SEMESTER – III

21CS71 PROJECT WORK – I

vide Automotive Engineering 21AE71

SEMESTER – IV

21CS81 PROJECT WORK – II

Vide Automotive Engineering 21AE81

PROFESSIONAL ELECTIVE THEORY COURSES (Four to be opted)

21CS21 STRUCTURAL STABILITY

3 0 0 3

CONCEPTS OF STABILITY AND COMPRESSION MEMBERS: Introduction – Stability Criteria – Equilibrium, Energy and dynamic approaches - South well Plot – Stability of link models. Higher order Differential equations – Analysis for various boundary conditions – Behaviour of imperfect column – Initially bent column – Eccentrically loaded column - Energy method - Rayleigh Ritz, Galerkin methods – Numerical techniques – Newmark's method – Finite Element Method. (13)

STABILITY OF PLATES AND ELEMENTS OF NON-LINEAR THEORY OF BUCKLING: Governing Differential equation – Equilibrium, Energy concepts – Buckling of plates of various end conditions – Finite Difference Method – Post-buckling strength – Finite Element Method. Perfect Systems – Imperfect Systems – Imperfection in-sensitive and sensitive systems – Symmetric and Asymmetric Bifurcation – Non-linear analysis of shell and spatial structures – Basic concepts. (11)

LATERAL STABILITY OF BEAMS AND BEAM-COLUMNS: Differential equations for lateral buckling – Lateral buckling of beams in pure bending – Lateral buckling of cantilever and simply supported 'I' beams. Beam-columns with concentrated lateral load – Distributed loads – Effect of axial loads on bending stiffness – Stability of frames – Stability functions – PΔ effect. (11)

INELASTIC BUCKLING AND BUCKLING OF THIN-WALLED OPEN & CLOSED SECTIONS: Introduction – Double modulus theory (reduced modulus) – Tangent modulus theory – Shanley's theory – Determination of double modulus for various sections. Torsional buckling – Torsional flexural buckling – Equilibrium and Energy approaches. (10)

Total L: 45

REFERENCES:

1. Timoshenko, S.P. and Gere J.M., "Theory of Elastic Stability", 2nd Ed. McGraw-Hill, 2017.
2. Alfutov N. A., "Stability of Elastic structures", Springer verlog, 2000.
3. El Naschie M. S., "Stress, Stability and Chaos in Structural Engineering: An Energy Approach", McGraw Hill International Editions, 1992.
4. Iyengar N.G.R., "Structural Stability of Columns and Plates", Affiliated East West press Pvt Ltd., New Delhi, 2007.
5. Chajes A., "Principles of Structural Stability Theory", Prentice Hall, New Jersey, 1980.
6. Gambhir, M.L., "Stability Analysis and Design of Structures", Springer, New York, 2009.

21CS22 / 21CN23 PRESTRESSED CONCRETE STRUCTURES

3 0 0 3

ANALYSIS AND DESIGN FOR FLEXURE: Principles - types - prestressing - materials definition of Type I, Type II and Type III structures – requirements - behaviour of PSC elements - force transmitted by pretensioned and post tensioned systems-analysis - service loads - methods - losses - ultimate strength-Design For Flexure And Deflection: Philosophy - limit states - concepts - collapse and serviceability - service load - basic requirements - stress range approach - Lin's approach - Magnel's approach - cable layouts. Deflection - importance - short and long term deflection of uncracked and cracked members. (11)

DESIGN FOR SHEAR AND TORSION: Shear and principal stresses - limit state shearing resistance of cracked and uncracked sections - design of shear reinforcement by limit state approach. Behaviour under torsion - modes of failure - design for combined torsion, shear and bending. Transfer of prestress: Transmission of prestressing force by bond in pretensioned members - Transmission length - Factors affecting transmission length - check for transmission length - transverse tensile stresses - end zone reinforcement. Anchorage zone stresses in post-tensioned members - Magnel's method - Calculation of bearing stress and bursting tensile forces - code provisions - Reinforcement in anchorage zone. (11)

COMPOSITE CONSTRUCTION OF PRESTRESSED & INSITU CONCRETE: Need - types of composite construction - behaviour - analysis for flexural stresses - shear - differential shrinkage - design for flexure and shear- Tanks and Pipes: Circular prestressing in liquid retaining tanks - analysis for stresses - design of tank wall. PSC pipes - types - design of non cylinder pipes (11)

STATICALLY INDETERMINATE STRUCTURES: Methods of achieving continuity - assumptions in elastic analysis - pressure line - linear transformation - concordant cables - Guyon's theorem - analysis and design of continuous beams. -Other Structures**:** Design of prestressed concrete columns, sleepers, poles and tension members - Methods of achieving partial prestressing - Advantages and disadvantages - use of non-prestressed reinforcement. (12)

Total L : 45

REFERENCES:

1. Rajagopalan N, "Prestressed Concrete", Narosa Publishing House, New Delhi, 2010.
2. Krishna Raju N, "Prestressed Concrete", Tata McGraw Hill Publishing Company Ltd., New Delhi 2018.
3. Dayaratnam P, “Prestressed Concrete Structures”, Oxford & IBH., Publishing Co. Pvt., 2018.

21CS23 / 21CN24 BRIDGE ENGINEERING

3 0 0 3

HYDRAULIC AND GEOMENTRIC DESIGN OF BRIDGES: Definition and components of a bridge – layout and planning of a bridge – classification – investigation of a bridge – preliminary data collection – choice and type of a bridge – hydraulic design of a bridge.Traffic design – loading – highway and railway loading – specification - Provisions of IRC : 6. (10)

REINFORCED CONCRETE BRIDGES: Straight and curved bridge decks – decks of various types – slab hollow and voided slab – beam – slab box – reinforced concrete slab bridges – load distribution – Pigeaud’s theory – skew slab deck – RC tee beam and slab bridge – Balanced Cantilever bridge – rigid frame bridge – box girder bridge - Provisions of IRC : 112. (13)

PRESTRESSED CONCRETE AND STEEL BRIDGES: Pre-stressed concrete bridge – Composite beam bridge– Analysis and Design for static, moving and dynamic loading.Plate girder bridge – box Girder Bridge – truss bridge – influence lines for forces in member- cable stayed bridge- Analysis for static, moving and dynamic loading. - Provisions of IRC : 18. (13)

SUBSTRUCTURE DESIGN, CONSTRUCTION AND MAINTENANCE OF BRIDGES:

Piers and abutments – bridge bearings – steel rocker and roller bearings – reinforced concrete rocker and roller bearings – elastomeric bearings.

Construction methods – short span – long span – false work for concrete bridges – construction management – inspection and maintenance – lessons from bridge failures – rehabilitation of a bridge – load testing of bridge . (9)

Total L: 45

REFERENCES:

1. Johnson Victor D, “Essentials of Bridge Engineering”, Oxford & IBH publishing co. Pvt. Ltd., New Delhi, 2019.
2. Krishna Raju N, “Design of Bridges”, Oxford Publishing co Pvt. Ltd., New Delhi, 2018.
3. Raina V K “Concrete Bridge Practice”, Tata McGraw-Hill publishing co, New Delhi, 2014.
4. Ponnuswamy S, “Bridge Engineering”, Tata McGrawHill Pub co., New Delhi, 2017.
5. Jagadeesh. T.T., Jayaram.M.A, “Design of Bridge Structures”, PHI Learning Pvt Ltd, 2014.

21CS24 ASEISMIC DESIGN OF STRUCTURES

3 0 0 3

BASIC CONCEPTS AND ANALYSIS: Elements of Engineering Seismology - Indian Seismology - earthquake history - catastrophes - failures - lessons learnt in past earthquakes - time history and response spectrum method - modal analysis - earth quake response to linear systems - response spectrum characteristics - ground motion parameters - construction of design spectrum - lumped mass system - shear building - symmetrical and unsymmetrical buildings - multiple support excitation - introduction to deterministic earth quake response to continuous systems on rigid base. (13)

STRUCTURAL DESIGN CRITERIA: Principles and design criteria for structures as per IS1893 - modal response contribution - modal participation factor - response history - spectral analysis - problems - design and construction of buildings as per IS4326 - general principles - special construction features - types of construction - building categories - construction of masonry walls - precast floors and roofs - guidelines for earthquake resistant of low strength masonry buildings as per IS13828 - behaviour and design of masonry structures - behavior of masonry infills in RC frame - guidelines for improving earthquake resistance of earthen buildings as per IS13827 - guidelines for repair and seismic strengthening of buildings as per IS13935. (12)

BEHAVIOUR OF RC STRUCTURES: Capacity design - design and detailing as per IS13920 - behavior of RC structures - cyclic load - shear wall frame system - Khan and Saboronis method - Coupled shear wall system - Rosman’s method - ductility requirements in concrete structures - beam column junction - push over analysis. (10)

BEHAVIOUR OF STEEL STRUCTURES: Behaviour of steel under cyclic load - behavior of flexural members under cyclic loading - steel bracing systems - behavior and design aspects - ductile design of frame members - frame members subjected to axial compression and bending - beam column joints - detailing of steel connections - retrofitting and strengthening of steel frames - analysis for lateral loads - base isolation techniques. (10)

Total L: 45

REFERENCES:

1. Anil K Chopra, "Dynamics of Structures - Theory and Applications to Earthquake Engineering", Prentice Hall, New Delhi, 2014.

1. Duggal S K, “Earthquake Resistant Design of Structures”, Oxford University Press, New Delhi, 2013.
2. Agarwal P and Shrikande M, “Earthquake Resistant Design of Structures”, Prentice Hall of India, 2006.
3. Chen W F and Scawthorn, “Earthquake Engineering Hand Book”, CRC press, 2003.
4. Naeim F, "The Seismic Design Hand Book", Kluwer Academic Publishers, London, 2001.
5. Hand Book on Seismic Retrofitting of Buildings, Published by CPWD & Indian Building Congress in Association with IIT, Madras, Narosa Publishing House, 2008.

21CS25 BEHAVIOUR AND DESIGN OF TALL BUILDINGS

3 0 0 3

LOADING AND STRUCTURAL SYSTEMS: History-Design Philosophy- Strength and Stability- Stiffness and Drift- Creep, Shrinkage and Temperature-Fire-Settlement. Loading – Gravity loading, wind loading, Earthquake loading and combinations of loading. Structural Forms- Floor Systems – RCC and Steel.Modelling for Approximate and Accurate Analysis – Reduction Techniques. (10)

BEHAVIOUR OF FRAMED SYSTEMS: Braced Frame-Behaviour of Bracing and Braced bents- Member Force Analysis – Drift Analysis. Rigid Frame – Behaviour- Approximate Analysis for Gravity and Lateral Loading. Drift Analysis – Flat Plate Structures- Reduction Techniques. In-filled Frame – Behaviour- Forces – Design of infill, Frame and Horizontal Deflection.(12)

BEHAVIOUR OF SHEAR WALL SYSTEMS: Shear Wall-Behaviour- Proportionate and Non proportionate- Twisting and Non Twisting-Effects of Discontinuity- Stress AnalysisCoupled Shear Wall- Behaviour-Continuous Medium Method – Frame Analogy Method- Wall-Frame – Behaviour- Approximate analysis-Solution for UDL and Alternative Loading- Analysis using Graphs . (12)

OUTRIGGER STRUCTURES AND STABILITY OF TALL BUILDINGS: Outrigger Braced – Analysis of Forces and Horizontal Deflections – Generalized Solutions – Optimum Locations – PerformanceStability –overall buckling analysis of Frames, Wall frames. Second-Order Effects –P-Delta Analysis – Translational-Torsional instability - Out of Plumb EffectConcepts and Behaviour of Core and Tubular Structures. Behaviour of Connections-Rigid and Semi rigid-Beam and Beam-Column Connections- Connections for ductility. (11)

Total L: 45

REFERENCES:

1. Smith B.S. and Coull A., “Tall Building Structures Analysis and Design”, John Wiley and Sons, Inc, 2011.
2. Bangash M.Y.H., “Prototype Building Structures – Analysis and Design”, Thomas Telford, 1999.
3. Bryan Stanfford Smith, Alex Coull, “Tall Building Structures: Analysis and Design”, John Wiley and Sons, 2011.
4. Bungale.S.Taranath, “Reinforced Concrete Design of Tall Buildings”, CRC Press, 2011.
5. Mark Sarkisian, “Design Tall Buildings: Structure as Architecture”, Taylor & Francis, 2012.

21CS26 / 21CN25 ADVANCED CONCRETE TECHNOLOGY

3 0 0 3

CONSTITUENTS OF CONCRETE: Composition and properties of Portland cement –hydration of cement – structure of hydrated cement paste-gel theories –Effect of cement characteristics on strength and heat of hydration- physical properties – acceptance criteria – types of cements and applications – aggregates – fine aggregate characteristics and significance – mechanical properties of coarse aggregates – acceptance criteria – influence of aggregate properties on strength of concrete-alkali-aggregate reaction – grading requirements. (11)

PROPERTIES OF CONCRETE: Microstructure of concrete – nanometer scale –C-S-H structure – transition zone and micro cracking -Workability - Factors affecting workability - Tests for workability -segregation - bleeding - Modern trends in concrete production , placement, compaction and curing –- Vacuum dewatering and underwater concreting – special formwork - Factors affecting strength of concrete - Maturity of concrete – Rheological properties of concrete - Shrinkage - Creep of concrete - Factors affecting creep and shrinkage of concrete – Compression, Split Tension, Flexure ,Bond strength - IS code provisions - Factors affecting strength test results - Accelerated strength tests - Stress strain characteristics - Determination of modulus of elasticity – Non-destructive evaluation of reinforced concrete– load test on structural components . (12)

DURABILITY ASPECTS AND MIX DESIGN: Permeability-causes of concrete deterioration- Chemical attack - Sulphate attack - Quality of water - Marine environment – effect of fire- frost action- thermal properties of concrete - fire resistance and corrosion protection - Methods to improve durability- Mix design- Basic considerations – frequency of sampling – nominal and design mixes – quality control and acceptance criteria -Factors in the choice of mix proportions - Mix design methods - ACI method, IS method - Mix proportions for weigh batching and volume batching - correction for moisture content and bulking - yield of concrete – design of high strength concrete (Shacklok and Entroy) (11)

ADMIXTURES AND SPECIAL CONCRETES : Classification of admixtures- uses of chemical and mineral admixtures- influences of admixtures on properties of concrete- Light weight concrete - Fibre reinforced concrete - Polymer concrete - High Performance Concrete and future trends– Pumpable concrete – Self compacting concrete- tests for key properties and aspects of mix design- preplaced concrete – smart concrete – geo polymer concrete – concrete using industrial, agro and construction & demolition waste materials – sprayed concrete- reactive powder concrete – ready mixed concrete – high toughness and ductile concrete -concrete composites. (11)

Total L: 45

REFERENCES:

1. Neville A M and Brooks J J, “Concrete Technology”, Pearson Education Asia Pvt. Ltd, 2018.
2. Mehta P K, Pauls J M and Monteiro, “Concrete: Micro Structure, Properties and Materials”, Tata McGraw Hill Education Private limited, New Delhi, 2014.
3. Zongjin Li, “Advanced Concrete Technology”, John-Wiley & Sons inc, New York, 2012.
4. Jayant D Bapat, “Mineral Admixtures in Cement and Concrete”, CRC Press, New Delhi, 2017.
5. Malhotra V M and Carino N J, “Handbook on Non-destructive Testing of Concrete”, CRC Press, 2003.

21CS27 / 21CN29 OPTIMIZATION TECHNIQUES

3 0 0 3

CONCEPTS OF OPTIMIZATION AND LINEAR PROGRAMMING: Introduction – Engineering applications of optimization – statement of an optimization problem - classification of optimization problems. Standard form of a Linear Programming Problem – plastic design of frames – Graphical method – Simplex method – Basic solution – computation – maximization and minimization. Duality in Linear Programming – General Primal – Dual relations – Dual simplex method – Transportation problem – Assignment method. (13)

NONLINEAR PROGRAMMING: One dimensional minimization methods – Dichotomous search, Fibonacci method and Golden section method. Unconstrained optimization techniques – Classification – Direct search, Pattern search, Cauchy’s steepest Descent method, Conjugate Gradient method and Davidon Fletcher Powell method – Constrained function of a single variable – several variables. (13)

DYNAMIC PROGRAMMING: Bellman’s principle of optimality - Multistage decision processes – representation and types – concept of sub optimization problems using Classical and Tabular methods – conversion of a final value problem into an initial value problem – Linear Programming as a case of dynamic Programming. (10)

GENETIC ALGORITHM, EVOLUTION STRATEGIES AND ANT COLONY OPTIMIZATION: Introduction – Representation of design variables, objective function and constraints – Choice of population – Genetic operators – survival of the fittest – generation – generation history – application to trusses. Probability – finding the shortest path – pheromone trail – travelling salesman problem – Application to structural engineering problems. (9)

Total L: 45

REFERENCES:

1. Rajasekaran S. and Vijayalakshmi Pai G. A., "Neural Networks, Fuzzy Logic and Genetic Algorithms", Prentice Hall of India, New Delhi, 2013.
2. K. Deb, “Multi – objective Optimization using Evolutionary Algorithms”, John Wiley and Sons, 2009.
3. Goldberg D.E., “Genetic Algorithms in Search, Optimization and Machine Learning”, Pearson Education, 2008.
4. Iyengar N.G.R and Gupta S.K, “Structural Design Optimization”, Affiliated East West Press Ltd., New Delhi, 1997.
5. Rao S.S. “Optimization Theory and Applications”, Wiley Eastern, 2000.
6. R.T. Hafta and Z. Gurdal, “Elements of Structural Optimization”, 3rd Ed. Kluwer Academic Publishers, 1996.

21CS28 SHELL AND SPATIAL STRUCTURES

3 0 0 3

THEORY OF SHELLS AND SPATIAL STRUCTURES: Definition - Historical development - Types - Materials - practical difficulties - construction - support conditions - cladding - aesthetics - Structural behaviour of thin shells - General specification of shells - Analysis of shells - Membrane theory of shells - Edge disturbances - classification of shells - methods of generating the surface of different shells like conoid, hyperbolic and elliptic paraboloid - formex data generation of space structure. (11)

DESIGN OF CYLINDRICAL AND HYPERBOLIC PARABOLOID SHELLS: Surface definition - Design of cylindrical shells with edge beam using theory for long shells - Design of cylindrical shell with ASCE manual coefficients - Detailing of reinforcement in shells and edge beams. Geometry of hypar shell - Analysis of membrane forces and moments - Determination of forces in the edge members - types of hyperbolic paraboloid roofs - Design of hypar shell roof of the inverted and tilted inverted umbrella types. (12)

SINGLE AND MULTI-LAYER GRIDS AND DOMES: Advantages - cladding - water drainage - progressive collapse and composite space trusses - Network domes - geodesic domes - double dome - ice dome - erection - connectors - ORS**:** Classification - ball joint systems - socket joint - plate joint - slot joint - shell joint - modular system - composite system - prefabricated systems. (12)

STRESSED SKIN - CABLE SUSPENDED STRUCTURES: Stressed skin steel buildings - stressed skin grids - cable suspended roofs - design of cable roofs - erection of cable roofs - Finite element analysis of skeletal structures - approximate methods - optimal design of space structures - Failure of shell and space structures - case histories. (10)

Total L: 45

REFERENCES:

1. Ramaswamy G.S, "Design and Construction of Concrete Shell roofs", CBS Publishers & Distributors, New Delhi, 2005.
2. Ramaswamy G. S., Eekhout M. and Suresh G. R., “Analysis, Design and Constructions of Space Structures”, Thomas Telford, 2002.
3. Subramanian N., “Principles of Space Structures”, Wheeler Publishing, 1999.
4. Chatterjee B.K., "Theory and Design of Concrete Shells", Chapman and Hall Ltd., London, 1990.
5. Varghese, P.C, “Design of Reinforced Concrete Shells and Folded Plates”, PHI Learning Pvt. Ltd., 2010.

21CS29 / 21CN30 EXPERIMENTAL TECHNIQUES AND INSTRUMENTATION

3 0 0 3

FORCES AND STRAIN MEASUREMENT: Measurement system: purpose system and elements - characteristics of measurement system - accuracy, precision, repeatability, Errors in measurements - Strain gauge, principle, types, performance and uses. Photo elasticity - principle and applications - Hydraulic jacks and pressure gauges - Electronic load cells - Proving Rings - Calibration of Testing Machines - Long term monitoring-vibrating wire sensors - fiber optic sensors - Introduction to structural modeling. (12)

MEASUREMENT OF VIBRATION AND WIND FLOW: Characteristics of Structural Vibrations - Linear Variable Differential Transformer (LVDT) - Transducers for velocity and acceleration measurements. Vibration meter - Seismographs - Vibration Analyzer - Display and recording of signals - Cathode Ray Oscilloscope – wind tunnels-flow meter-venturimeter - Digital Data Acquisition Systems. (10)

DISTRESS MEASUREMENTS AND ITS CONTROL: Diagnosis of distress in structures - crack observation and measurements – corrosion of reinforcement in concrete-Half cell, construction and use-damage assessment - controlled blasting for demolition-techniques for residual stress measurements - structural health monitoring. (11)

NON DESTRUCTIVE TESTING METHODS: Load testing on structures, buildings, bridges and towers-Rebound Hammer - acoustic emission - ultrasonic testing principles and application - Holography - use of laser for structural testing - Brittle coating - Advance NDT methods - ultrasonic pulse echo, impact echo, impulse radar techniques, advanced rebar corrosion rate determination system, ground penetrating radar (GPR) - Applications of NDT for quality assessment and damage detection of structures and materials, probability application in NDT, statistical quality control. (12)

Total L: 45

REFERENCES:

1. Sadhu Singh, "Experimental Stress Analysis", Khanna Publishers, New Delhi, 2006.
2. Ganesan T P, “Model analysis of Structures”, University Press 2000.
3. Srinath et.al L.S, "Experimental Stress Analysis", Tata McGraw Hill Company, New Delhi, 2003.
4. Sirohi R S, Radhakrishna H C, "Mechanical Measurements", New Age International (P) Ltd., 2013.

21CS30 THEORY OF PLATES

3 0 0 3

ELEMENTS OF PLATE - BENDING THEORY AND BENDING OF ISOTROPIC RECTANGULAR PLATES: General behaviour of plates - Small deflection theory of thin plates - Governing differential equation for deflection of plates -Boundary conditions – Kirchoff’s theory - Navier solution for an all - round simply supported rectangular plate subjected to uniformly distributed load, sinusoidal load and Patch load - Levy's solution for a rectangular plate with different boundary conditions and subjected to uniformly distributed load. (13)

BENDING OF CIRCULAR PLATES: Symmetrical bending of circular plates - Simply supported solid circular plate subjected to an uniformly distributed load, an end moment and partially distributed load. (11)

NUMERICAL METHODS: Finite difference method - Isotropic Rectangular plates - Boundary conditions - All round simply supported square plate and fixed square plate subjected to uniformly distributed load. Plates of various shapes - Rectangular plate - All round clamped square plate subjected to an uniform load. (12)

ANISOTROPIC PLATES: Bending of anisotropic plates - large deflection theory of plates - Plates on elastic foundation. (9)

Total L: 45

REFERENCES:

1. Timoshenko S. and Kreiger S.W., "Theory of Plates and Shells", McGraw Hill Book Company, India, 2010.
2. Chandrashekhara, K., "Theory of Plates", Universities Press (India) Ltd., Hyderabad, 2001.
3. Ansel C. Ugural, "Stresses in Plates and Shells", third edition, McGraw Hill International Editions, 2009.
4. Reddy J.N., “Theory and Analysis of Elastic Plates and Shells”, McGraw Hill Book Co., 2006.
5. Gambhir, M. L., “Stability Analysis and Design of Structures”, Springer, New York, 2009.
6. R. Szilard, “Theory and Analysis of Plates - Classical and Numerical Methods”, John Wiley & Sons, 2004.

21CS31 INDUSTRIAL STRUCTURES

3 0 0 3

PLANNING AND FUNCTIONAL REQUIREMENTS: Classification of Industries and Industrial Structures – planning for layout requirements regarding lighting, ventilation and fire safety - protection against noise and vibration – guidelines from factories act – material handling systems - structural loads-Estimation of wind load. (10)

SINGLE STOREY INDUSTRIAL STRUCTURES: Types of roofing – roofing sheets – purlins – light gauge sections – built-up sections – roof trusses – pre-engineered structures. Foundations for industrial structures (13)

MATERIAL HANDLING SYSTEMS: Design Philosophy and practices -Cranes – Types design of EOT over head travelling cranes, zib cranes and Goaliath cranes. Design of Gantry girders for over head cranes. Conveyor systems – Supports for conveyor systems-Foot Bridge-Transmission line towers (10)

INDUSTRIAL STORAGE & ENVIRONMENTAL CONTROL STRUCTURES: Silos, Bins and Bunkers – Design of supporting system for storage hoppers and bunkers - Electro Static Precipitators - Wet and dry Scrubbers – Chimneys – Self supporting, Guyed and Braced chimneys-Corrosion protection of steel structures-Fire and Fatigue resistant design (12)

Total L: 45

REFERENCES:

1. Shiyekar M R, “Limit State Design in Structural Steel”, PHI Learning private limited, New Delhi, 2017.
2. Subramanian N, “Design of Steel Structures”, Oxford university press, New Delhi, 2016.
3. Karuna Moy Ghosh, “Analysis and Design Practice of Steel Structures”, PHI Learning private limited, New Delhi, 2014.
4. Sai Ram K S, “Design of Steel Structures”, Pearson, New Delhi, 2013.
5. Alexander Newman, “Metal Building Systems – Design and Specifications”, McGraw Hill, New Delhi, 2004.

21CS32 MECHANICS OF COMPOSITE MATERIALS

3 0 0 3

BASICS AND MACROMECHANICS OF COMPOSITES: Classification – polymer - metal – ceramic – carbon-carbon – recycling of fiber reinforced composites – mechanics terminology – advantages Stress and strain – Hooke’s law - Engineering Constants of angle lamina - Hygrothermal stresses. (12)

MICROMECHANICAL ANALYSIS OF A LAMINA: Volume and mass fraction – density – evaluation of elastic moduli – semi-empirical models – elasticity approach – ultimate strength of uni-directional lamina – coefficients of thermal expansion. (10)

MICROMECHANICAL ANALSYSIS OF LAMINATE: Introduction – laminate code – stress – strain for a laminate – in-plane and flexural modulus of a laminate – hygrothermal effects – warpage of laminates. (12)

FAILURE, ANALYSIS AND DESIGN OF LAMINA & LAMINATES: Special cases of laminates – symmetric – cross-ply, angle –ply, antisymmetric, Balanced, Quasi-isotropic – strength failure theories – Tsai – Hill failure theory – Tsai –Wu failure theory – failure criterion - design of a laminated composite (11)

Total L: 45

REFERENCES:

1. Kollar L.P. and Springer G.S., “Mechanics of Composite Structures”, Cambridge University Press, 2003.
2. Reddy J.N., “Mechanics of Laminated Composite Plates - Theory and Analysis”, CRC Press, USA, 2003.
3. Jones R.M., “Mechanics of Composite Materials”, CRC Press, USA, 2018.
4. Kaw A.K., “Mechanics of Composite Materials”, CRC Press, 2005, USA.

21CS33 SOFT COMPUTING IN STRUCTURAL ENGINEERING

3 0 0 3

NEURAL NETWORKS, ASSOCIATIVE MEMORY AND ADAPTIVE RESONANCE THEORY: Basic Concepts - Artificial Neural Network (ANN) Architecture - Learning Methods - Back Propagation Network (BPN) - Single layer ANN - Multilayer ANN - Learning Method of Effect of tuning parameters. Kosko's Discrete (Bi-directional Associative Memory) BAM - input normalization - Evolution Equation - vector quantization - Architecture of ART1 and ART2 - Application to structural engineering problems. (13)

FUZZY LOGIC: Fuzzy sets and relations – Fuzzy sets and Crisp sets - Predicate logic - Fuzzy quantifiers - Fuzzy Rule based systems – Fuzzification and Defuzzification methods - Application to controllers- Application to structural Engineering problems. (11)

GENETIC ALGORITHMS: Basic concepts – Representation of design variables, objective function and constraints - Genetic operators - reproduction - selection - cross over - mutation – Choice of population – Survival of the fittest – generation – generation history - convergence of GA - optimal design using GA - Application to structural engineering problems. (12)

HYBRID SYSTEMS AND SUPPORT VECTOR MACHINES: Neuro - Fuzzy Hybrids - Fuzzy genetic hybrids - Neuro genetic hybrid - Fuzzy BPN - Fuzzy Art Map - Fuzzy controlled GA. Support vector regression – Classifications. (9)

Total L: 45

REFERENCES:

1. Rajasekaran S. and VijayalakshmiPai G. A., "Neural Networks, Fuzzy Logic and Genetic Algorithms", Prentice Hall of India, New Delhi, 2017.
2. Goldberg D. E., "Genetic Algorithms in Search Optimization and Machine Learning", Addison Wesley, Rading Mass, USA, 2006.
3. Gunn S. R., "Support Vector Machines for Classification and Regression", Technical Report ISIS-I-98 - University of Southampton, 1998.
4. Tsoukalas H. L. and Uhrig E. R., "Fuzzy in Neural Approaches in Engineering", John Wiley and Sons, USA, 1997.
5. Adeli H. and Hung S. L., "Machine Learning, Neural Networks, Genetic Algorithms and Fuzzy Systems, John Wiley and Sons, New York, 1995.

21CS34 DESIGN OF STEEL CONCRETE COMPOSITE STRUCTURES

3 0 0 3

CONNECTIONS: Introduction – limit states of composite sections –Design philosophies-codes of practice- shear connectors – types of shear connectors – degree of shear connection – partial and complete shear connections –Load bearing mechanism-strength of shear connectors- standard tests for shear connectors. (10)

COMPOSITE BEAMS: Elastic behavior of composite beams-Ultimate load behavior-Full Types of Profile steel sheeting-Design of composite beam propped and un propped construction– simply supported and continuous beams– beam with profile sheeted deck slab - Analysis and design of composite beams without profile sheet. (10)

COMPOSITE SLABS: Introduction of composite floors - shear transferring mechanism in profile deck system – resistance to longitudinal shear-resistance to vertical shear-Bending resistance of composite slab - Design considerations of composite floor - profiled sheeting – sheeting parallel to span – sheeting perpendicular to span –analysis and design of composite floor system-limit state of serviceability. (13)

COMPOSITE COLUMNS AND COMPOSITE CONSTRUCTION: Types– design of composite columns – Relative slenderness -resistance to axial, uniaxial and biaxial loading-Transverse and longitudinal shear- in-filled and encased columns-Design Philosophy. Case studies on steel concrete composite construction in buildings- beam column joints-classification of joints-Effects of Temperature, shrinkage, creep and vibration on composite beams. (12)

Total L:45

REFERENCES:

1. Qing Quan Liang," Analysis and Design of Steel and Composite Structures", CRC Press, Taylor and Francis Group,2015.
2. Johnson R.P, "Composite Structures of Steel and Concrete", Wiley India Pvt. Ltd, India, 2013.
3. Sai Ram K S, "Design of Steel Structures", Pearson Education, 2010.
4. Oehers D.J. and Bradford M.A., "Composite Steel and Concrete Structural Members, Fundamental Behaviour", Permagon Press, Oxford, 2013.
5. Teaching resource material for, "Structural Steel Design," Volume 2 of 3, Institute for Steel Development and Growth (INSDAG), 2002.
6. Narayanan R, "Composite Steel Structures – Advances, Design and Construction", Elsevier, Applied Science, UK, 1987.

21CS35 / 21CN28 PREFABRICATED STRUCTURES

3 0 0 3

DESIGN PRINCIPLES: Road to industrialization in buildings – History - Standardization and Components - Types of prefabrication – Prefabrication systems - Disuniting of structures - IS Code Specifications - Construction principles – Manufacture of prefabricated components – Transport and Erection of structural components – Finishing and Fitting -up operations – Dimensional deviation and Tolerance – Principles of structural design of prefabricated components (11)

ROOF, FLOOR UNITS AND WALL PANELS: Roofing slabs – Large slab type roof components – Floor units – Structural design of roof and floor units – Manufacture of roof and floor units – Dimensional variations – General consideration on external wall construction - Types of wall panels - Load bearing walls – Wind bracing (shear wall) – Curtain walls – Window panels – Connections and joints for wall panels – External wall panel examples – Manufacture, transport and erection of wall panels – Structural design and problems. (12)

INDUSTRIAL BUILDINGS: Structural Systems - Single bay - Multi-bay buildings - Low rise buildings - Applications - Design and Detailing - Crane track beams - Columns – Frames - Structural Connections - Execution of construction work – Structural design and stability problems. (10)

SEISMIC DESIGN OF PRECAST CONCRETE BUILDING STRUCTURES: Lessons From previous earthquakes-Demand versus capacity Assessment-Ductility provisions for structural members- Lateral Force resisting systems-Diaphragms- Seismic Detailing of Diaphragms-Inelastic behaviour of connection ns between precast structural elements. (12)

Total L: 45

REFERENCES:

1. Handbook on Precast Concrete Buildings, Indian Concrete Institute, 2016.
2. Kim S.Elliot, Collin K.Jolly, "Multi storey Precast concrete framed structures", 2nd edition, wiley Blackwell, Hoboken, United States, 2013.
3. Kim S.Elliot, "Precast concrete structures", 2nd edition, CRC Press (Taylor and Francis Group), London,2016.
4. PCI Design Handbook, Precast/Prestressed Institute, Eighth Edition, 2015.
5. PCI Connections Manual for Precast & Prestressed Concrete Construction, First Edition, 2008.
6. Fib 27, "Seismic design of precast concrete building structures, "International federation for structural concrete (Fib), Switzerland, 2003.

21CS36/21CN26 MAINTENANCE AND REHABILITATION OF STRUCTURES

3 0 0 3

DIAGONOSIS AND CONDITIONAL ASSESSMENT OF EXISTING STRUCTURES: Types of maintenance – Routine maintenance works in buildings – Inspection – Structural appraisal. Crack – principal sources for crack formation- Durability aspects. Conditional survey – visual inspection – field and laboratory testing stage – concrete strength assessment **(**11)

SELECTION OF REPAIR MATERIALS & DEMOLITION TECHNIQUES: Construction chemicals – repair chemicals – epoxies – polymers and latex – acrylic polymers – polyester resins - corrosion inhibitors as admixture – bonding coats for reinforcement –shrinkage compensating compounds - water proofing compounds. Special materials for construction and repair of buildings and special methods of placing concrete – Demolition Technique (11)

REPAIR OF STRUCTURAL ELEMENTS & NON-STRUCTURAL ELEMENTS: Repair against rising dampness and efflorescence in masonry wall, repair of cracks in masonry wall and concrete member. Repair against rainwater leakage in building, renovation of water proofing works of RC flat roofs against rain, repair of valley gutters of sloping roof, leakage of bathing area of toilets, sunken floors of toilets in multistoreyed building. (11)

STRENGTHENING OF EXISTING STRUCTURES: Strengthening of superstructure - Conversion to composite construction – Post stressing – Jacketing – Bonded overlays – Addition of reinforcement – Strengthening of substructure – Underpinning – Structural Health Monitoring (12)

Total L: 45

REFERENCES:

1. Poonam I. Modi & Chirag N Patel," Repair and Rehabilitation of Concrete Structures", PHI, Delhi 2016.
2. Varghese P.C, "Maintenance, Repair and Rehabilitation& Minor works of Buildings", PHI Learning Pvt. Ltd., Delhi, 2014.
3. Malhotra V.M., "Handbook on Non- Destructive testing of Concrete", CRC Press, 2014.
4. Allen R.T.L and Edwards S.C., "The repair of Concrete Structures", Thompson Press (India) Ltd., Delhi, 2019.
5. Bhattacharjee, "Concrete Structure Repair Rehabilitation & Retrofitting, CBS, 2005.

21CS37 / 21CN33 SMART MATERIALS AND SMART STRUCTURES

3 0 0 3

INTRODUCTION AND MEASURING TECHNIQUES: Properties of smart materials - mechanisms – instrumented structures functions and response sensing system – self diagnosis – signal processing consideration – actuation systems and effectors. Strain measuring techniques using electrical strain gauges, types – resistance-capacitance – inductance – wheat stone bridges - pressure transducers - load cells - temperature compensation – strain rosettes. (13)

SENSORS AND ACTUATORS: Sensing technology – types of sensors – physical measurement using piezo electric strain measurement – inductively read transducers – LVDT – fiber techniques - fiber optic strain sensors - Actuator techniques – Actuator and Actuator materials - piezo electric and electro resistive material – magneto structure material – shape memory alloys electrorheological fluids (ER) – electromagnetic actuation – role of actuators and actuator materials. (12)

SIGNAL PROCESSING AND CONTROL SYSTEMS: Data Acquisition and processing – signal processing and control for smart structures – sensors as geometrical processors – signal processing – control system – linear and non linear. (9)

INTRODUCTION TO STRUCTURAL HEALTH MONITORING (SHM): Definition and characters of SHM, SHM and bio mimetics, SHM as a part of system management, Passive and Active SHM, NDE, SHM and NDECS – basic components of SHM – Applications – SHM of a bridge – applications for external post tensioned cables, monitoring historical buildings. (11)

Total L: 45

REFERENCES:

1. Gauenzi, P., “Smart structures”, Wiley, 2009.
2. Hand Book on Seismic Retrofitting of Buildings, Published by CPWD & Indian Building Congress in Association with IIT, Madras, Narosa Publishing House, 2008.
3. Daniel Balageas, Claus - Peter Fritzenaml Alfredo Guemes, Structural Health Monitoring, Published by ISTE Ltd., U.K. 2006.
4. Brain Culshaw, “Smart Structures and Materials”, Artech House, London, 2000.
5. L.S.Srinath, “Experimental Stress Analysis”, Tata McGraw Hill, 2001.

21CS38 STRUCTURAL HEALTH MONITORING

3 0 0 3

INTRODUCTION AND VIBRATION BASED TECHNIQUES FOR SHM: Definition and characters of SHM, SHM as a way of making materials and structures smart, SHM and Biomimetics, Process and pre-usage monitoring as a part of SHM, Passive and active SHM, NDE, SHM and NDECS. Basic vibration concepts for SHM, Local and global methods, Damage diagnosis as an inverse problem, Model-based damage assessment, Mathematical description of structural systems with damage, General dynamic behavior, State-space description of mechanical systems, Modeling of damaged structural elements, Damage identification in non-linear systems. (13)

FIBER-OPTIC SENSORS: Classification of fiber-optic sensors, Photoelasticity in a plane stress state, Structures with embedded fiber Bragg gratings, Orientation of the optical fiber optic with respect to the reinforcement fibers, Ingress/Egress from the laminate, Fiber Bragg gratings as damage sensors for composites, Measurement of strain and stress variations, Examples of applications in civil engineering (10)

SHM WITH PIEZOELECTRIC SENSORS: The use of embedded sensors as acoustic emission (AE) detectors, Experimental results and conventional analysis of acoustic emission signals, Algorithms for damage localization, Algorithms for damage characterization, New concepts in acoustic emission, State of the-art and main trends in piezoelectric transducer-based acousto-ultrasonic SHM research, Acousto-ultrasonic signal and data reduction methods. (9)

SHM USING ELECTRICAL RESISTANCE and LOW FREQUENCY ELECTROMAGNETIC TECHNIQUES: Composite damage, Electrical resistance of unloaded composite, Percolation concept, Anisotropic conduction properties in continuous fiber reinforced polymer, Influence of temperature, Composite strain and damage monitoring by electrical resistance, unidirectional and Multidirectional laminates, Damage localization. Theoretical considerations on electromagnetic theory, Maxwell‘s equations, Applications to the NDE/NDT domain and SHM domain, General principles, Magnetic method, Electric method and Hybrid methods. (13)

Total L: 45

REFERENCES:

1. Douglas E Adams, “Health Monitoring of Structural Materials and Components-Methods with Applications”, John Wiley and Sons, 2007.
2. Victor Giurglutiu, “Structural Health Monitoring with Wafer Active Sensors”, Academic Press Inc, 2007.
3. Daniel Balageas, Claus-Peter Fritzen, Alfredo Güemes, “Structural Health Monitoring”, Wiley-ISTE, 2006.
4. J.P. Ou, H.Li and Z.D. Duan, “Structural Health Monitoring and Intelligent Infrastructure”, Vol-1, Taylor and Francis Group, London, U.K, 2006.
5. Huston.D, “ Structural Sensing, Health Monitoring and Performance Evaluation” ,CRC Press, A Taylor & Francis book,2011

21CS39 / 21CN39 FOUNDATION STRUCTURES

3 0 0 3

SHALLOW FOUNDATIONS: Site investigation – Field penetration tests – Bearing capacity based on N-value - Choice of shallow foundations for different situations – Proportioning of foundations for equal settlement, Sizing of foundations based on bearing capacity – strip, isolated, combined and strap – raft foundation. (9)

DEEP FOUNDATIONS: Pile foundation - Provisions of IS 2911 (Part 1 and Part 3) on structural design of piles - Structural design of straight piles - Different shapes of pile cap - Structural design of pile cap - Well foundation - Different types based on shape in plan – Grip length – Load carrying capacity based on SPT results – Thickness of steining and bottom plug – Forces acting on the well – Stability of well subjected to lateral load by Terzaghi’s approach – Methods to rectify tilt of well foundation. (14)

SHEET PILE WALL AND ANCHORED BULKHEADS: Different types of sheet pile – Cantilever sheet pile wall in granular soils, in cohesive soils with granular backfill – Anchored bulkhead- Free earth and Fixed earth support methods – in cohesive soils, in cohesive soil with cohesionless backfill . (10)

INTRODUCTION TO MACHINE FOUNDATIONS, SOIL-STRUCTURE INTERACTION PROBLEMS AND SHELL FOUNDATION: Fundamentals of soil dynamics – Determination of dynamic properties of soil based on Block Vibration Test and Cyclic plate load test – Barkan’s method of design of block foundation subjected to vertical vibrations – Vibration Isolation –

Transmissibility – Methods of Isolation– Modulus of subgrade reaction – Winkler model – Analysis of infinite beams resting on elastic medium and subjected to point load, uniformly distributed load and moment – Introduction to shell foundation. (12)

Total L: 45

REFERENCES:

1. Kurian K P, “Design of Foundation Systems”, Narosa Publishing House, New Delhi, 2014.
2. Varghese P C, “Foundation Engineering”, Prentice Hall of India Ltd., New Delhi, 2013.
3. Narasinga Rao B N D, “Soil Mechanics and Foundation Engineering”, Wiley Publishers, New Delhi, 2015.
4. Murthy V N S, “Textbook of Soil Mechanics and Foundation Engineering Geotechnical Engineering Series”, CBS Publishers and Distributors Pvt. Ltd., New Delhi, 2017.
5. Bowles J E, “Foundation Analysis and Design”, McGraw-Hill International Editions, 2017.

21CS40 / 21CN41 GROUND IMPROVEMENT TECHNIQUES

3 0 0 3

INTRODUCTION AND MECHANICAL MODIFICATION: Need for ground improvement - methods of ground improvement - geotechnical problems in alluvial and black cotton soils – selection of suitable ground improvement techniques based on soil conditions; Methods of compaction, principles of soil densification, properties of compacted soil, dynamic compaction, Preconsolidation technique. (12)

SOIL NAILING AND MICROPILING: Introduction – functions and applications of soil nailing – methods of construction of soil nailed cut – components of sail nail system; Reinforcing mechanism of micro pile – installation of micro pile. (11)

GEOSYNTHETICS AND DEWATERING SYSYTEMS: Introduction – functions of geosynthetics – types of geosynthetics - properties of geosynthetics and its applications; Dewatering techniques- well points – vacuum and electro osmatic methods. (11)

GROUTING TECHNIQUES AND SOIL STABILIZATION: Types of grouts, grouting equipment and machinery, injection methods, grout monitoring – applications of grouting; Lime stabilization - Base exchange mechanism, Pozzolanic reaction, lime-soil interaction, Design of Foundation on lime columns. Cement stabilization: Mechanism, amount, age and curing. (11)

Total L: 45

REFERENCES:

1. Satyendra Mittal, "An Introduction to Ground Improvement Techniques", Scientific International Pvt. Ltd., New Delhi, 2013.
2. Nihar Ranjan Patra, "Ground Improvement Techniques", Vikas Publishing House Pvt. Ltd., New Delhi, 2012.
3. Purushothama Raj P, “Ground Improvement Techniques”, Laxmi Publications (P) Ltd., 2016.
4. Sivakumar Babu G L, “Introduction to Soil Reinforcement and Geosynthetics”, Universities Press, Hyderabad, 2009.
5. Manfred R.Hausmann, “Engineering Principles of Ground Modification”, Pearson Education Inc., New Delhi, 2008.

21CS41 GEOTECHNICAL EARTHQUAKE ENGINEERING

3 0 0 3

ELEMENTS OF EARTHQUAKE SEISMOLOGY AND DYNAMIC SOIL PROPERTIES: Mechanism of earthquakes, causes of earthquake, earthquake fault sources, elastic rebound theory, seismic wave in earthquake shaking, definition of earthquake terms, Quantification of earthquakes – Dynamic soil properties – Representation of state of stresses by Mohr circle, Measurement of soil properties – Field and laboratory tests (12)

LIQUEFACTION AND DYNAMIC ANALYSIS OF SOLID WASTE LANDFILLS AND LINING SYSTEMS: Liquefaction and its related phenomena, Evaluation of liquefaction hazards, Liquefaction susceptibility – Historical, geologic, compositional and state criteria – Initiation of liquefaction, Effects of liquefaction – Alteration of ground motion, sand boils, settlement and instability. Performance of solid waste landfills during earthquakes, Analysis of solid waste landfills stability during earthquakes, Monitoring and safety control of landfills, Safety and risk analyses (13)

SEISMIC SLOPE STABILITY: Types of earthquake induced landslides, Earthquake induced landslide activity, Evaluation of slope stability. Review of static slope stability analysis, Seismic slope stability analysis – Analysis for inertial and weakening instability (10)

SEISMIC DESIGN OF RETAINING WALLS: Review of calculation of static pressures on retaining walls, Dynamic response of retaining walls, Seismic pressures on retaining walls – Yielding and non yielding walls, Effect of water, finite element analysis, Seismic displacements on retaining walls, seismic design considerations. (10)

Total L: 45

REFERENCES:

1. Swamisaran,” Soil Dynamics and Machine Foundations”, Galgotia Publications Pvt.Ltd., NewDelhi,2017.
2. Prasad B. B., “Fundamentals of Soil Dynamics and Earthquake Engineering”, PHI Learning Private Limited, New Delhi, 2013.

3. Ansal A., “Recent Advances in Earthquake Geotechnical Engineering and Microzonation", Kluwer Academic Publishers, The Netherlands, 2004.
4. Kramer S. L.,“Geotechnical Earthquake Engineering", Pearson Education (Singapore) Private Ltd. (Indian Branch), New Delhi, 2003.

21CS42 SOIL STRUCTURE INTERACTION

3 0 0 3

SOIL-FOUNDATION INTERACTION: Introduction to soil-foundation interaction problems – Soil behaviour, Foundation behaviour, Interface behaviour, Scope of soil foundation interaction analysis, Soil response models, Winkler, Elastic continuum, two parameter models, Elastic plastic behaviour, Time dependent behaviour (10)

BEAM ON ELASTIC FOUNDATION-SOIL MODELS: Infinite beams, two parameters, Isotropic elastic half space, Analysis of beams of finite length, Classification of finite beams based on their stiffness. (11)

PLATE ON ELASTIC MEDIUM: Infinite plate, Winkler, Two parameters, Isotropic elastic medium, Thin and thick plates, Analysis of finite plates, rectangular and circular plates, Numerical analysis of finite plates – Simple solutions. (11)

ELASTIC ANALYSIS OF PILE: Elastic analysis of single pile, Theoretical solutions for settlement and load distributions, Analysis of pile group, Interaction analysis, Load distribution in groups with rigid cap.Load deflection prediction for laterally loaded piles, Subgrade reaction and elastic analysis, Piled raft system, Solutions by influence charts. (13)

Total L: 45

REFERENCES:

1. Timoshenko S. P and Young D.H.,, “Theory of Structures”, McGraw Hill International Editions, 2002.
2. Poulos H.G. and Davis, E.H. “Pile Foundation Analysis and Design”, John Wiley, 2008.
3. Selvadurai A.P.S., “Elastic Analysis of Soil Foundation Interaction”, Elsevier, 1979.
4. Bowles J E, “Foundation Analysis and Design”, McGraw-Hill International Editions, 2017

OPEN ELECTIVE THEORY COURSES (One to be opted)

21CS91 WASTE TO ENERGY

3 0 0 3

WASTE FORMS OF ENERGY SOURCES AND CHARACTERIZATION: Waste production in different sectors such as domestic, agriculture, industrial waste (hazardous and non-hazardous). Characterization of waste for energy recovery and utilization. Waste selection criteria. Waste to energy options: combustion (unprocessed and processed fuel), anaerobic digestion, fermentation, gasification, pyrolysis. (9)

ENERGY RECOVERY THROUGH COMBUSTION: Perfect, complete and incomplete combustion - stoichiometric air requirement for bio fuels -equivalence ratio – fixed Bed and fluid Bed combustion – fuel and ash handling systems – steam cost comparison with conventional fuels - Incineration - energy from waste - Briqueting technology: Production of RDF and briquetted fuel. Properties of fuels derived from waste to energy technology - Pyrolysis - Classification - chemical processing - process governing parameters – Typical yield rates. Pollution preventive measures. (11)

ENERGY RECOVERY THROUGH BIOCHEMICAL CONVERSION: Energy recovery from organic waste adopting anaerobic digestion - phases in biogas production – parameters affecting gas production – biogas yield and effect of additives – possible feed stocks - biogas plants – types – design – constructional details and comparison – Pollution preventive measures - *bioreactor landfill* - biogas appliances – burner, luminaries and power generation – effect on engine performance. (12)

LIQUIFIED BIO FUELS & BIO ETHANOL AND GASIFICATION: Usage of Straight Vegetable Oil (SVO) as fuel - Bio ethanol production and fermentation technologies - Process chemistry - Biodiesel effects / emissions / performance of bio fuels - Production of alcoholic fuels (methanol and ethanol) from biomass – engine modifications - Cultivation and energy production of algal biomass using wastewater. Chemistry of gasification - types – comparison – application – performance evaluation – economics - Carbonization Techniques – merits of carbonized fuels - Producer gas - Pollution preventive measures. (13)

Total L: 45

REFERENCES:

1. George Tchobanoglous, Hilary Theisen, Samuel Vigil, “Integrated Solid Waste Management: Engineering Principles and Management Issues”, McGraw Hill Education 2014 New Delhi
2. Jayarama Reddy P, “Municipal Solid Waste Management: Processing Energy Recovery Global Examples”, BS Publications 2011 Hyderabad.
3. William A Worrell, Aarne Vesilind P, Tarun Gupta, “Solid Waste Engineering”, Cengage Learning India P Ltd 2017 New Delhi
4. Paul T Williams, “Wastewater Treatment and Disposal, Wiley India Pvt Ltd 2013 New Delhi
5. Cherry PM, “Solid and Hazardous Waste Management”, CBS Publishers & Distributors 2017 New Delhi
6. Avraam Karagiannidis, “Waste to Energy: Opportunities and Challenges for Developing and Transition Economics”, Springer - Verlag 2012 London

21CS92 SUSTAINABLE SOLID WASTE MANAGEMENT TECHNOLOGIES

3 0 0 3

WASTE MANAGEMENT AND SUSTAINABILITY: Introduction-Environmental Health-Driving forces of sustainability-Integrated waste management and sustainability-Waste Characteristics and generation-Types, sources, and characteristics of waste-generation of waste-waste testing and analysis (9)

WASTE STORAGE, SEGREGATION, AND COLLECTION: Introduction-source segregation-waste storage – collection – separation-Health and safety issues-waste prevention-waste prevention in context of sustainability-the policy context-Waste Prevention at the Level of Production and Supply-Waste Prevention at the Level of Consumption and the Household -Barriers to Waste Prevention-Best practices in the EU (12)

MATERIAL RECYCLING AND RESOURCE RECOVERY: Resource Recovery Progress and Statistics Indian Scenario-plastic and rubber-metals- glass waste –paper and other wastes-Public Engagement for Implementation of Waste Reduction and Recycling Policies-Public Participation in Waste Management Systems-Public Participation Policy in Global Context-Typical Areas of Public Participation in Waste Management Systems- Case studies (12)

TECHNOLOGIES FOR PROCESSING THE WASTE: Thermal Treatment Techniques: Incineration, Gasification, and Pyrolysis-Anaerobic Digestion or Co-Digestion for Sustainable Solid Waste Treatment/Management-Composting for Organic Waste Management -Biochar for Waste Management and Environmental Sustainability-Innovative Technologies: Plasma Arch Gasification-Construction and Demolition Waste-Treatment and Use of Ashes from Solid Waste Processing. (12)

Total L: 45

REFERENCES:

1. George Tchobanoglous, Hilary Theisen, Samuel A Vigil, " Integrated Solid Waste Management: Engineering Principles And Management Issues",Mcgraw Hill Publications, 2015
2. Nicholas P Cheremisinoff, "Handbook Of Solid Waste Management and Waste Minimization Technologies", Butterworth Publications, 2003
3. Dex Baker, "Handbook Of Solid Waste Technology and Management", Anmol Publications, 2013

ONLINE RESOURCES:

1. India VNR 2020 Decade of actionTaking SDGs from Global to Local: https://sustainabledevelopment.un.org/content/documents/26279VNR_2020_India_Report.pdf
2. Improving Management of Municipal Solid Waste in India-Overview and Challenges.http://documents1.worldbank.org/curated/en/178191468035334268/pdf/370700IN0Munic1ver0P08436401PUBLIC1.pdf
3. SwachhBharath Mission, Municipal solid waste management manual - 2016.http://cpheeo.gov.in/upload/uploadfiles/files/Part1(1).pdf
4. Sustainable development framework (2018-22) ,Government of India and the united nations https://en.unesco.org/sites/default/files/unsdf_india_2018-2022.pdf