Natural & Man made Disaster & their Reduction, CSIR, NewDelhi.
9. M.C. Gupta, Manuals on Natural Disaster management in India, National Centre for Disaster Management, IIPA, New Delhi,2001.

RESEARCH METHODOLOGY AND IPR

[As per Choice Based Credit System (CBCS) Scheme]
SEMESTER-I

Subject Code	**19RM15**	**CIE Marks**	50
Number Lecture Hour/Week	**02**	**SEE Marks**	50
Number of Lecture Hours	**30**	**Exam Hours**	03

CREDITS-02

Course objectives:

- To give an overview of the research methodology and explain the technique of defining a research problem
- To explain the functions of the literature review in research.
- To explain carrying out a literature search, its review, developing theoretical and conceptual frameworks and writing a review.
- To explain various research designs and their characteristics.
- To explain the details of sampling designs, and also different methods of data collections.
- To explain the art of interpretation and the art of writing research reports.
- To explain various forms of the intellectual property, its relevance and business impact in the changing global business environment.
- To discuss leading International Instruments concerning Intellectual Property Rights.

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module -1		
Research Methodology: Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India.	**06 Hours**	**L1,L2**
Module -2		
Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration. **Reviewing the literature:** Place of the literature review in research, Bringing clarity and focus to your research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, How to review the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed.	**06 Hours**	**L1,L2**

Module -3		
Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs. **Design of Sample Surveys:** Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs.	**06 Hours**	**L1,L2, L3**
Module-4		
Data Collection: Experimental and Surveys collection of Primary Data, Collection of SecondaryData, Selection of Appropriate Method for Data Collection, Case Study Method. **Interpretation and Report Writing:** Meaning of Interpretation, Technique of Interpretation,Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports.	**06 Hours**	**L1, L2, L3**
Module-5		
Intellectual Property: The Concept, Intellectual Property System in India, Development of TRIPS Complied Regime in India, Patents Act, 1970, Trade Mark Act, 1999,The Designs Act, 2000, The Geographical Indications of Goods (Registration and Protection) Act1999, Copyright Act,1957,The Protection of Plant Varieties and Farmers' Rights Act, 2001,The Semi-Conductor Integrated Circuits Layout Design Act, 2000, Trade Secrets, Utility Models, IPR and Biodiversity, The Convention on Biological Diversity (CBD) 1992,Competing Rationales for Protection of IPRs, Leading International Instruments Concerning IPR, World Intellectual Property Organisation (WIPO),WIPO and WTO, Paris Convention for the Protection of Industrial Property, National Treatment, Right of Priority, Common Rules, Patents, Marks, Industrial Designs, Trade Names, Indications of Source, Unfair Competition, Patent Cooperation Treaty (PCT), Advantages of PCT Filing, Berne Convention for the Protection of Literary and Artistic Works, Basic Principles, Duration of Protection, Trade Related Aspects of Intellectual Property Rights(TRIPS) Agreement, Covered under TRIPS Agreement, Features of the Agreement, Protection of Intellectual Property under TRIPS, Copyright and Related Rights, Trademarks, Geographical indications, Industrial Designs, Patents, Patentable Subject Matter, Rights Conferred, Exceptions, Term of protection, Conditions on Patent Applicants, Process Patents, Other Use without Authorization of the Right Holder, Layout-Designs of Integrated Circuits, Protection of Undisclosed Information, Enforcement of Intellectual Property Rights, UNSECO.	**08 Hours**	**L1,L2, L3**

Course outcomes: At the end of the course the student will be able to: • Discuss research methodology and the technique of defining a research problem • Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review. • Explain various research designs and their characteristics. • Explain the art of interpretation and the art of writing research reports		
Text Books: **1.** Research Methodology: Methods and Techniques C.R. Kothari, Gaurav Garg New Age International 4th Edition, 2018. **2.** Research Methodology a step-by- Research Methodology a step-by- Ranjit Kumar , SAGE PublicationsLtd, 3rd Edition, 2011. **3.** Study Material (For the topic Intellectual Property under module 5) Professional Programme Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament, September 2013.		
Reference Books: 1. Research Methods: the concise knowledgebase Trochim ,Atomic Dog Publishing 2005 2. Conducting Research Literature Reviews: From the Internet to Paper, Fink A Sage Publications 2009		

ADVANCE CONCRETE TESTING LAB

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – I

Subject Code	21CSEL26	IA Marks	50
Number of Lecture Hours/Week	04	Exam Marks	50
Total Number of Lecture Hours	42	Exam Hours	03

CREDITS – 02

Course objectives:

The objective of this course is to make students to learn principles of design of experiments, To investigate the performance of structural elements.To evaluate the different testing methods and equipments

Modules	**Teaching Hours**	**RBT Level**
1. Testing of beams for deflection, flexureandshear *-12Hrs* 2. Experiments on Concrete, including Mixdesign *-10Hrs* 3. Experiments on vibration of multi storey frame models for Natural frequencyandmodes. *-10Hrs* 4. Use of Nondestructive testing (NDT) equipment's – Rebound hammer, Ultra sonic pulse velocity meter andProfometer *-10Hrs*	**42 Hours**	**L_1, L_2, L_3, L_4, L_5, L_8**

Course outcomes:

On completion of this course, students are ableto:

- Achieve Knowledge of design and development of programmingskills.
- Understand the principles of structural analysis anddesign
- Design and develop analyticalskills.
- Summarizetheperformanceofstructuresforstaticanddynamicforces.

STRUCTURAL ENGINEERING LAB-1

[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – I

Subject Code	21CSEL27	IA Marks	50
Number of Lecture Hours/Week	04	Exam Marks	50
Total Number of Lecture Hours	42	Exam Hours	03

CREDITS – 02

Course objectives:

1. The objective of this course is to make students
2. To analyze the structure using FE based Software
3. To learn principles of design
4. To investigate the performance of structural elements.
5. To design the structural components using excel sheets

Modules	Teaching Hours	RBT Level
1. Static and Dynamic analysis and design of Multistory Building structures using any FE based software *-16Hrs* 2. Design of RCC and Steel Tall structures using any FE based software-*16Hrs* 3. Preparation of EXCEL sheets for structural design *-10Hrs*	**42 Hours**	**L_1, L_2, L_3, L_4, L_5, L_8**

Course outcomes:

On complete of this course the students will able to

- Achieve Knowledge of design and development of programming skills.
- Understand the principles of structural analysis and design
- Design and develop analytical skills.
- Summarize the performance of structures for static and dynamic forces.

English For Research Paper Writing

[As per Choice Based Credit System (CBCS) Scheme]
SEMESTER-I/II

Subject Code	21AD11/21	CIE Marks	50
Number of Lecture Hour/Week	01	SEE Marks	50
Total Number of Lecture Hours	20	Exam Hours	03

CREDITS-00

Course Objectives: This course will enable students to:

1. Understand that how to improve your writing skills and level of readability
1. Learn about what to write in each section
2. Understand the skills needed when writing a Title Ensure the good quality of paper at very first-time submission

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module -1		
Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness	**04 Hours**	**L1,L2**
Module -2		
Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction	**04 Hours**	**L1,L2**
Module -3		
Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.	**04 Hours**	**L1,L2**
Module -4		
key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.	**04 Hours**	**L1, L2,L3**
Module-5		
Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions. useful phrases, how to ensure paper is as good as it could possibly be the first- time submission	**04 Hours**	**L1, L2,L3**

Text Books:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press

DISASTER MANAGEMENT

[As per Choice Based Credit System (CBCS) Scheme]
SEMESTER-I/II

Subject Code	21AD12/22	CIE Marks	50
Number Lecture Hour/Week	01	SEE Marks	50
Number of Lecture Hours	20	Exam Hours	03

CREDITS-00

Course Objectives:-Students will be able to:

1. Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
2. Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
4. Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module -1		
Introduction Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.	**04 Hours**	**L1,L2**
Module -2		
Repercussions Of Disasters And Hazards: Economic Damage, Loss Of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.	**04 Hours**	**L1,L2**

Module -3		
Disaster Prone Areas In India Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics	**04 Hours**	**L1,L2**
Module -4		
Disaster Preparedness And Management Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.	**04 Hours**	**L1, L2,L3**
Module-5		
Risk Assessment Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival. **Disaster Mitigation** Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.	**8 Hours**	**L1,L2,L3**

Course outcomes: After learning the course the students should be able to:

1. Understand disasters, disaster preparedness and mitigation measures
2. Understand role of IT, remote sensing, GIS and GPS in risk reduction
3. Understand disaster management acts and guidelines along with role of various stackholders during disasters.

Text Books:

1. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.
2. Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of

India, New Delhi.
3. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep &Deep Publication Pvt. Ltd., New Delhi.

SANSKRIT FOR TECHNICAL KNOWLEDGE

[As per Choice Based Credit System (CBCS) Scheme]
SEMESTER-I/II

Subject Code	21AD13/23	CIE Marks	50
Number Lecture Hour/Week	01	SEE Marks	50
Number of Lecture Hours	20	Exam Hours	03

CREDITS-00

Course Objectives:-Students will be able to:

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

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module -1		
Alphabets in Sanskrit	**04 Hours**	**L1,L2**
Module -2		
Past/Present/Future Tense, Simple Sentences	**04 Hours**	**L1,L2**
Module -3		
Order, Introduction of roots	**04 Hours**	**L1,L2**
Module -4		
Technical information about Sanskrit Literature	**8 Hours**	**L1, L2,L3**
Module-5		
Technical concepts of Engineering-Electrical,	**8 Hours**	**L1,L2,L3**

Mechanical, Architecture, Mathematics		

Course outcomes: Students will be able to

1. Understanding basic Sanskrit language

2. Ancient Sanskrit literature about science & technology can be understood

3. Being a logical language will help to develop logic in students.

Text Books:

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

VALUE EDUCATION

[As per Choice Based Credit System (CBCS) Scheme]
SEMESTER-I/II

Subject Code	21AD14/24	CIE Marks	50
Number Lecture Hour/Week	01	SEE Marks	50
Number of Lecture Hours	20	Exam Hours	03

CREDITS-00

Course Objectives:-Students will be able to:

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

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module -1		
Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non- moral valuation. Standards and principles. Value judgments	**04 Hours**	**L1,L2**
Module -2		
Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism.Love for nature.	**04 Hours**	**L1,L2**
Module -3		
Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour. Universal brotherhood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-	**04 Hours**	**L1,L2**

destructive habits. Association and Cooperation.		
Module -4		
Character and Competence –Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence,Humility, Role of Women.	**8 Hours**	**L1, L2,L3**
Module-5		
All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively	**8 Hours**	**L1,L2,L3**
Course outcomes: Students will be able to 1. Knowledge of self-development 2. Learn the importance of Human values 3. Developing the overall personality		
Text Books: 1. Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi		

CONSTITUTION OF INDIA

[As per Choice Based Credit System (CBCS) Scheme]
SEMESTER-I/II

Subject Code	21AD15/25	CIE Marks	50
Number Lecture Hour/Week	01	SEE Marks	50
Number of Lecture Hours	20	Exam Hours	03

CREDITS-00

Course Objectives:-Students will be able to:

1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module -1		
History of Making of the Indian Constitution: History Drafting Committee, (Composition & Working)	**04 Hours**	**L1,L2**
Module -2		
Philosophy of the Indian Constitution: Preamble Salient Features	**04 Hours**	**L1,L2**
Module -3		
Contours of Constitutional Rights & Duties: Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy	**04 Hours**	**L1,L2**
Module -4		

Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers Judiciary, Appointment and Transfer of Judges, Qualifications	**04 Hours**	**L1, L2,L3**
Module-5		
Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: ZilaPachayat. Elected officials and their roles, CEO ZilaPachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Election Commission: Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.	**8 Hours**	**L1,L2,L3**

Course outcomes: Students will be able to

1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.

Text Books:

1. The Constitution of India, 1950 (Bare Act), Government Publication.

2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.

3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.

4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

PEDAGOGY STUDIES

[As per Choice Based Credit System (CBCS) Scheme]
SEMESTER-I/II

Subject Code	21AD16/26	CIE Marks	50
Number Lecture Hour/Week	01	SEE Marks	50
Number of Lecture Hours	20	Exam Hours	03

CREDITS-00

Course Objectives:-Students will be able to:

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

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module -1		
Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions. Overview of methodology and Searching.	**04 Hours**	**L1,L2**
Module -2		
Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher education.	**04 Hours**	**L1,L2**
Module -3		
Evidence on the effectiveness of pedagogical practices Methodology for the in depth stage: quality assessment of included studies. How can teacher education	**04 Hours**	**L1,L2**

(curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? Theory of change. Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches.		
Module -4		
Professional development: alignment with classroom practices and follow-up support Peer support Support from the head teacher and the community. Curriculum and assessment Barriers to learning: limited resources and large class sizes	**04 Hours**	**L1, L2,L3**
Module-5		
Research gaps and future directions Research design Contexts Pedagogy Teacher education Curriculum and assessment	**8 Hours**	**L1,L2,L3**

Course outcomes: Students will be able to

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

Text Books:

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

STRESS MANAGEMENT BY YOGA

[As per Choice Based Credit System (CBCS) Scheme]
SEMESTER-I/II

Subject Code	21AD17/27	CIE Marks	50
Number Lecture Hour/Week	01	SEE Marks	50
Number of Lecture Hours	20	Exam Hours	03

CREDITS-00

Course Objectives:-Students will be able to:

1. To achieve overall health of body and mind
2. To overcome stress

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module -1		
Definitions of Eight parts of yog. (Ashtanga)	**04 Hours**	**L1,L2**
Module -2		
Ahinsa, satya, astheya, bramhacharya andaparigraha	**04 Hours**	**L1,L2**
Module -3		
Shaucha, santosh, tapa, swadhyay, ishwarpranidhan	**04 Hours**	**L1,L2**
Module -4		
Various yog poses and their benefits for mind & body	**04 Hours**	**L1, L2,L3**
Module-5		
Regularization of breathing techniques and itseffects-Types of pranayam	**04 Hours**	**L1,L2,L3**

Course outcomes: Students will be able to

1. Develop healthy mind in a healthy body thus improving social health also
2. Improve efficiency

1. 'Yogic Asanas for Group Tarining-Part-I" :Janardan Swami Yogabhyasi Mandal, Nagpur

2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda,AdvaitaAshrama (Publication

Department), Kolkata

PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS

[As per Choice Based Credit System (CBCS) Scheme]
SEMESTER-I/II

Subject Code	21AD18/28	CIE Marks	50
Number Lecture Hour/Week	01	SEE Marks	50
Number of Lecture Hours	20	Exam Hours	03

CREDITS-00

Course Objectives:-Students will be able to:

1. To learn to achieve the highest goal happily
2. To become a person with stable mind, pleasing personality and determination
3. To awaken wisdom in students

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module -1		
Neetisatakam-Holistic development of personality	**04 Hours**	**L1,L2**
Module -2		
Approach to day to day work and duties.	**04 Hours**	**L1,L2**
Module -3		
Shrimad BhagwadGeeta	**04 Hours**	**L1,L2**
Module -4		
Shrimad BhagwadGeeta:	**04 Hours**	**L1, L2,L3**
Module-5		
Personality of Role model. Shrimad BhagwadGeeta:	**04 Hours**	**L1,L2,L3**

Course outcomes: Students will be able to

1. Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life

2. The person who has studied Geeta will lead the nation and mankind to peace and prosperity

3. Study of Neetishatakam will help in developing versatile personality of students.

Text Books:

1. “Srimad Bhagavad Gita” by Swami SwarupanandaAdvaita Ashram (Publication

2. Department), Kolkata

3. Bhartrihari’s Three Satakam (Niti-sringar-vairagya) by P.Gopinath,

4. Rashtriya Sanskrit Sansthanam, New Delhi.

MECHANICSOFDEFORMABLEBODIES

[AsperChoiceBasedCreditSystem(CBCS)scheme]

SEMESTER–II

SubjectCode	**21CSE21**	CIEMarks	50
NumberofLecture Hours/Week	03	SEEMarks	50
TotalNumberofLe ctureHours	52	ExamHours	03

CREDITS–03

Prerequisites: StrengthofMaterials

Courseobjectives:

Courseobjectives:Theobjectiveofthiscourseistomakestudents to learnprinciples of Analysis of Stress and Strain, To predict the stress-strain behaviour ofcontinuum.To evaluatethestress and strain parameters and their inter relationsofthecontinuum

Modules	**TeachingHours**	**RBT Level**
Module-1		
Theory of Elasticity: Introduction: Definition of stress andstrainandstrainatapoint,componentsof stress andstrainatappointofCartesianandpolarcoordinates.Constitutive relations, equilibrium equations, compatibilityequationsandboundaryconditionsin2-Dand3-Dcases.	**10Hours**	**L1,L2**
Module-2		
Transformation of stress and strain at a point,Principalstressesandprincipalstrains,invariantsofstressandstrain,hydrostaticanddeviatricstress,sphericalanddeviatricstrainsmax.shearstrain.	**10Hours**	**L2,L3**
Module-3		
Planestressandplanestrain:Airy'sstressfunctionapproach to 2-D problems of elasticity, simple problems ofbendingofbeams.Solutionofaxisymmetricproblems,stress concentration due to the presence of a circular holeinplates.	**10Hours**	**L2,L3**
Module-4		

Elementaryproblemsofelasticityinthreedimensions,stretching of a prismatic bar by its own weight, twistofcircular shafts, torsion of non-circular sections, membraneanalogy, Propagation of waves in solid media. Applicationsoffinitedifferenceequationsinelasticity.	**12Hours**	**L2, L3,L4**
Module-5		
TheoryofPlasticity:Stress–straindiagraminsimpletension,perfectlyelastic,Rigid–Perfectlyplastic,Linear work – hardening, Elastic Perfectly plastic, ElasticLinearworkhardeningmaterials,Failuretheories,yieldconditions, stress – space representation of yield criteriathroughWestergardstressspace,TrescaandVon-Misescriteriaofyielding	**10Hours**	**L1,L2**

Courseoutcomes:

Oncompletionofthiscourse,studentsareableto:

- AchieveKnowledgeofdesignanddevelopmentofproblemsolvingskills.
- Understandtheprinciplesofstress-strainbehaviourofcontinuum
- Designanddevelopanalyticalskills.
- Describethecontinuumin2and3-dimensions
- Understandtheconceptsofelasticityandplasticity

Question paper pattern:

The question paper will have ten questions; each question carries equal marks,therewillbetwo fullquestions orwithamaximum of four sub questions fromeachmodule,studentswillhavetoattendfivefullquestionsfromeachmodule.

ReferenceBooks:

1. Timoshenko&Goodier,"TheoryofElasticity",McGrawHill
2. SrinathL.S.,AdvancedMechanicsofSolids,10thprint,TataMcGrawHillPublishingcompany,NewDelhi,1994.
3. SadhuSingh,"TheoryofElasticity",KhannaPublishers
4. VermaP.D.S,"TheoryofElasticity",VikasPublishingPvt.Ltd
5. ChennW.PandHendryD.J,"PlasticityforStructuralEngineers",SpringerVerlag
6. ValliappanC,"ContinuumMechanicsFundamentals",OxfordIBHPublishingCo.Ltd.
7. SadhuSingh,"AppliedStressAnalysis",KhannaPublishers
8. XiLu,"TheoryofElasticity",JohnWiley.

STABILITY OF STRUCTURES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – II

Subject Code	21CSE22	IA Marks	50
Number of Lecture Hours/Week	03	Exam Marks	50
Total Number of Lecture Hours	52	Exam Hours	03

CREDITS – 03

Course objectives:

The objective of this course is to make students to learn principles of stability of structures, To analyse the structural elements for stability. To evaluate the use of strain energy in plate bendingand stability.

Modules	Teaching Hours	RBT Level
Module -1		
Beam – column – Differential equation. Beam column subjected to (i) lateral concentrated load, (ii) several concentrated loads, (iii) continuous lateral load. Application of trigonometric series, Euler's formulation using fourth order differential equation for pined – pined, fixed – fixed, fixed – free and fixed – pinnedcolumn.	**10 Hours**	**L_1, L_2**
Module -2		
Buckling of frames and continuous beams. Elastic Energy method: Approximate calculation of critical loads for a cantilever. Exact critical load for hinged – hinged column using energy approach. Buckling ofbar on elastic foundation. Buckling of cantilever column under distributed loads. Determination of critical loads by successive approximation. Bars with varying cross section. Effect of shear force on critical load. Column subjected to non – conservative follower and pulsatingforces.	**10 Hours**	**L_2, L_3**
Module -3		
Stability analysis by finite element approach – deviation of shape function for a two nodded Bernoulli – Euler beam element (lateral and translation of) – element stiffness and element geometric stiffness matrices – assembled stiffness and geometric stiffness matrices for a discretised column with differentboundary condition – calculation of critical loads for a discretised (two elements) column (both endsbuilt in). Buckling of pin jointed frames (maximum of two active DOF) – symmetrical single bay portal frame.	**12 Hours**	**L_2, L_3, L_4**
Module -4		

Lateral buckling of beams – differential equation – pure bending – cantilever beam with tip load – simply supported beam of I section subjected to central concentrated load. Pure Torsion of thin – walled bars of open cross section. Non – uniform Torsion of thin – walled bars of open crosssection.	**10 Hours**	**L_1, L_2, L_3**
Module -5		
Expression for strain energy in plate bending with in plate forces (linear and non – linear). Buckling of simply supported rectangular plate – uniaxial load and biaxial load. Buckling of uniformly compressed rectangular plate simply supported along two opposite sides perpendicular to the direction of compression and having various edge conditionalong the other two sides	**10 Hours**	**L_1, L_2, L_3**

Course outcomes:

On completion of this course, students are ableto:

- AchieveKnowledgeofdesignanddevelopmentofproblemsolvingskills.
- Understand the principles of strength andstability
- Design and develop analyticalskills.
- Appraise the Stability analysis by finite elementapproach.
- Understand the concepts of Lateral buckling ofbeams.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 10marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under amodule.
- The students will have to answer 5 full questions, selecting one full question from eachmodule.

REFERENCE BOOKS:

1. Stephen P.Timoshenko, James M Gere, "Theory of Elastic Stability"-2nd Edition, McGraw – Hill, NewDelhi.
2. Robert D Cook et.al, "Concepts and Applications of Finite Element Analysis"-3rd Edition, John Wiley and Sons, NewYork.
3. S.Rajashekar, "Computations and Structural Mechanics"-Prentice – Hall,India.
4. Ray W Clough and J Penzien, "Dynamics of Structures" - 2nd Edition, McGraw Hill, NewDelhi
5. H.Zeiglar, "Principles of Structural Stability"-BlaisdallPublications

CORRODION OF STEELINCONCRETE

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – II

Subject Code	21CSE 231	IA Marks	50
Number of Lecture Hours/Week	03	Exam Marks	50
Total Number of Lecture Hours	52	Exam Hours	03

CREDITS – 03

Course objectives:

To impartsufficientknowledgeonmechanismofcorrosionofsteelinconcrete, different types of corrosion, causes for corrosion, corrosion damage in conventionalandprestressedconcretestructures,corrosioncontrolmethods suchasprotectivecoatings,highperformanceconcrete,corrosioninhibitors, stainless steel reinforcement and cathodic protection, condition evaluation ofcorrosionaffectedstructuresandtechniquesforcorrosionmeasurement, rehabilitation methodologies and repair materials for corrosion affected structures based on severity, Indian and American codal requirements for enhancing durability of concrete and performance evaluation of corrosion controlmethods.

Modules	Teaching Hours	RBT Level
Module -1		
INTRODUCTION CorrosionMechanism– Blackrust,pits,straycurrentandbacterialcorrosion. Causes of Corrosion – Carbonation, Chloride attack, Influence of concrete cover.Corrosiondamage–DamageinconventionallyReinforcedConcrete and Prestressed concrete, Stress Corrosion Cracking, Hydrogen Embrittlement. Cost of Corrosion – A world wide scenario.	**10 Hours**	**L_1, L_2**
Module -2		
CORROSIONCONTROL Energy methods for rectangular and circular plates with clamped edges subjected to symmetric loadings.	**10 Hours**	**L_2, L_3**
Module -3		

CONDITION EVALUATION AND CORROSION RATE MEASUREMENT Control of carbonation, Control of chlorides, High Performance Concrete, Corrosion Inhibitors – Anodic, Cathodic and Mixed Inhibitors. Protective Coatings to Steel Rebars – Fusion Bonded Epoxy Coating, Galvanization, Cement Polymer Composite Coating, Inhibited cement slurry coating and Polymer Cementious coatings, Stainless Steel Reinforcement, Sealersand Membranes, CathodicProtection.	**10 Hours**	**L_2, L_3**
Module -4		
REHABILITATION TECHNIQUESPhysical and Chemical Rehabilitation Techniques - Concrete removal and surface preparation, patches, coatings, sealers, membranes and barriers, Encasement and overlays, Sprayed concrete, corrosion inhibitors. ElectrochemicalRepairTechniques–BasicPrinciple–CathodicProtection, Chloride Removal andRealkalization.	**10 Hours**	**L_2, L_3**
Module -5		
CODAL REQUIREMENTSFORDURABILITY Indian Standard codal requirements for enhancing durability of R.C.C. Structures.IndianandASTMcodalprovisionsforcoatedrebars,Galvanized reinforcement, corrosion inhibitors and Bond strengthtest.	**12 Hours**	**L_2, L_3, L_4**

Course outcomes:

On completion of this course, students are ableto:

- AchieveKnowledgeofdesignanddevelopmentofproblemsolvingskills.
- Understand the principles of Analysis andDesign
- Design and develop analyticalskills.
- Summarize the performance ofshells
- Understand the concepts of energyprinciple.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 10marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under amodule.
- The students will have to answer 5 full questions, selecting one full question from eachmodule.

REFERENCE BOOKS:

1. Arnon Bentur, Sidney Diamond and Neal S. Berke, "Steel Corrosion in Concrete – Fundamentals and Civil Engineering Practice", E & FN SPON Publications, Madras(1997).
2. John P.Broomfield, "Corrosion of steel in concrete - Understanding, investigation and repair", E & FN SPON Publications, Madras(1997).
3. Mars G. Fontana, "Corrosion Engineering" Mc-Graw Hill Publishers, New Delhi(2001).
4. Philip H. Perkins, "Repair, Protection and Waterproofing of Concrete Structures", Elsevier Applied Science Publishers, London(1988).

EARTHQUAKE RESISTANT STRUCTURES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – II

Subject Code	21CSE22	IA Marks	50
Number of Lecture Hours/Week	03	Exam Marks	50
Total Number of Lecture Hours	52	Exam Hours	03

CREDITS – 03

Course objectives:

The objective of this course is to make students to learn principles of engineering seismology, To design the reinforced concrete buildings for earthquakeresistance.Toevaluatetheseismicresponseofthestructures

Modules	Teaching Hours	RBT Level
Module -1		
Engineering Seismology: Causes of Earthquakes; Nature and Occurrence of Earthquakes; Seismic Waves; Measurements of Earthquakes; Local Site Effects; Classification of Earthquakes; Earthquake ground motion characteristics: Amplitude, frequency and duration; Seismic zoning map of India	**12 Hours**	**L_1, L_2**
Module -2		

Response Spectrum: Basics of structural dynamics; Free and forced vibration of SDOF system; Effect of frequency of input motion and Resonance; Numerical evaluation of response of SDOF system (Linear acceleration method), Earthquake Response spectrum: Definition, construction, Characteristics and application; Elastic design spectrum.	**10 Hours**	**L_2, L_3, L_4, L_5**
Module -3		
Seismic Performance of Buildings and Over View of IS-1893 (Part-1): Types of damages to building observed during past earthquakes; Plan irregularities; mass irregularity; stiffness irregularity; Concept of soft and weak storey; Torsional irregularity and its consequences; configuration problems; continuous load path; Architectural aspects of earthquake resistant buildings; Lateral load resistant systems. Seismic design philosophy; Structural modeling; Code based seismic design methods	**10 Hours**	**L_2, L_4, L_5**
Module -4		
Determination of Design Lateral Forces: Equivalent lateral force procedure and dynamic analysis procedure. Step by step procedures for seismic analysis of RC buildings using Equivalent static lateral force method and response spectrum methods (maximum of 4 storeys and without infill walls)	**10 Hours**	**L_2, L_4, L_5**
Module -5		
Earthquake Resistant Analysis and Design of RC Buildings: Typical failures of RC frame structures, Ductility in Reinforced Concrete, Design of Ductile Reinforced Concrete Beams, Seismic Design of Ductile Reinforced Concrete column, Concept of weak beam-strong column, Detailing of Beam-Column Joints to enhance ductility, Detailing as per IS-13920. Retrofitting of RC buildings	**10 Hours**	**L_2, L_5, L_8**

Course outcomes:

On completion of this course, students are ableto:

- AchieveKnowledgeofdesignanddevelopmentofproblemsolvingskills.
- Understand the principles of engineeringseismology
- Design and develop analyticalskills.
- SummarizetheSeismicevaluationandretrofittingofstructures.
- Understand the concepts of earthquake resistance of reinforced concrete buildings.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 10marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under amodule.
- The students will have to answer 5 full questions, selecting one full question from eachmodule.

REFERENCE BOOKS:

1. Dynamics of Structures – Theory and Application to Earthquake Engineering- 2nd ed. – Anil K. Chopra, PearsonEducation.
2. EarthquakeResistantDesignofBuildingStructures,VinodHosur,WILEY(india)
3. EarthquakeResistantDesignofStructures,Duggal,OxfordUniversityPress
4. Earthquake resistant design of structures - Pankaj Agarwal, Manish Shrikande - PHIIndia
5. IS – 1893 (Part I): 2002, IS – 13920: 1993, IS – 4328: 1993, IS-13828: 1993
6. Design of Earthquake Resistant Buildings, Minoru Wakabayashi, McGraw Hill Pub.
7. SeismicDesignofReinforcedConcreteandMasonryBuildings,TPaulayandMJN Priestley, John Wiley and Sons

DESIGN CONCEPTS OF SUBSTRUCTURES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – II

Subject Code	21CSE233	IA Marks	50
Number of Lecture Hours/Week	03	Exam Marks	50
Total Number of Lecture Hours	52	Exam Hours	03

CREDITS – 03

Course objectives:

The objective of this course is to make students to learn principles of subsoil exploration, To design the sub structures. To evaluate the soil shear strength parameters.

Modules	Teaching Hours	RBT Level
Module -1		

Introduction, Site investigation, In-situ testing of soils, Subsoil exploration, Classification of foundations systems. General requirement of foundations, Selection of foundations, Computations of Loads, Designconcepts.	**12 Hours**	**L_2, L_4, L_5**
Module -2		
Concept of soil shear strength parameters, Settlement analysis of footings, Shallow foundations in clay, Shallow foundation in sand & C-Φ soils, Footings on layered soils and sloping ground, Design for Eccentric or MomentLoads.	**10 Hours**	**L_2, L_4, L_5**
Module -3		
Types of rafts, bearing capacity & settlements of raft foundation, Rigid methods, Flexible methods, soil- structure interaction, different methods of modeling the soil. Combined footings (rectangular & trapezoidal), strap footings & wall footings, Raft – super structure interaction effects & general concepts of structural design, Basementslabs	**10 Hours**	**L_2, L_4, L_5**
Module -4		
Deep Foundations: Load Transfer in Deep Foundations, Types of Deep Foundations, Ultimate bearing capacity of different types of piles in different soil conditions, Laterally loaded piles, tension piles & batter piles, Pile groups: Bearing capacity, settlement, uplift capacity, load distribution between piles, Proportioning and design concepts ofpiles.	**10 Hours**	**L_2, L_3, L_4, L_5**
Module -5		
Types of caissons, Analysis of well foundations, Design principles, Well construction and sinking. Foundations for tower structures: Introduction, Forces on tower foundations, Selection of foundation type, Stability and design considerations, Ring foundations – generalconcepts.	**10 Hours**	**L_2, L_3, L_4, L_5**

Course outcomes:

On completion of this course, students are ableto:

- AchieveKnowledgeofdesignanddevelopmentofproblemsolvingskills.
- Understand the principles of subsoilexploration
- Design and develop analyticalskills.
- Identify and evaluate the soil shear strengthparameters.
- Understand the concepts of Settlementanalysis.

IMPORTANT NOTE:

Only design principles of all type footings as per relevant BIS codes are to be covered, design of RC elements need notbe

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 10marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under amodule.
- The students will have to answer 5 full questions, selecting one full question from eachmodule.

REFERENCE BOOKS:

1. Swami Saran – "**Analysis & Design of Substructures**"- Oxford &IBH Pub. Co. Pvt. Ltd.,1998.
2. Nainan P Kurian – "**Design of Foundation Systems**"- Narosa Publishing House,1992.
3. R.B. Peck, W.E. Hanson & T.H. Thornburn – "**FoundationEngineering"-** Wiley Eastern Ltd.,Second Edition,1984.
4. J.E. Bowles – "**Foundation Analysis and Design**"- McGraw-Hill Int. Editions, Fifth Ed.,1998.
5. W.C. Teng – "**Foundation Design"-** Prentice Hall of India Pvt. Ltd., 1983.
6. Bureau of Indian Standards:IS-1498, IS-1892, IS-1903, IS-8403, IS-8009, IS-2950, IS-11089, IS-11033, IS-2911 and allother relevant codes

REPAIR AND REHABILITATION OF STRUCTURES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – II

Subject Code	21CSE 234	IA Marks	50
Number of Lecture Hours/Week	03	Exam Marks	50
Total Numberof Lecture Hours	52	Exam Hours	03

CREDITS – 03

Course objectives:

The objective of this course is to make students to investigate the cause of deterioration of concrete structures, To strategize different repair and rehabilitation of structures. To evaluate the performance of the materials for repair

Modules	Teaching Hours	RBT Level
Module -1		
General: Introduction, Cause of deterioration of concrete structures, Diagnostic methods &analysis, preliminary investigations, experimental investigations using NDT, load testing, corrosion mapping, core drilling and other instrumental methods, Quality assurance for concrete construction, as built concrete properties strength, permeability, thermal properties andcracking.	**10 Hours**	**L_3, L_5**
Module -2		
Influence on Serviceability and Durability: Effects due to climate, temperature, chemicals, wear and erosion, Design and construction errors, corrosion mechanism, Effects of cover thickness and cracking, methods of corrosion protection, corrosion inhibitors, corrosion resistant steels, coatings, and cathodicprotection.	**11 Hours**	**L_3, L_4, L_5**
Module -3		
Maintenance and Repair Strategies: Definitions: Maintenance, repair and rehabilitation, Facets of Maintenance, importance of Maintenance, Preventive measures on various aspects. Inspection, Assessment procedure for evaluating a damaged structure, causes of deterioration, testingtechniques	**11 Hours**	**L_2, L_3, L_5**
Module -4		
Materials for Repair: Special concretes and mortars, concrete chemicals, special elements for accelerated strength gain, Expansive cement, polymer concrete, sulphur infiltrated concrete, Ferro cement, Fiber reinforced concrete. Techniques for Repair: Rust eliminators and polymers coating for rebar during repair foamed concrete, mortar and dry pack, vacuum concrete, Gunite and Shot Crete Epoxy injection, Mortar repair for cracks, shoringand underpinning.	**10 Hours**	**L_2**
Module -5		
Examples of Repair to Structures: Repairs to overcome low member strength, Deflection, Cracking, Chemical disruption, weathering wear, fire, leakage, marine exposure, engineered demolition techniques for dilapidated structures - casestudies	**10 Hours**	**L_2, L_5**

Course outcomes:

On completion of this course, students are ableto:

- AchieveKnowledgeofdesignanddevelopmentofproblemsolvingskills.
- Understand the cause of deterioration of concretestructures.
- Design and develop analyticalskills.
- Summarizetheprinciplesofrepairandrehabilitationofstructures
- Understands the concept of Serviceability and Durability.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 10marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from eachmodule.

REFERENCE BOOKS:

1. Sidney, M. Johnson "Deterioration, Maintenance and Repair ofStructures".
2. Denison Campbell, Allen & Harold Roper, "Concrete Structures – Materials, Maintenance and Repair"- Longman Scientific andTechnical
3. R.T.Allen and S.C. Edwards, "Repair of Concrete Structures"-Blakie andSons
4. Raiker R.N., "Learning for failure from Deficiencies in Design, Constructionand Service"- R&D Center (SDCPL

FINITE ELEMENT METHOD OF ANALYSIS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – II

Subject Code	21CSE241	IA Marks	50
Number of Lecture Hours/Week	03	Exam Marks	50
Total Number of Lecture Hours	52	Exam Hours	03

CREDITS – 03

Course objectives:

The objective of this course is to make students to learn principles of Analysis of Stress and Strain, To apply the Finite Element Method for the analysis of one and two dimensional problems. To evaluate the stress and strain parameters and their inter relations of thecontinuum.

Modules	Teaching Hours	RBT Level
Module -1		
Basic concepts of elasticity – Kinematic and Static variables for various types of structural problems – approximate method of structural analysis – Rayleigh– Ritz method – Finite difference method – Finite element method. Variation method and minimization of Energy approach of element formulation. Principles of finite element method –advantages &disadvantages – Finite element procedure. Finite elements used for one, two & three dimensional problems – Element aspect ratio – mesh refinement vs. higher order elements – Numbering of nodes to minimize bandwidth.	**12 Hours**	**L_1, L_2**
Module -2		
Nodal displacement parameters – Convergence criterion – Compatibility requirements – Geometric invariance – Shape function – Polynomial form of displacement function. Generalized and Natural coordinates – Lagrangian interpolation function – shape functions for one, two & three dimensional elements.	**10 Hours**	**L_1, L_2, L_4, L_5**
Module -3		
Isoparametric elements, Internal nodes and higher order elements, Serendipity and Lagrangian family of Finite Elements, Sub-parametric and Super- parametric elements, Jacobian transformation Matrix. Development of strain-displacement matrix and stiffness matrix, consistent load vector.	**10 Hours**	**L_1, L_2, L_4, L_5**
Module -4		
Application of Finite Element Method for the analysis of one & two dimensional problems, Analysis of simple beams, Application to planestress/strain/ axisymmetric problems using CST & Quadrilateral Elements	**10 Hours**	**L_1, L_2, L_3, L_4, L_5**
Module -5		
Application to Plates & Shells, Introduction to non – linear analysis – basic methods – application to Special structures. Techniques for Non – linear Analysis.	**10 Hours**	**L_1, L_2**

Course outcomes:

On completion of this course, students are ableto:

- AchieveKnowledgeofdesignanddevelopmentofproblemsolvingskills.
- Understand the principles of stress-strain behaviour ofcontinuum
- Design and develop analyticalskills.
- Describe the state of stress in acontinuum
- Understand the concepts of elasticity andplasticity.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 10marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under amodule.
- The students will have to answer 5 full questions, selecting one full question from eachmodule.

REFERENCE BOOKS:

1. KrishnamoorthyCS,"FiniteElementAnalysis"-TataMcGrawHill
2. Desai C and Abel J F, "Introduction to the Finite Element Method"- East West Press Pvt. Ltd.,1972
3. Bathe K J, "Finite Element Procedures in Engineering Analysis"- Prentice Hall
4. Rajasekaran. S, "Finite Element Analysis in Engineering Design"-Wheeler Publishing
5. Cook R D, Malkan D S & Plesta M.E, "Concepts and Application of Finite Element Analysis" - 3rd Edition, John Wiley and Sons Inc.,1989
6. ShamesIHandDymCJ,"EnergyandFiniteElementMethodsin Structural Mechanics"- McGraw Hill, New York, 1985

DESIGN OF TALL STRUCTURES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – II

Subject Code	21CSE242	IA Marks	50
Number of Lecture Hours/Week	03	Exam Marks	50
Total Number of Lecture Hours	52	Exam Hours	03
CREDITS – 03			

Course objectives:

The objective of this course is to make students to learn principles of stability of tall buildings, To design the tall buildings for earthquake and wind resistance. To evaluate the performance of tall structures for strength and stability

Modules	Teaching Hours	RBT Level
Module -1		
Design Criteria: Design philosophy, loading, sequential loading, and materials – high performance concrete, fiber reinforced concrete, lightweight concrete, design mixes.	**10 Hours**	**L_1, L_2**
Module -2		
Loading and Movement: Gravity loading: Dead and live load, methods of live load reduction, Impact, Gravity loading, Construction loads **Wind loading**: static and dynamic approach, Analytical and wind tunnel experimentation method. Earthquake loading: Equivalent lateral force, modal analysis, combinations of loading, working stress design,Limitstatedesign,Plasticdesign.	**8 Hours**	**L_1, L_3, L_4, L_5**
Module -3		
Behavior of Various Structural Systems: Factors affectinggrowth, Height and structural form; High rise behavior, Rigid frames,braced frames, in-filled frames, shear walls, coupled shear walls, wall-frames, tubular, cores, Futigger–braced and hybrid mega system.	**10 Hours**	**L_2, L_3**
Module -4		
Analysis and Design: Modeling for approximate analysis, accurate analysis and reduction techniques, analysis of building as total structural system considering overall integrity and major subsystem interaction, analysis for member forces; drift and twist, computerized general three dimensional Analyses.	**12 Hours**	**L_2, L_3, L_4**
Module -5		

Stability of Tall Buildings: Overall buckling analysis of frames, wall frames, approximate methods, second order effects of gravity of loading, P-Delta analysis, simultaneous first order and P-Delta analysis, Transnational, Torsional instability, out of plum effects, stiffness of member in stability, effect of foundation rotation. Structural elements: sectional shapes, properties and resisting capacities, design, deflection, cracking, pre-stressing, shear flow. Design for differential movement, creep and shrinkageeffects,temperature effects and fire.	**12 Hours**	**L_2, L_3, L_4, L_5**

Course outcomes:

On completion of this course, students are ableto:

- AchieveKnowledgeofdesignanddevelopmentofproblemsolvingskills.
- Understand the principles of strength andstability
- Design and develop analyticalskills.
- Summarize the behavior of various structuralsystems.
- Understand the concepts of P-Deltaanalysis

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 10marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from eachmodule.

REFERENCE BOOKS:

1. Taranath B.S, "Structural Analysis and Design of Tall Buildings"- McGrawHill
2. Wilf gang Schuller, "High rise building structures"- JohnWiley
3. Bryan Stafford Smith & Alexcoull, "Tall building structures Analysis and Design"- JohnWiley
4. T.Y Lin & D.Stotes Burry, "Structural concepts and system for Architects and Engineers"- JohnWiley
5. Lynn S.Beedle, "Advances in Tall Buildings"- CBS Publishers andDistributors.
6. Dr. Y.P. Gupta – Editor, "Proceedings National Seminar on High Rise Structures- Design and Construction practices for middle level cities"- New Age InternationalLimited

PAVEMENTANALYSISANDDESIGN

[AsperChoiceBasedCredit System(CBCS)scheme]

SEMESTER– II

Subject Code	21CSE244	CIEMarks	50
NumberofLectureHours/Week	03	SEE Marks	50
Total NumberofLectureHours	52	ExamHours	03

CREDITS–03

Courseobjectives: Thiscoursewillenablestudentsto

. Understandthefactorsaffectingpavementdesignandperformance
. Evaluatethestrengthofsoilsubgradesoilandfactorsthat affectthebehaviorofsoil.
. Computethestressesanddeflectionsinflexiblepavementlayersundertheactionofwheelloads.
. Design the thickness of flexible pavements by different methods under different exposure conditions andmaterials.
. DesignthethicknessofconcretepavementsandjointsassociatedwithCCpavementsinadditiontothecomputation ofstressesinCCpavements.

Modules

Module -1

Pavementsandpavementlayers-types,functions,choiceFactorsaffectingdesignofflexible,compositeandrigid pavements – Pavement design factors, loads – axle load distribution, ESWL, EWL, VDF due to varyingloadsand CSA. Highwayand Airfield Pavements

Module -2

Subgrade support - CBR and plate bearing tests, Resilient Modulus, fatigue tests, permanent deformationPavement Material Characterization, climatic, drainage and environmental factors, their effects and evaluation.Factorsaffectingdesignandperformanceofairportpavements.

Module -3

StressesandDeflection/straininflexiblepavements: Applicationofelastic theory,stresses,deflections/strainsinsingle,twoandthree-layerandmulti-layersystem,Applicationsinpavementdesign.problems

Module -4

Flexible pavement design: Empirical, semi- empirical and theoretical design approaches, principle,advantages and application. Design steps by CBR method as per IRC, outline of other common designmethodssuchasAASHTO andAsphalt Institutemethods,Problems.

ApplicationofIITPAVEsoftware,ANSYS,KENPAVE,KENLAYER,AASHTOWARE

Module -5

Rigid pavement design: Determination of ESWL, EWL for dual and dual tandem wheel loads in Rigidpavements, General design principle, Stresses in rigid pavements, stresses due to wheel loads and temperaturevariations,designofcementconcretepavements(jointsandslabthickness)asperIRC/PCAguidelines. DesignfeaturesofCRCP,SFRCandICBP,Problems.

ApplicationofDesignSoftware.

Courseoutcomes:

Afterstudyingthiscourse,studentswill be ableto:

1. Gettheknowledgeoffactorsaffectingpavementdesignandperformance

2. Evaluatethestrength ofsoilsubgrade soilandidentifythefactorsthataffectthebehavior ofsoil.
3. Computethestressesanddeflectionsinflexiblepavementlayersundertheactionofwheelloads.
4. Designthethicknessofflexiblepavementsbydifferentmethodsunderdifferentexposureconditionsandmat erials.
5. DesignthethicknessofconcretepavementsandjointsassociatedwithCCpavementsinadditiontothecomput ationofstressesinCCpavements.

GraduateAttributes(asperNBA)

EngineeringKnowledge.
ProblemAnalysis.
Design/developmentofsolutions (partly).
Interpretationofdata.

Questionpaperpattern:

- The question paper will have ten questions.
- Each full question consists of 10marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from eachmodule

TextBooks:

. YangH.Huang,"PavementAnalysisandDesign",SecondEdition,PearsonEducation,2008.
. Rajib B. Mallick and Tahar EL-Korchi., "Pavement Engineering Principles and Practice", ThirdEdition, CRCPressTaylorand Francis Group.
. Yoder,E.J.andWitczak,M.W.,"PrinciplesofPavement Design",SecondEdition,JohnWileyandsons

ReferenceBooks:

. Huang,"PavementAnalysis"-ElsevierPublications
. DavidCroney,PaulCroney,"Design&PerformanceofRoadPavements"-McGrawhillBookCo.
. W.RonaldHudson,RalphHaasandZeniswki"ModernPavementManagement"-McGrawHillandCo.
. S.K.Khanna,C.E.G JustoandA.Veeraragavan"HighwayEngineering"-NemChandandBros.,Roorkee.Revised10th Edition.
. Relevant IRCCodes

DESIGN OF CONCRETE BRIDGES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Subject Code	21CSE 311	IA Marks	50
Number of Lecture Hours/Week	03	Exam Marks	50
Total Number of Lecture Hours	52	Exam Hours	03

CREDITS – 03

Course objectives:

The objective of thiscourse is to make students to learn principles of StructuralDesign,Todesigndifferenttypesofstructuresand to detailthe structures. To evaluate performance of thestructures.

Modules	Teaching Hours	RBT Level
Module -1		
Introduction: Historical Developments, Site Selection for Bridges, Classification of Bridges Forces on Bridges. Bridge substructures: Abutments, piers and wing walls Balanced Cantilever Bridge: Introduction and proportioning of components, Design of simply supported portion and design of cantilever portion, design ofarticulation	**12 Hours**	**L_1, L_2, L_3, L_4**
Module -2		
Box Culvert: Different Loading Cases IRC Class AA Tracked, Wheeled and Class A Loading, working out the worst combination of loading, Moment Distribution, Calculation of BM & SF, Structural Design of Slab Culvert, with ReinforcementDetails.	**10 Hours**	**L_2, L_3, L_4**
Module -3		
T Beam Bridge Slab Design: Proportioning of Components Analysis of interior Slab & Cantilever Slab Using IRC Class AA Tracked, Wheeled Class A Loading, Structural Design of Slab, with Reinforcement Detail. T Beam Bridge Cross Girder Design: Analysis of Cross Girder for Dead Load & Live Load Using IRC Class AA Tracked, Wheeled Class A Loading A Loads, Structural Design of Beam, with ReinforcementDetail.	**10 Hours**	**L_2, L_3, L_4**
Module -4		
T Beam Bridge Main Girder Design: Analysis of Main Girder for Dead Load & Live Load Using IRC Class AA Tracked, Wheeled Class A Loading Using COURBON'S Method, Analysis of Main Girder Using HENDRY-JAEGER and MORICE-LITTLE Methodfor IRC Class AA Tracked vehicle only, BM & SF fordifferent loads, Structural Design of Main Girder With Reinforcement Details	**10 Hours**	**L_2, L_3, L_4**
Module -5		

PSC Bridges: Introduction to Pre and Post Tensioning, Proportioning of Components, Analysis and Structural Design of Slab, Analysis of Main Girder using COURBON's Method for IRC Class AA tracked vehicle, Calculation of pre-stressing force, cable profile and calculation of stresses, Design of End block and detailing of maingirder	**10 Hours**	**L_1, L_2, L_3, L_4**

Course outcomes:

On completion of this course, students are ableto:

- Achieve Knowledge of design and development of problem solvingskills.
- Understand the principles ofoptimization.
- Design and develop analyticalskills.
- Summarize the Linear, Non-linear and GeometricProgramming
- Understands the concept of Dynamicprogramming

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 10marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under amodule.
- The students will have to answer 5 full questions, selecting one full question from eachmodule.

REFERENCE BOOKS:

1. "Essentials of Bridge Engineering"- D Johnson Victor, Oxford & IBH Publishing Co NewDelhi
2. "Design of Bridges"- N Krishna Raju, Oxford & IBH Publishing Co NewDelhi
3. "Principles and Practice of Bridge Engineering"- S P Bindra Dhanpat Rai & Sons NewDelhi
4. IRC 8 – 1988 "Standard Specifications And Code Of Practice For Road Bridges"- Section II Loads and Stresses, The Indian Road Congress NewDelhi
5. IRC 21 – 1988 "Standard Specifications And Code Of Practice For Road Bridges"-Section III Cement Concrete (Plain and reinforced) The Indian Road Congress NewDelhi
6. IS 458 – 2000 "Indian Standard Plain and Reinforced Concrete Code of Practice"- (Fourth Revision) BIS NewDelhi
7. IS 1343 – "Indian Standard Prestressed Concrete Code of Practice"- BIS New Delhi
8. Raina V.K., "Concrete Bridge Practice"- Tata McGrawHill
9. Bakht B & Jaeggar, "Bridge Analysis Simplified"- McGrawHill
10. Ponnuswamy. S, "Bridge Engineering"- Tata McGrawHill.
11. Derrick Beckett, "An Introduction to Structural Design of Concrete Bridges"- Surrey University Press

OPTIMIZATION TECHNIQUES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Subject Code	21CSE 312	IA Marks	50
Number of Lecture Hours/Week	03	Exam Marks	50
Total Number of Lecture Hours	52	Exam Hours	03

CREDITS – 03

Course objectives:

The objective of this course is to make students to learn principles of optimization, To implement the optimization Concepts for the structural engineering problems. To evaluate different methods ofoptimization.

Modules	**Teaching Hours**	**RBT Level**
Module -1		
Introduction: Introduction to optimization, engineering applications of optimization, Formulation of structural optimization problems as programming problems. Optimization Techniques: Classical optimization techniques, single variable optimization, multivariable optimization with no constraints, unconstrained minimization techniques and algorithms constrained optimization solutions by penalty function techniques, Lagrange multipliers techniques and feasibilitytechniques.	**10 Hours**	**L_1, L_2, L_4**
Module -2		
Linear Programming: Linear programming, standard form of linear programming, geometry of linear programming problems, solution of a system of linear simultaneous equations, pivotal production of general systems of equations, simplex algorithms, revised simpler methods, duality in linear programming.	**10 Hours**	**L_2, L_4, L_5**
Module -3		

Non-linear programming: Non-linear programming, one dimensional minimization methods, elimination methods, Fibonacci method, golden section method, interpolation methods, quadratic and cubic methods, Unconstrained optimization methods, direct search methods, random search methods, descent methods	**12 Hours**	**L_2, L_3, L_4, L_5**
Module -4		
Constrained optimization techniques such as direct methods, the complex methods, cutting plane method, exterior penalty function methods for structural engineering problems. Formulation and solution of structural optimization problems by differenttechniques	**10 Hours**	**L_2, L_3, L_4, L_5**
Module -5		
Geometric programming: Geometric programming, conversion of NLP as a sequence of LP/ geometric programming. **Dynamic programming:** Dynamic programming conversion of NLP as a sequence of LP/ Dynamic programming	**10 Hours**	**L_4, L_5**

Course outcomes:

On completion of this course, students are ableto:

- AchieveKnowledgeofdesignanddevelopmentofproblemsolvingskills.
- Understand the principles ofoptimization.
- Design and develop analyticalskills.
- Summarize the Linear, Non-linear and GeometricProgramming
- Understands the concept of Dynamicprogramming

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 10marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under amodule.
- The students will have to answer 5 full questions, selecting one full question from eachmodule.

REFERENCE BOOKS:

1. Spunt, "Optimum Structural Design"- PrenticeHall
2. S.S. Rao, "Optimization – Theory and Practice"- Wiley EasternLtd.
3. Uri Krisch, "Optimum Structural Design"- McGrawHill
4. Richard Bronson, "Operation Research"- Schaum's OutlineSeries
5. Bhavikatti S.S.- "Structural optimization using sequentiallinear programming"- Vikas publishing house

CONSTRUCTIONPROJECTANDMANAGEMENT

[OutcomeBasedEducation(OBE)andChoiceBasedCreditSystem(CBCS)]

SEMESTER– III

SubjectCode	21CSE314	CIEMarks	50
NumberofLectureHours/Week	03	SEEMarks	50
TotalNumberof LectureHours	52	ExamHours	03

CREDITS–03

CourseObjectives:

Thiscoursewillenable studentsto

1. Understandthevariousmanagementtechniquesforsuccessfulcompletionof constructionprojects.
2. Understand theeffectofmanagementforprojectorganization.

Modules	Teaching Hours	RBTLevel
Module-1		
Introduction: Construction Projects- Concept, Project Categories,Characteristicofprojects,projectlifecyclephase.ProjectManagement-ProjectManagementFunction,Role ofProject Manager. Organizing For Construction - Principles of organization, type oforganizationstructure.	**10 Hours**	**L1,L2,L3,L4,L5**
Module-2		
ProjectFeasibilityReports: Introduction,Significanceinfeasibilityreport-Technicalanalysis,Financialanalysis,Economicanalysis,Ecologicalanalysis,Flow diagram for feasibility studyof aproject. **Project planning Scope:** Planning Process, Objectives, Types ofProjectplans, ResourcePlanningProcess.	**10 Hours**	**L1,L2,L3,L4,L5**
Module-3		
Scheduling: Introductiontosoftware'sinconstructionscheduling(MSP,Primavera, Construction manager), Project Monitoring & Controlling Bar Charts,Work Breakdown Structure, Time estimates, Applications of CPM and PERT, A-O-NNetwork-LogicandPrecedencediagrams,advantages,Drawing A-O-N networkfromA-O-Anetworkandrelatedproblems.	**10Hours**	**L1,L2,L3,L4,L5**
Module-4		
Time Cost relationship: Direct and indirect cost, step in optimization of cost,relatedproblem.Allocationofresources:Histogram,Resourcesmoothening,Resource leveling and related problem. Project updating using CPM network andrelated numericalproblems.	**10 Hours**	**L1,L2,L4,L5**
Module-5		
Resources: Scheduling,MonitoringandUpdating.LineofBalance Scheduling. Resource Planning-Leveling and Allocation.IntroductiontoBuildingInformationModel(	**10 Hours**	**L1,L2**

BIM).		

Courseoutcomes:

Oncompletionofthiscourse,studentsareableto:

- Allocatethe fundsforeachworkandexecutethe same.
- Calculate the total time required to complete the job without delay and delay in theprojectandalsoestimatetheamountofadditionalfundsmayrequiretocompletethejob.

Questionpaperpattern:

- The question paper will have ten questions.
- Each full question consists of 10marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from eachmodule

TextBooks:

1. Chitkara, K.K. **"Construction Project Management: Planning, Scheduling and Control"**, TataMcGraw-HillPublishingCompany, NewDelhi,1998.
2. ChoudhuryS,**"ProjectManagement"**,McGraw-HillPublishingCompany,NewDelhi,1988.
3. Chris Hendrickson and Tung Au, **"Project Management for Construction – FundamentalConcepts for Owners, Engineers, Architects and Builders"**, Prentice Hall, Pittsburgh, 2000.

ReferenceBooks:

1. SrinathL.S,**"PERTandCPM"**,EastWestPressPvtLtdNewDelhi.
2. FrankHarrisandRolandMcCaffer,**"ModernConstructionManagement"**-4thEd.BlackwellScienceLtd.

BUSSINESS ANALYTICS

[As per Choice Based Credit System (CBCS) Scheme]

SEMESTER-III

Subject Code	21CSEOE321	CIE Marks	50
Number of Lecture Hour/Week	03	SEE Marks	50
Total Number of Lecture Hours	40 HRS	Exam Hours	03

CREDITS-03

Course Objectives: This course will enable students to:

1. The main objective of this course is to give the student a comprehensive understanding of business analyticsmethods.

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module -1		
BusinessAnalysis:OverviewofBusinessAnalysis,OverviewofRequirements,Role of the BusinessAnalyst. Stakeholders: the project team, management, and the front line, Handling, Stakeholder Conflicts.	**08 Hours**	**L1,L2,L3**
Module -2		
Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. ImportantResources,BusinessAnalyticsPersonnel,Dataandmodelsfor Business analytics, problem solving, Visualizing and Exploring Data, Business AnalyticsTechnology.	**08 Hours**	**L1,L2,L3**
Module -3		
Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictiveanalyticsanalysis,DataMining,DataMiningMethodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinearOptimization.	**08 Hours**	**L1,L2,L3**

Module -4		
Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. MonteCarloSimulationandRiskAnalysis:MonteCarleSimulationUsing Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.	**08 Hours**	**L1, L2,L3**
Module-5		
Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making. Recent Trends in : Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.	**8 Hours**	**L1,L2,L3**

1. **Course outcomes:**Studentswilldemonstrateknowledgeofdataanalytics.
2. Studentswilldemonstratetheabilityofthinkcriticallyinmakingdecisionsbasedon data and deepanalytics.
3. Students will demonstrate the ability to use technical skills in predicative and prescriptive modeling to support businessdecision-making.
1. Studentswilldemonstratetheabilitytotranslatedataintoclear,actionableinsights..

REFERENCE BOOKS:

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans,ChristopherM.Starkey,PearsonFTPress.
2. BusinessAnalyticsbyJamesEvans,personsEducation.

Industrial Safety

[As per Choice Based Credit System (CBCS) Scheme]
SEMESTER-III

Subject Code	21CSEOE322	CIE Marks	50
Number Lecture Hour/Week	3	SEE Marks	50
Number of Lecture Hours	40	Exam Hours	03
CREDITS-03			

Course Objectives: This course will enable students to:

1.To know about Industrial safety programs and toxicology, Industrial laws , regulations and source models

2.To understand about fire and explosion, preventive methods, relief and its sizing methods.

3. To analyse industrial hazards and its risk assessment

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module -1		
Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1940 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.	**08 Hours**	**L1,L2**
Module -2		
Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment	**08 Hours**	**L1,L2**
Module -3		
Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.	**08 Hours**	**L1,L2**
Module -4		
Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic,automotive, thermal and electrical	**08 Hours**	**L1, L2,L3**

equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.		
Module-5		
Periodic and preventive maintenance: Periodic inspection-concept and need, decreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance	**8 Hours**	**L1,L2,L3**

Course outcomes: By the end of the course the students will be able to

1. Analyze the effect of release of toxic substances
2. Understand the industrial laws, regulations and source models.
3. Apply the methods of prevention of fire and explosions.
4. Understand the relief and its sizing methods.
5. Understand the methods of hazard identification and preventive measures.

Text Books:

1. Digital signal processing – Principles Algorithms & Applications, Proakis & Monalakis, Pearson education, 4th Edition, New Delhi, 2007.
2. Digital signal processing-Theory and Lab practice, D.Ganesh Rao, Vineeta P.Gejji, Second addition, PEARSON, 2010.

Reference Books:

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

OPERATION RESEARCH

[As per Choice Based Credit System (CBCS) Scheme]

SEMESTER-III

Course Code	21CSEOE323	CIE Marks	50
Number of Lecture Hours/Week	03	SEE Marks	50
Total Number of Lecture Hours	40	Exam Hours	03
CREDITS– 03			

Course Learning Objectives:

1. Analyze any real life systems with limited constraints and depict it in model form.
2. Understand variety of problems such as Assignment, Transportation, Travelling sales man etc.
3. Formulate and solve problems as Networks and Graphs.
4. Construct Linear Integer Programming Models and discuss the solution Techniques.
5. Set up Decision Models and use some Solution Methods for Nonlinear Optimization Problems.
6. Propose the best Strategy using Decision making methods under Uncertainty.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module -1		
Introduction: What is Operation Research, Operation Research Models, Solving the OR Model, Art of Modeling, More than Just Mathematics, Phases of an OR Study. **Modeling with Linear Programming**: Two Variable LP Model, Graphical LP Solution, Selected LP Applications, Computer Solution with Excel Solver and AMPL.	**08 Hrs**	**L1,L2,L 3**
Module -2		
Simplex method and sensitivity analysis: LP Model in Equation Form, Transition from Graphical to Algebraic Solution, the Simplex Method, Artificial Starting Solution, Special Cases in Simplex Method, Sensitivity Analysis.	**08 Hrs**	**L1,L2,L 3**
Module -3		
Duality and post –optimal analysis: Definition of the Dual Problem, Primal-Dual Relationships, Economic Interpretation of Duality, Additional Simplex Algorithms, Post Optimal Analysis.	**08 Hrs**	**L1,L2,L 3**
Module --4		
Transportation model and its variable: Definition of the Transportation Model, Nontraditional Transportation Models, the Transportation Algorithm, the Assignment Model, the Transshipment Model. **Network Models:** Scope and Definition of Network Models, Minimal Spanning Tree Algorithm, Shortest-Route Problem, Maximal Flow Model, CPM and PERT.	**08 Hrs**	**L1,L2,L 3**
Module -5		
Classical optimization theory: Unconstrained problem, constrained problem.	**08**	**L1,L2,L 3**

Nonlinear programming algorithms: Unconstrained algorithm, constrained algorithm.	**Hrs**	

Course Outcomes: At the end of this course, students should be able to

1. Understand the given problem as transportation and assignment problem and solve.
2. Solve problems as Networks and Graphs.
3. Construct Linear Integer Programming Models.
4. Solve the problems on Strategy using Decision making methods under Uncertainty.
5. Solve the problems on Decision Models and use some Solution Methods for Nonlinear Optimization Problems.

Text Book:

1. H.A Taha, Operations Research, An Introduction, PHI, 2008.
2. D.S Hira and PK Gupta, Operations Research, (Revised Addition), published by S. Chand and company Ltd. 2014.

Reference Books:

1. S Kalavathy, operation Research, Vikas Publishing House Pvt Limited, 01-Aug-2002.
2. S D Sharma, Operation Research, KedarNath Ram Nath Publishers.

COST MANAGEMENT OF ENGINEERING PROJECTS

[As per Choice Based Credit System (CBCS) Scheme]

SEMESTER-III

Subject Code	21CSEOE324	CIE Marks	50
Number of Lecture Hour/Week	03	SEE Marks	50
Total Number of Lecture Hours	40	Exam Hours	03

CREDITS-03

Course Objectives: This course will enable students to:

1. Recognize and apply appropriate theories, principles and concepts relevant to cost accounting.
2. Exercise appropriate judgment in selecting and presenting information using various methods relevant to cost accounting
3. Plan, design and execute practical activities using techniques and procedures appropriate to cost accounting .
4. Respond to change within the external and internal business environments and its effect on cost accounting.
5. Develop appropriate effective written and oral communication skills relevant to cost accounting.
6. Use organization skills (including task and time management) relevant to cost accounting systems both individually an in a group situation.
7. Solve problems relevant to cost accounting systems using ideas and techniques some of which are at the forefront of th discipline.

Modules	**Teaching Hours**	**Revised Bloom's Taxonom (RBT) Level**
Module -1		
Introduction and Overview of the Strategic Cost Management Process	**08 Hours**	**L1,L2,L3**
Module -2		
Costconceptsindecision-making;Relevantcost,Differentialcost,IncrementalcostandOpportunity ost.ObjectivesofaCostingSystem;Inventoryvaluation;CreationofaDatabaseforoperationalcontrol; Provision of data forDecision-Making.	**08 Hours**	**L1,L2,L3**
Module -3		
Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and non- technical activities. Detailed Engineering activities. Pre project execution main clearances and documentsProjectteam:Roleofeachmember.ImportanceProjectsite:Datarequiredwithsignificance. Projectcontracts.Typesandcontents.ProjectexecutionProjectcostcontrol.BarchartsandNetwork diagram. Project commissioning: mechanical andprocess	**08 Hours**	**L1,L2,L3**
Module -4		
Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems.StandardCostingandVarianceAnalysis.Pricingstrategies:ParetoAnalysis.Targetcosting, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity-Based CostManagement,BenchMarking;BalancedScoreCardandValue-ChainAnalysis.BudgetaryControl; FlexibleBudgets;Performancebudgets;Zero-	**08 Hours**	**L1, L2,L3**

basedbudgets.MeasurementofDivisionalprofitability pricing decisions including transferpricing.		

Module-5

Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.	**08 Hours**	**L1,L2,L3**

Course outcomes: Studentswilldemonstrateknowledgeofdataanalytics.

. On completion of this course, students should be able to identify, use and interpret the results of costing techniques appropriat o different activities and decisions.

. Formulate and use standards and budgets for planning and control purposes; understand the role o esponsibility accounting and performance .

REFERENCE BOOKS:

1. CostAccountingAManagerialEmphasis,PrenticeHallofIndia,NewDelhi
2. CharlesT.HorngrenandGeorgeFoster,AdvancedManagementAccounting
3. RobertSKaplanAnthonyA.Alkinson,Management&CostAccounting
4. AshishK.Bhattacharya,Principles&PracticesofCostAccountingA.H.Wheelerpublisher
5. N.D.Vohra,QuantitativeTechniquesinManagement,TataMcGrawHillBookCo.Ltd.

COMPOSITE MATERIALS

[As per Choice Based Credit System (CBCS) Scheme]
SEMESTER-III

Subject Code	21CSEOE325	CIE Marks	50
Number Lecture Hour/Week	03	SEE Marks	50
Number of Lecture Hours	40	Exam Hours	03

CREDITS-03

Course Objectives: This course will enable students to:

1. Identify, describe and evaluate the properties of fibre reinforcements, polymer matrix materials and commercial composites.
2. Develop competency in one or more common composite manufacturing techniques, and be able to select the appropriate technique for manufacture of fibre-reinforced composite products.

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module -1		
INTRODUCTION: Definition – Classification and characteristics of Composite materials. Advantages and	**08 Hours**	**L1,L2**

application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.		
Module -2		
REINFORCEMENTS: Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.	**08 Hours**	**L1,L2**
Module -3		
Manufacturing of Metal Matrix Composites: Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.	**08 Hours**	**L1,L2**
Module -4		
Manufacturing of Polymer Matrix Composites: Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.	**08 Hours**	**L1, L2,L3**
Module-5		
Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygro thermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.	**8 Hours**	**L1,L2,L3**

Course outcomes: After studying this course, students will be able to:

1. Explain the mechanical behavior of layered composites compared to isotropic materials.
2. Apply constitutive equations of composite materials and understand mechanical behavior at micro and macro levels..

Text Books:

1. Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.
2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.

Reference Books:

1. Hand Book of Composite Materials-ed-Lubin.
2. Composite Materials – K.K.Chawla.
3. Composite Materials Science and Applications – Deborah D.L. Chung.
4. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi.

Waste to Energy

[As per Choice Based Credit System (CBCS) Scheme]
SEMESTER-III

Subject Code	21CSEOE326	CIE Marks	50
Number Lecture Hour/Week	03	SEE Marks	50
Number of Lecture Hours	40	Exam Hours	03

CREDITS-03

Course Objectives: This course will enable students to:

1. The objective of the course is to provide insights into waste management options by reducing the waste destined for disposal and encouraging the use of waste as a resource for alternate energy production
2. . This course is designed to provide an understanding of the various aspects of Waste to Energy.

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module -1		

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors	**08 Hours**	**L1,L2**
Module -2		
Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.	**08 Hours**	**L1,L2**
Module -3		
Biomass Gasification: Gasifiers Fixed bed system Downdraft and updraft gasifiers Fluidized bed gasifiers Design, construction and operation Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.	**08 Hours**	**L1,L2**
Module -4		
Biomass Combustion: Biomass stoves Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.	**08 Hours**	**L1, L2,L3**
Module-5		
Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.	**8 Hours**	**L1,L2,L3**
Course outcomes:. After studying this course, students will be able to: 1.To provide insights into waste management options by reducing the waste destined for disposal and encouraging the use of waste as a resource for alternate energy production.		

2.To provide an understanding of the various aspects of Waste to Energy.

Reference Books:

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