CIVIL ENGINEERING

STRUCTURAL ENGINEERING

Program Structure (Applicable to 2023 admission onwards)

YEAR	FIRST SEMESTER						SECOND SEMESTER					
	SUB CODE	**SUBJECT NAME**	**L**	**T**	**P**	**C**	**SUB CODE**	**SUBJECT NAME**	**L**	**T**	**P**	**C**
I	MAT ****	OPTIMIZATION TECHNIQUES	3	1	0	4	CIE ****	DESIGN OF PRE-STRESSED CONCRETE STRUCTURES	3	1	0	4
	CIE ****	ADVANCED MECHANICS OF SOLIDS	3	1	0	4	CIE ****	EARTHQUAKE RESISTANT DESIGN OF STRUCTURES	3	1	0	4
	CIE ****	ANALYSIS AND DESIGN OF TALL STRUCTURES	3	1	0	4	CIE ****	PROGRAM ELECTIVE I	3	1	0	4
	CIE ****	FINITE ELEMENT METHOD	3	1	0	4	CIE ****	PROGRAM ELECTIVE II	3	1	0	4
	CIE ****	STRUCTURAL DYNAMICS	3	1	0	4	CIE ****	PROGRAM ELECTIVE III	3	1	0	4
	HUM ****	RESEARCH METHODOLOGY & TECHNICAL COMMUNICATION*	1	0	3	-	***.****	OPEN ELECTIVE	3	0	0	3
	CIE ****	PROFESSIONAL PRACTICE IN STRUCTURAL ENGINEERING	0	0	3	1	HUM ****	RESEARCH METHODOLOGY & TECHNICAL COMMUNICATION*	1	0	3	2
	CIE ****	COMPUTATIONAL AND STRUCTURAL ENGINEERING LAB	0	0	6	2	CIE ****	COMPUTER APPLICATIONS LAB	0	0	6	2
	Total					**23**						**27**
	THIRD AND FOURTH SEMESTER											
II	CIE ****	PROJECT WORK & INDUSTRIAL TRAINING							**0**	**0**	**0**	**25**

*TAUGHT IN BOTH SEMESTERS AND EVALUATED AND CREDITED IN THE SECOND SEMESTER

**LAB COURSES 2 & 3 AND 4&5 MAY BE COMBINED INTO ONE BY EITHER ALLOTTING 6 Hrs/WEEK OR 3 Hrs/WEEK WITH A PROVISION FOR MINI PROJECT/ASSIGMENTS

PROGRAM ELECTIVES		OPEN ELECTIVES	
COURSE CODE	COURSE TITLE	COURSE CODE	COURSE TITLE
CIE ****	ADVANCED DESIGN OF RCC STRUCTURES	CIE ****	ADVANCED STRENGTH OF MATERIALS
CIE ****	ADVANCED DESIGN OF STEEL STRUCTURES	CIE ****	ENERGY AND ENVIRONMENT
CIE ****	ADVANCED FOUNDATION ENGINEERING	CIE ****	NON - DESTRUCTIVE TESTING OF MATERIALS
CIE ****	ANALYSIS, DESIGN AND CONSTRUCTION OF SHELL STRUCTURES		
CIE ****	APPLICATIONS OF FINITE ELEMENT METHOD FOR STRUCTURAL ENGINEERING		
CIE ****	DESIGN OF BRIDGES AND FLYOVERS		
CIE ****	DESIGN OF PRECAST CONCRETE STRUCTURES		
CIE ****	MASONRY STRUCTURES		
CIE ****	OFFSHORE STRUCTURAL ENGINEERING		
CIE ****	RELIABILITY ANALYSIS AND DESIGN OF STRUCTURES		
CIE ****	SOIL STRUCTURE INTERACTIONS		
CIE ****	STRUCTURAL STABILITY		

I SEMESTER

MAT **** OPTIMIZATION TECHNIQUES [3 1 0 4]

Linear programming: Graphical method, Algorithm for simplex method, 2-phase method, Dual simplex method. Duality theory and sensitivity analysis. Integer linear programming. Transportation problem. Project Management - Networks, Project planning and control using PERT and CPM. Game theory - 2 persons zero sum games, Minimax principle, games with mixed strategies. Dominance theory.

Non Linear Programming Problem: Multi-variable optimization with and without constraints-semi definite, Multi-variable optimization with equality constraints – direct substitution, Method of constrained variation: Method of Lagrange multipliers, Kuhn Tucker conditions.

Eigenvalue and eigenvectors, Properties, Given's method, Householder's method for symmetric matrices.

References:

- Bronson R, Theory and Problem of Operation Research. Mc-Graw Hill. Inc, New York, 1982.
- Taha H.A., Operations research: an introduction. Pearson Education India, 2013.
- Hadley G, Linear programming. Narosa publishing house, 2002.
- Lieberman G.J., Hillier F.S., Introduction to operations research. New York, McGraw-Hill Inc., 2005.
- Lay D.C, Lay S.R., McDonald J., Linear algebra and its applications. Pearson Education, 2016.

CIE **** ADVANCED MECHANICS OF SOLIDS [3 1 0 4]

Theory of Elasticity in rectangular and polar co-ordinates – equilibrium equations, stress strain relations, compatibility equations, principal stresses and strains, Theories of elastic failure. Airy's stress function. Theory of rectangular and circular plates – slopes and curvatures, strain displacement relations, moment curvature relations, differential equations of plates, bending of plates. Theory of Shells – membrane and bending action of shells, analysis of simple shells.

References:

- Timoshenko, S.P., Goodier, J.N., Theory of elasticity, (3e), Auckland: McGraw Hill Book Company, 2008.
- Fenner, R.T., Engineering Elasticity: Application of numerical and analytical techniques, Chichester: Horwood, England, 1986.
- Timoshenko S.P., Woinowsky-Krieger S., Theory of plates and shells, (2e), McGraw Hill Book Company, New York, 2015.
- Ugural, A.C., Plates and Shells: theory and analysis, (4e), CRC Press, Taylor & Francis Group, 2018.
- Ramaswamy, G.S., Design and construction of Concrete shell roofs, Revised Edition, Krieger Publishing Company, 2005.

CIE **** ANALYSIS AND DESIGN OF TALL STRUCTURES [3 1 0 4]

Introduction to analysis and design of tall structures: Design criteria: Design philosophy, Loadings, IS 16700-2018 code provisions. Materials: High performance concrete and high strength steel. Structural planning and structural forms for tall buildings, floor systems. Foundations for Tall structure: Raft and pile foundation general principles. Approximate analysis of different form of tall structures to Lateral loads. Chimneys/Hollow shafts subjected to lateral loads, foundations, transmission line towers.

References:

- Taranath, B.S., Structural Analysis and Design of Tall Buildings, (1e), CRC Press, 2010.
- Pinfold G.M., Reinforced Concrete Chimneys and Towers, Viewpoint publisher, 1975.
- Stafford Smith, B., Coull, A., Tall building structures: analysis and design. John Willey, New York, 1991.

CIE **** FINITE ELEMENT METHOD [3 1 0 4]

Theory of elasticity, plane stress and plane strain problems, concept of an element, types of elements, displacement models, shape functions, minimization of potential energy approach, application of boundary conditions, application of finite element method to analyze pin jointed and rigid jointed structures, natural co-ordinates, application to plane stress and plane strain problems.

References:

- Desai C.S., Abel J.E., Introduction to the Finite element method, CBS publications, New Delhi, 1987.
- Krishnamoorthy, C. S., Finite element analysis: theory and programming. Tata McGraw-Hill Education, 2017.
- Cook, R. D., Concepts and applications of finite element analysis. John Wiley & sons, New York, 2007.
- Bathe, K. J. Finite element procedures. Klaus-Jurgen Bathe, 2006.
- Zienkiewicz, O. C., Taylor, R. L., Zhu, J. Z. The finite element method: its basis and fundamentals, Elsevier, 2005.

CIE **** STRUCTURAL DYNAMICS [3 1 0 4]

Types of dynamic problems. Formulation of equations of motion. Free Vibration of SDOF system. Forced vibrations of SDOF system subjected to harmonic excitation and general dynamic loading. Free and forced vibration (Harmonic and impulse loads only) of MDOF structure. Raleigh's method, improved Raleigh's method, Dunkerley's method, matrix iteration method. Continuous Systems: Free longitudinal vibration of bars, flexural vibration of single span beams, forced vibration of beams.

References:

- Chopra, A. K., Dynamics of structures. Pearson Education India. 2007.
- Paz. M., Structural Dynamics: Theory and Computation, Springer, 2018.
- Biggs J.M., Introduction to structural dynamics, McGraw Hill publications, 1964.
- Clough, R.W. & Penzien, J., Dynamics of structures, McGraw Hill publications, 1993.
- Humar, J., Dynamics of structures. CRC press, 2012.

HUM **** RESEARCH METHODOLOGY & TECHNICAL COMMUNICATION [1 0 3 2]

Research Methodology: Basic concepts: Types of research, Significance of research, Research framework. Sources of data, Methods of data collection. Research formulation: Components, selection and formulation of a research problem, Objectives of formulation, and Criteria of a good research problem. Research hypothesis: Criterion for hypothesis construction, Nature of hypothesis, Characteristics and Types of hypothesis, Elements of research design, Introduction to various sampling methods Sources of data, Collection of data, Research reports, references styles, Effective Presentation techniques, Research Ethics.

References:

- Sekaran U., Bougie R., Research methods for business: A skill building approach, John Wiley & Sons, 2016.
- Zikmund W.G., Babin B.J., Carr J.C., & Griffin M., Business research methods, Cengage Learning, 2013.
- Creswell J.W., Creswell J.D., Research design: Qualitative, quantitative, and mixed methods approaches, Sage Publications, 2018.
- Cooper D.R., Schindler P.S., Business Research Methods, McGraw Hill International, 2003.

CIE **** PROFESSIONAL PRACTICE IN STRUCTURAL ENGINEERING [0 0 3 1]

Roles and Responsibilities, Professional Conduct, Qualities and Qualifications, Challenges of practicing, Essential Handbooks and Library. Principles of Structural Engineering. Concepts. Practical Loads and Materials: Common Materials, Availability, Suitability Concrete, Steel, Aluminium Composites. Practical Analysis, Design and Detailing of Structures: Suitability of Structural Systems. Thumb rules, Approximate Methods for review of results. Important failure case studies, Risks, Law, Accreditations and licenses, Civil and Criminal Implications in Practice, Agreements, Disputes, Arbitration, Ethical Practices, Social Responsibility, Continuing Professional Development, Association, Professional Bodies

References:

- Krishnamurthy K.G., Ravindra S.V., Construction and project management. CBS Publishers & Distributors Private Limited, 2017.
- Hansen K., Zenobia K., Civil engineer's handbook of professional practice. John Wiley & Sons, 2011.

- Humphreys K.K., What every engineer should know about ethics. CRC Press, 1999.
- James, M., Risk Management in Civil, Mechanical, and Structural Engineering: Proceedings of the Conference Organized by the Health and Safety Executive in Co-operation with the Institution of Civil Engineers, Thomas Telford, 1996.

CIE **** COMPUTATIONAL AND STRUCTURAL ENGINEERING LAB [0 0 6 2]

Developing Computer Program for analysis of axially loaded bar, plane trusses, space trusses, plane rigid frames and continuous beams. Concrete mix design by IS Code and other methods. Study on flexural behavior of beams. Non-destructive tests on concrete. Experimental study on models for verification of Maxwell's reciprocal Theorem. Experimental study and analysis on models of Two hinged arch, Cantilever beams, Fixed beams. To study Influence Line diagram in frames and beams using Muller Breslau's principle. Study of flexural behaviour and evaluating toughness of FRC beam specimen as per standards. Fatigue testing of concrete specimen.

References:

- Krishnamoorthy, C. S. Finite element analysis: theory and programming. Tata McGraw-Hill Education, 2017.
- IS:10262, Indian Standard recommended guidelines for concrete mix design, 2009.
- SP: 23, Handbook of Concrete mixes, 1982.
- Krishna Raju N., Design of Reinforced Concrete Structures (4e), CBS publishers, New Delhi, 2019.
- Krishna Raju N., Prestressed Concrete, (6e), Tata McGraw Hill Publishing Co. New Delhi. 2018.
- Lin T.Y., Burns N.H., Design of Prestressed Concrete Structures (3e), John Willey and Sons, New York, 2010.

II SEMESTER

CIE **** DESIGN OF PRE-STRESSED CONCRETE STRUCTURES [3 1 0 4]

Introduction, Code Provisions, Loses, Analysis of Type1 & Type2 members under Flexure at Transfer and at Service, Analysis for Ultimate Strength, Limiting Zone, Magnel's Graphical Method, Design of Sections for Type 1 & type 2 flexure members, Limit State of Collapse for Shear & Torsion, Calculation of Deflection, Crack Width, Transmission of Prestress. Analysis of Continuous and cantilever Beams: Moment due to Reactions, Pressure Line due to Prestressing Force, Principle of Linear Transformation, Concordant Tendon Profile, Tendon Profiles, Analysis for Ultimate Strength, Moment Redistribution. Analysis & Design of Composite Sections, Design of One-way Slabs, Compression Members, Circular Prestressing members: Prestressed Concrete Pipes. Analysis of two-way slab and Compression Members.

References:

- Amlan K. S., Devdas M., Prestressed Concrete Structures, NPTEL.
- Krishna Raju N., Prestressed Concrete, (6e), Tata McGraw Hill Publishing Co. New Delhi, 2018.
- Lin T.Y., Burns N.H., Design of Prestressed Concrete Structures (3e), John Willey and Sons, New York, 2010.
- Nilson A. H., Design of pre-stressed concrete, (2e), John Wiley & sons, publications, New York, 1987.
- IS 1343, Indian Standard code of practice for pre-stressed concrete, Bureau of Indian Standards, New Delhi, 2012.
- IS 784, Pre-stressed concrete pipes- specification, Bureau of Indian Standard, New Delhi, 2001.

CIE **** EARTHQUAKE RESISTANT DESIGN OF STRUCTURES [3 1 0 4]

Importance of earthquake resistant design. Types of seismic waves. Earthquake intensity, modified Mercalli scale. Response to ground acceleration, response analysis by mode superposition, response spectrum analysis, earthquake response of in-elastic structures. Codal provisions. Design criteria for multi-storey buildings, elevated structures like: elevated tanks and stack like structures.

References:

- Chopra, A. K., Dynamics of structures. Pearson Education India. 2007.
- Clough, R.W. & Penzien, J. Dynamics of structures, McGraw Hill publications, 1993.
- Duggal S. K., Earthquake Resistant Design of Structures, Oxford University Press, New Delhi, 2007.
- Paz. M., Structural Dynamics: Theory and Computation, Springer, 2018.
- IS:1893(Part 1), Indian Standard Criteria for Earthquake Resistant Design of Structures, Bureau of Indian Standards, New Delhi. 2016.

CIE **** COMPUTER APPLICATIONS LAB [0 0 6 2]

Introduction to Software packages and analysis of plane truss, plane frame, grid floor and space frame subjected to various types of static and dynamic loading and their combinations as per Indian standards. Mini project related to structural engineering structures.

References:

- Relevant software reference Manuals.
- Hibbeler R.C., Structural Analysis, (10e), Pearson, 2017.
- IS: 456, Indian Standard Code of practice for plain and reinforced concrete, Bureau of Indian Standards, 2000.

III and IV SEMESTERS

CIE **** PROJECT WORK [0 0 0 25]

Students are required to undertake innovative and research-oriented projects, which not only reflect their knowledge gained in the previous two semesters but also reflects additional knowledge gained from their own effort. The project work can be carried out in the institution/ industry/ research laboratory or any other competent institutions.

The duration of project work should be a minimum of 36 weeks. There will be a mid-term evaluation of the project work done after about 18 weeks. An interim project report is to be submitted to the department during the mid-term evaluation. Each student has to submit to the department a project report in prescribed format after completing the work.

The final evaluation and viva-voice will be after submission of the report. Each student has to make a presentation on the work carried out, before the departmental committee for project evaluation. The mid-term & end semester evaluation will be done by the departmental committee including the guides.

PROGRAM ELECTIVES

CIE ****ADVANCED DESIGN OF RCC STRUCUTRES [3 1 0 4]

Analysis and Design of continuous beams, multi-storey frames, bunkers and silos, overhead water tanks: Rectangular and Intze type water tanks, Design of deck and beams of T beam deck Slab Bridge. Pre-fabricated construction: Requirements for pre-fabricated R.C. members – design and erection of pre-fabricated members – general erection principles – transportation and storage – joints in pre-fabricated structures – analysis and design of embedded parts.

References:

- Ferguson P.M., Breen J.E., Jirsa J.O., Reinforced Concrete Fundamentals, John Wiley & Sons, New York, 1988.
- Nilson A.H. and Winter G., Design of Concrete Structures (12e), McGraw Hill Publishing Company, Singapore, 1997.
- Cook J. P., Composite Construction, John Wiley and sons. New York. 1977.
- Benson C.S., Advanced Structural Design, ELBS and B.T. Batsford Ltd., London, 1963
- IS: 456, Indian Standard Code of practice for plain and reinforced concrete, Bureau of Indian Standards, 2000.
- IS:3370 (Part IV), Indian Standard Code of practice for the storage of liquids, Bureau of Indian Standards, 2009.
- SP:16, Design Aids for Reinforced Concrete to IS: 456-1978, Bureau of Indian Standards, New Delhi, 1980.

CIE **** ADVANCED DESIGN OF STEEL STRUCUTRES [3 1 0 4]

Limit state method of design of steel frames. Design of members subjected to combined forces. Design of steel plate girder bridge. Design of tubular Trusses and scaffoldings using circular hollow, rectangular hollow. Design of Transmission towers. Design of Pre-engineered buildings Design of Composite beams and columns.

References:

- Beedle, L.S., Plastic design of steel structures, John Wiley & Sons, 1961.
- Segui W.T., LRFD steel design (3e), Nelson Engineering, 2002.
- Nethercot D., Limit state, design of structural steel work, (3e), Routledge, 2001.
- Arya A. S., Ajmani, J. L., Design of Steel Structures, (6e), Nem chand & brothers, 2014
- IS: 800, General Construction in Steel - Code of Practice, Bureau of Indian Standards, 2007.
- SP: 6, Handbook for structural engineers, Bureau of Indian Standards, 1964.

CIE ****ADVANCED FOUNDATION ENGINEERING [3 1 0 4]

Shallow foundation: Design of combined footings, and mats by conventional method. Pile foundations: Types, Pile capacity by dynamic & Static formula, Analysis of piles. resistance by wave equation, Pile load tests, settlement of single pile – Elastic solutions – Well foundations: Forces acting on well foundation, analysis of well foundation using Terzaghi's method. Machine foundations: Machine foundations – Type of machine foundations – Methods of analysis of machine foundation. Foundations for tall structures, special foundations: hyperbolic parabolic shells etc.

References:

- Bowles J. E., Foundation Analysis and Design, (5e), McGraw Hill Book Co., 2001.
- Winterkorn H.F., Fang H. Y., Foundation Engineering Handbook – Van Nostrand Reinhold, 2010.
- Leonards G. A., Foundation Engineering, McGraw Hill Book Co., 1962.
- Poulos H.G., Davis E.H., Pile Foundation Analysis and Design, John Wiley & sons, 1980.
- Teng W. C, Foundation Design, Practice Hall of India, 1981.

CIE **** ANALYSIS, DESIGN AND CONSTRUCTION OF SHELL STRUCTURES [3 1 0 4]

Classification of Shells, Properties of curves, Membrane Theory, Beam Theory, Cylindrical shells, Bending Theory, North light shells. Membrane Theory for shells of revolution -Domes, Paraboloids, Conical shell, Rotational Hyperboloids. Synclastic shells – Elliptic paraboloids. Anticlastic shells – Hyperbolic paraboloid – umbrella roof. Conoids - Folded plates. Construction of concrete shell roofs.

References:

- Ramaswamy, G.S., Design and Construction of shell roofs, CBS Publications, New Delhi. 2005.
- Chatterjee, B.K., Theory and Design of Concrete Shells, Chapman and Hall, 1988.
- Timoshenko S. P, Woinowsky-Krieger S., Theory of Plates and Shells, (2e), Tata - McGraw Hill, New York, 2017.
- Ugural, A.C., Stresses in Plates and Shells, (2e), McGraw Hill, New York, 1998.

CIE ****APPLICATIONS OF FEM FOR STRUCTURAL ENGINEERING [3 1 0 4]

Application of finite element method - for three dimensional analyses, for the analysis of plates, for dynamic analysis of pin and rigid jointed structures, for non-linear analysis, for elastic stability problems, for soil - structure interaction analysis, memory management techniques

References:

- Desai C.S., Abel J.E., Introduction to the Finite element method, CBS publications, New Delhi, 2005.
- Krishnamoorthy C.S., Finite element analysis: Theory and Programming, (2e), Tata McGraw Hill Publishing company Ltd., New Delhi, 2017.
- Cook R.D., Malkas D.S., Plesha, M.E., Concepts and Applications of Finite element Analysis, (4e), John Wiley and Sons, New York, 2007.
- Bathe K.J., Finite element procedures in Engineering Analysis, (3e), Prentice Hall Engle Wood, Cliffs, NJ, 1997
- Zinkiewicz O.C., Taylor R.L., Jhu J.Z., The Finite element method: Its Basis and Fundamentals, (7e), Butterworth-Heinemann Ltd, 2013.

CIE **** DESIGN OF BRIDGES AND FLYOVERS [3 1 0 4]

Introduction: Historic Developments-Importance of Bridges, Classifications-Steps involved in Bridge Projects- Typical forms of Reinforced Concrete Bridges. Limit State Method of Design of Bridges: Basis of Design as per IRC, Design of Deck Slabs, Design of Solid Slab Culverts. T- Beam Bridges: Analysis and Design, Detailing of Longitudinal Beam, Balanced Cantilever Bridge, Grade Separators: Flyovers, Under Passes, Forms and Parts, Analysis Design of Single Cell Box Type Under Passes, Analysis and Design of Single Bay Portal Type Under Passes- IRC SP 90- IRC -54. Sub- structures and Foundations: Bearings, -Stability Analysis of Piers and Abutments, Foundations.

References:

- Victor D.J., Essentials of Bridge Engineering, (6e), Oxford, 2019.
- Raju N.K., Design of Bridges, (5e), Oxford & IBH Publishing, 2019.
- Jagadeesh T.R., Jayaram M.A., Design of Bridge Structures, (3e), PHI Learning Pvt. Ltd, 2020.
- IRC: 6, Standard Specifications and Code of Practice for Road Bridges- Section II – Loads & Stresses, 2017.
- IRC: 112, Code of Practice for Concrete Bridges, 2011.

- IRC: 78, Standard Specifications and Code of Practice for Road Bridges- Section VII – Foundations and Substructures, 2014.

CIE **** DESIGN OF PRECAST CONCRETE STRUCTURES [3 1 0 4]

Introduction: Suitability of precast construction, Preliminary Design Consideration, General Design Principles. Precast Frame Analysis: Types of Precast Construction, Precast Concrete Beams, Column and Shear Wall, Horizontal Floor Diaphragm: Shear Transfer Mechanism, Edge Profile and Tie Steel Details. Joint and Connections: Definitions, Basic Mechanism, Compression and Tension Joint, Pinned Jointed, Moment Resistance Connection, Ties in Precast Concrete Structures.

References:

- Elliott K.S., Precast Concrete Structures, (2e) CRC Press, 2016.
- FIP Planning and Design Handbook on Precast Building Structures, SETO Ltd., 1994.
- Bachmann H., Steinle A., Precast Concrete Structures, Wiley India Pvt. Ltd., 2018.

CIE **** MASONRY STRUCTURES [3 1 0 4]

Material properties, masonry units; Masonry in compression, prism strength, eccentric loading, kern distance; Masonry under lateral loads, in-plane and out-plane loads, analysis of perforated shear walls, lateral force distribution for flexible and rigid diaphragms; cyclic loading, ductility of masonry walls for seismic design, infill masonry; Structural design of masonry, working and ultimate strength design, strengthening of existing masonry structures.

References:

- Hendry A.W., Sinha B.P., Davies S.R., Design of masonry structures, CRC Press, 2017.
- Paulay T, Priestley M.N., Seismic design of reinforced concrete and masonry buildings, Wiley, New York, 1992.
- Orton A., Structural design of masonry, Longman Publishing Group, 1992.
- Sunset Books, Basic Masonry, Sunset Publishing Corporation, 1995.
- Beall C., Masonry Design and Detailing, (6e), McGraw Hill, New York, 2011.
- IS:13828, Improving Earthquake Resistance of Low Strength Masonry Buildings - Guidelines, 1993.

CIE **** OFFSHORE STRUCTURAL ENGINEERING [3 1 0 4]

Introduction to Offshore Structural Engineering: types of offshore structures, construction aspects. Environmental loadings: Morison equation approach for wave force piles. Foundation analysis: pile axial and lateral load capacity and its response, bearing capacity of footings and its response, settlement of foundations. Dynamic analysis of offshore structure Fatigue analysis and examination for dynamic effects.

References:

- Dawson T.H., Offshore structural Engineering, Prentice Hall, 1983.

- Carneiro F.L.L.B., Ferrante A.J., Brebbia C.A., Offshore structure Engineering, Gulf Publishing, Houston, 1979.
- Design and Construction of Offshore Structures, Institution of Civil Engineers (ICE), London, 1977.

CIE **** RELIABILITY ANALYSIS AND DESIGN OF STRUCTURES [3 1 0 4]

Concepts of structural safety, statistics and probability. Statistical properties of concrete, Steel, Brick and Mortar. Characterization of variables. Probabilistic analysis of gravity and wind loads, Monte Carlo- simulation. Basic concept of structural systems: System reliability, modeling of structural systems, bounds on system reliability. Automatic generation of mechanisms. Application to RCC, PSC and Steel structures.

References:

- Ranganathan R., Reliability Analysis and Design of Structures, Tata - McGraw Hill Company Ltd., New Delhi, 1990.
- Ang A.H., Tang W.H., Probability Concepts in Engineering: Emphasis on Applications in Civil & Environmental Engineering, John Wiley and Sons, New York, 2006.
- Kapur K.C., Lamberson L.R., Reliability in engineering design, Wiley India Private Limited, 2009.
- Melchers R.E., Beck A.T., Structural reliability analysis and prediction, John Wiley & sons, 2018.
- Siddall J.N., Probabilistic Engineering Design, Marcel Dekker, New York, 1983.

CIE **** SOIL-STRUCTURE INTERACTION [3 1 0 4]

Soil-Foundation Interaction. Soil response model, Elasto-plastic behaviour, Time dependent behaviour. Beams on Elastic foundations, Analysis of beams of finite length. Plates on elastic medium, Infinite plates, thin and thick plates. Elastic analysis of piles, Analysis of pile groups, Interaction analysis.

References:

- Selvadurai A.P., Elastic analysis of soil-foundation interaction, Elsevier, 2013.
- Poulos H.G., Davis E.H., Pile-Foundation Analysis and Design, John Wiley & Sons, 1980.
- Scott R.F, Schoustra J.J., Soil Mechanics and Engineering, McGraw Hill, 1968.

CIE **** STRUCTURAL STABILITY [3 1 0 4]

Buckling of columns, lateral buckling of beams, beam - columns and frames: buckling of simple frames. Elastic buckling of plates and shells, failure of cylindrical shells. dynamic stability of structures, code specifications for design for the design of columns, beam columns, beams and stiffeners in girders.

References:

- Timoshenko S.P., Gere J.M., Theory of elastic stability, (2e), Dover Publications, 2009.
- Chajes A., Principles of structural stability theory, Prentice Hall, Englewood cliffs, New Jersey, 1993.
- Iyengar N.G.R., Structural stability of columns and plates, Ellis Horwood Ltd., 1988.
- Kumar A., Stability Theory of structures, Tata McGraw Hill, New Delhi, 1986.

OPEN ELECTIVES

CIE **** ADVANCED STRENGTH OF MATERIALS [3 0 0 3]

Torsion: Torsion of non-circular and thin walled sections. Unsymmetrical bending of straight beams, thin-walled beam cross sections – shear centre for thin walled sections. Bending of curved beams: crane hooks, closed rings - correction factor for flanged cross sections. Bending of beams curved in plan. Beams on Elastic foundation.

References:

- Srinath L.S., Advanced mechanics of solids, (3e), Tata McGraw-Hill Education, New Delhi, 2017.
- Boresi A.P., Schmidt R.J., Advanced mechanics of materials, (6e), John Wiley & Sons, 2009.
- Den Hartog J.P., Advanced strength of materials, Dover Publications Inc, 2013.
- Raju N.K., Advanced mechanics of solids and structures, McGraw-Hill Education, 2018.
- Riley W.F., Sturges L.D., Morris D.H., Statics and mechanics of materials: an integrated approach, John Wiley & Sons, 2001.

CIE **** ENERGY AND ENVIRONMENT [3 0 0 3]

Introduction: Energy consumption, crisis, Policies, Laws and Principles. Renewable sources of energy and Environmental aspects: example: solar energy, Hydro power, etc. Non-renewable sources of energy and Environmental aspects – coal, oil, natural gas. Global and regional impacts of Climate change: Greenhouse effects, global warming and Acid rain

References:

- Rai G.D., Rai C.D., Non-conventional energy sources, Khanna Publishers, 1992.
- Kothari D.P., Ranjan R., Singal K.C., Renewable energy sources and emerging technologies, (2e), PHI Learning Pvt. Ltd., Delhi, 2021.
- Wilbur L.C., Handbook of energy systems engineering: Production and utilization, John Wiley & Sons, 1985.
- Rao S., Parulekar B.B., Energy Technology: Non-conventional, renewable and conventional, (3e), Khanna Publication, 2012.

CIE ** NON- DESTRUCTIVE TESTING OF MATERIALS [3 0 0 3]**

Introduction, Liquid Penetrant Tests, Magnetic particle testing, Acoustic Emission Test, Ultrasonic test, Electromagnetic Testing Method, Leak Testing Methods, Radiographic Testing Method.

References

- Hull B., John V, Non-destructive testing, Macmillan, London, 1988.
- Halmshaw R., Non-destructive testing. (2e), Edward Arnold, Mill Rd, Dunton Green, Sevenoaks, London, 1991.
- McGonnagle W.J., Non-destructive testing, Gordon & Beach Science, New York, 1983.
- Handbook on Nondestructive evaluation and quality control, Volume 17, (9e), American Society of Metals, Metals Park, Ohio, USA, 1989.
- Mix P.E., Introduction to Nondestructive testing: a training guide, (2e), John Wiley & Sons, 2005.

Guidelines for Second year M Tech Project work & Industrial Training (Applicable to M Tech Curriculum – 2023)

1. A student of M Tech shall carry out a Project Work during the second year of the programme, in the institution/ industry/ research laboratory or any other institution of higher learning where facilities exist, with approval from the parent Department.

   Any one of the following options is permitted for undertaking the project work:

   1.1 A single project at the parent institute/industry/research laboratory/any other institution of higher learning.

   1.1.1 If the project work is undertaken at the industry/research laboratory/any other institute of higher learning, the minimum duration of the work will be 36 weeks.

   1.1.2 If it is undertaken at the parent institute of the student, the minimum duration for the project work will be 32 weeks and in addition to this, the student has to undergo a mandatory industrial training for 4 weeks.

   1.2 A project work for a minimum duration of 16 to 24 weeks at an industry/research laboratory/institution of higher learning and another project work at the parent institute for a minimum duration of 12 to 20 weeks so that the total duration of the two projects together will be a minimum of 36 weeks.

2. There will be a mid-term evaluation of the work after about 18 weeks by the department concerned if it is a single project. This evaluation will be out of 100 marks.

3. If the student undertakes two projects, one in an industry/research organization/institution of higher learning and the other one in the parent institute, there

will be a mid-term evaluation of the work by the department for each of them. The evaluation will be out of 50 marks each.

4. In case of external projects, the feedback of the external guide shall be considered during evaluation.

5. If the student has undertaken more than one project work, a single report has to be submitted at the end of the second year that includes the relevant contents of both the projects in the form such as PART A and PART B.

6. The final evaluation will be conducted after the completion of the project work and submission of the report, by a panel of examiners including the internal/institute guide. The final evaluation will be out of 300 marks.

7. The grade awarded to the student will be on the basis of total marks obtained out of 400 marks.