DEPARTMENT OF SHIP TECHNOLOGY

M. TechComputer Aided Structural Analysis & Design

Semester I

Course Code	Course	C/E	Hrs/Week				Credits
			L	T	P	Total	
ST183101	Advanced Engineering Mathematics	C	4	2	0	6	4
ST18 3102	Computer Aided Design in offshore Engineering	C	4	2	0	6	4
ST18 3103	Advanced Structural Analysis	C	4	2	0	6	4
	Elective I	E	4	2	0	6	4
	Elective II	E	4	2	0	6	4
Total		**-**	**20**	**10**	**0**	**30**	**20**

Electives

ST18 3104Marine Hydrodynamics

ST18 3105Fracture Mechanics

ST18 3106 Application of Stochastic Process Theory in Ocean Engineering

ST18 3107 Stability of Structures

ST18 3108 Marine Corrosion and Prevention

ST18 3109 Marine Pollution and its effect

ST18 3110 Pollution Control Technique

ST18 3111 Advanced Joining Techniques

Semester II

Course Code	Course	C/E	Hrs/Week				Credits
			L	T	P	Total	
ST18 3201	Dynamics of Structures	C	4	2	0	6	4
ST18 3202	Finite Element Methods Applied to Offshore Engineering	C	4	2	0	6	4
	Elective III	C	4	2	0	6	4
	Elective IV	E	4	2	0	6	4
	Elective V	E	4	2	0	6	4
Total		**-**	**20**	**10**	**0**	**30**	**20**

Electives

ST18 3203 Ocean Waves and Effects
ST18 3204Analysis of Special Structures
ST18 3205 Design of Offshore Structures
ST18 3206Fatigue Problems in Ships and Marine Structures
ST18 3207 Computer Application in Ship Manoeuvring

Semester III

Course Code	Course	C/E	Credits
ST18 3301	Project Progress Evaluation	C	18

Semester IV

Course Code	Course	C/E	Credits
ST18 3401	Project Dissertation Evaluation and Viva Voce	C	18

Revision -2018

Syllabus for M.Tech "COMPUTER AIDED STRUCTURAL ANALYSIS & DESIGN"

SEMESTER - I

ST18 3101 ADVANCED ENGINEERING MATHEMATICS

1. Fourier Analysis: Fourier series – Euler Formulae – Functions having arbitrary period – Even and odd functions - Half range expansions- The Fourier integral – Fourier transforms.
2. Partial differential equations: Basic concepts-vibrating string – One dimensional Wave equation – separation of variables – D'Alemberts' solution of the wave equation – One dimensional Heat equation – Heat flow in an infinite bar equation, problem & its solutions.Laplace transform, method of solving PDE.
3. Complex Analysis: Complex Analytic functions – Cauchy Riemann equations – Conformal Mapping – Line Integral Cauchy's intergran theorem – Cauchy's integral formula – Derivatives of Analytic functions – Tayler's series – Laurent's series – Residues – The residue theorem - Evaluation of real integrals –Integration around a small semi circle.
4. Numerical method: Eulers method, Runge-kutta method, Crack-Nicholson Scheme, Finite Difference Method, Backward, Forward and Central Difference Method.
5. Calculus of variations: Euler's equation isoperimetric problems – Approximate solution of boundary value problems – Hamilton's principle – Lagrange's equation.

References:

1. Kreyszig, E. Advanced Engineering Mathematics, Wiley, New York, 2013
2. Grewal, B.S., Higher Engineering Mathematics, Khanna Publishers, New Delhi,2016.

ST18 3102 COMPUTER – AIDED DESIGN IN OFFSHORE ENGINEERING

1. Introduction and Review of CAD: Introduction, Conventional Engineering Design process and Computer Aided Engineering Design process, Software tools and functions, Graphics standards, Programming language CAD development.

Basics of Computer Graphics: Introduction to computer graphics technology – picture representation, graphic display devices, graphic input devices; Representation of points and lines, Geometric transformations, two & three dimensional transformations and projections.

2. Geometric Modelling: Types of mathematical representation of curves, wire frame models, wire frame entities, parametric representation of curves; Hermite cubic splines, Bezier curves, B-splines curves.

   Surface Modelling: Mathematical representation surfaces, Surface model, Surface entities surface representation, Parametric representation, Surfaces of revolution, Sweep surface, Ruled & Developable surfaces, COONs Bi-cubic surface, Bezier surface, B- Spline surface.

3. Engineering Optimisation: Introduction, Engineering applications of Optimization, Review of single and multivariable optimization methods with and without constraints, Non-linear one-dimensional minimization problems, Examples.

   Unconstrained Optimization: Techniques: Introduction, Direct search method - Random, Univariate and Pattern search methods, Descent methods - Steepest Decent methods- Quasi-Newton's and Variable metric method, Examples.

4. Constrained Optimization: Techniques: Introduction, Direct methods - Cutting plane method and Method of Feasible directions, Indirect methods - Convex programming problems, Penalty function method, Examples and problems.

   Search Techniques: Introduction, Genetic Algorithm, Simulated Annealing, Artificial Neural Networks, Examples.

5. Fundamental Concepts Of Database Management: Introduction to DBMS, Data Models, Database Structure, Database languages, DBMS architecture, Database users and administrator, Entity-Relationship model, Relational model, SQL concepts, Object-Based databases and XML, Distributed databases, Integrity and Security to DBMS.

References:

1. Krishnamoorthy, C.S. & Rajeev, S.; Computer Aided Design- Software and Analytical Tools, Alpha Science International, 2005.
2. KhushdeepGoyal; Fundamental of computer aided design, S.K.Kataria& Sons, 2013
3. Sunil Kumar Srivastava; Computer Aided Design-a basic and mathematical approach, I.K. International publishing house, 2012.
4. Kernighan, B.W and Ritchie, D.M.; The Programming Language, Prentice – Hall, New Delhi. 2010
5. BjarneStroustrup; The C++ Programming Language, Addison-Wesley Publishing Company, 1995.
6. Rojers, D.F and Adams, J.A., Mathematical Elements Computer Graphics, McGraw Hill, New York. 2017
7. Vera B. Anand; Computer Graphics and Geometric Modelling for Engineers; John Wiley & Sons, Inc., 1993.
8. Steven Harrington: Computer Graphics-A Programming Approach; Second Edition, McGraw Hill International Edition, 1987.
9. Donald Hearn and M. Pauline Baker; Computer Graphics; Prentice Hall, 1997
10. Harrington, Computer graphics, McGraw Hill education, 2014
11. Newman, W.N. and Sproull R.F. Principles of Interactive Computer Graphics, McGraw Hill, New Delhi. Ed.2, 2010
12. Ammeral, L., Interactive 3D computer graphics, John Wiley, Singapore, 2010
13. Aoki, M. Introdution to Optimisation Techniques, TheMacmillian, Co., New York. 1991
14. Rao S.S.; Engineering Optimization Theory and Practice, John Wiley & Sons 2009
15. Rajesh Kumar Arora; Optimization, Algorithms and Applications, CRC Press, 2015
16. R. Pannerselvam; Operations Research, PHI Learning Private Ltd, 2017
17. Abraham Silberschatz, Henry F. Korth, S. Sudarshan; Database System Concepts,McGraw Hill Publications, 2013
18. Elmasri and Navathe, “Fundamentals of Database Systems”, 7/e Addison – Wesley,2017.

ST18 3103 ADVANCED STRUCTURAL ANALYSIS

1.Theory of Linear Elasticity:

Stress, Principal Stress and strain. Concepts and definition of strain – displacement relation. Equilibrium, constitutive and compatibility equations, St. Venant' principle, Plane stress, plane strain and axisymmetric conditions.

2. Energy Principles:

Principle of virtual work, principle of minimum potential, Castigliano's theorem – Numerical examples from frame and truss analysis

3. Principles of Structural Stability:

Methods of stability analysis – Column buckling – Euler equation, Frame instability – Energy approach. Application of matrix method to beam column problems

4. Structural Mechanics:

Theory of Beams – Analysis of Bernoulli and Timoshenko Beams, Ritzmethod – Beam on elastic foundation.

5. Approximate Numerical Methods

Application of Finite Difference Method, Raylegh Ritz method, Newton Raphson's method for solving beam bending problems.

References:

1.Timoshenko S.P. and Goodier, Theory of elasticity, McGraw Hill, New Delhi, 2010.

1. Tauchert T., Energy Principles in Mechanics. McGrawHill, New Delhi 1994.
2. Gere and Weaver – Matrix Method of Structural analysis, McGrawHill, New Delhi 1986.
3. Reddy.C.S. Basic Structural Analysis TMH, 1996
4. L.S. Srinath,Advanced mechanics of solids,McGraw Hill, 2017
5. Timoshenko SP and Gere, Theory of Elastic Stability, McGraw Hill,2017

6. Advanced mechanics of solids & structures-N Krishna Raju&D R Gururaja,narosa Publications,1997
7. Computational Elasticity-M Ameen, Alpha Science, 2011

ST18 3104 MARINE HYDRODYNAMICS

1. **Basics of Fluid Dynamics**

   Conservation of mass and momentum, Euler equation, Bernoulli's equation, potential flow, boundary conditions, fixed and moving bodies, Green's theorem and distributions of singularities.

2. **Waves**

   Classification of water waves; Two dimensional wave equation and wave characteristics; wave theories, small amplitude waves, finite amplitude wave, stokian, solitary theories; wave classification by relative water depth, water particle kinematics, pressure under progressive wave, wave energy power and wave group velocity, Standing Wave Theory; Wave deformation, reflections, diffraction and breaking of waves.

3. **Tides**

   Classification, long term effects, basin oscillations, tsunamis, storm

4. **Currents**

   Classification, behaviour, design criteria, scour and other effects of currents.

5. **Forces**

   Wave forces, current forces, wave-current-structure interaction, Morison equation, wave loads on offshore structures and pipe lines, diffraction theory, wave slamming and slapping. Hydrodynamic Test Facilities – Wave flumes, wave basins, towing tanks, circulating water channels etc

References:

1. Newman, J.N., *Marine Hydrodynamics*, MIT Press, Cambridge, Massachusetts, 1997.
2. Sarpakaya,T. and Isaacson, M. *Mechanics of wave forces on offshore structures*, Van Nostrand Reinhold Company, 1981,NY
3. Tucker MJ, Piyy EG: *Waves in Ocean Engineering*, Elsevier, 2001.
4. Dean, R. G. and Dalrymple, R. *A. Water Wave Mechanics for Engineers and Scientists*, Allied Publishers Ltd., 2001.

5. Mani, J. S. *Coastal Hydrodynamics*, PHI Learning Private Ltd., New Delhi, 2012.
6. Sorensen, R. M. *Basic Coastal Engineering*, Springer.
7. Sundar, V. *Ocean Wave Mechanics: Applications in Marine Structures*, Wiley, 2015.
8. Ananthakrishnan, P. *Finite Difference Method for Nonlinear Wave Hydrodynamics*, Wiley - Blackwell, 2017.

ST18 3105 FRACTURE MECHANICS

1. Basics of Elasticity and Plasticity

Types of Failures, Constitutive Models, Brittle and Ductile fracture, Fracture Mechanics and its applications.

2. Linear Elastic Fracture Mechanics

Inglis Concepts, Energy Release Rate, Griffith Contribution, Crack Resistance, R curve, Critical energy Release Rate, Stress Intensity Factor, Westergards –Approch, Edge cracks and Embedded cracks.

3 Nonlinear Fracture Mechanics

Crack Tip stress for plane stress and place strain condition, Effective crack length, J Integral, Crack Tip Opening displacement, Mixed mode crack initiation and growth

4.Experimental Fracture Mechanics

Experimental determination of stress intensity factor, energy release rate, J integral.Crack detection through Non Destructive Testing : Liquid penetration, Ultrasound testing, Radiographic Imaging and Magnetic Particle Inspection.

5.Fatigue and Computational Fracture Mechanics

Fatigue failure, Direct and Indirect methods to determine fatigue fracture parameters.

References:

1. Elements of Fracture Mechanics – Prasanth Kumar TMH, New Delhi, 2009.
2. Broek D., Elementary Engineering Fracture Mechanics, MartinusNijhoff Publishers., 2009
3. T L Anderson, Fracture Mechanics,Fundamentals& its applications, CRC press,2017
4. S Suresh,Fatigue of materials, Cambridge University Press,1998
5. Fracture Mechanics- An introduction-E E Gdoutos,Springer 2005

6. V G V Ukadgaonker, Theory of elasticity & Fracture Mechanics, Prentice Hall India,2016.

SEMESTER - II

ST18 3201 DYNAMICS OF STRUCTURES

1. Free and forced vibration of SDOF Systems, time and frequency domain approaches, vibration isolation
2. Formulation of equations of motion, Hamilton's Principle, Lagrange's equation of motion, continuous and discrete systems.
3. Study of MDOF System, Rayleigh-Ritz, Stodola and Holtzer methods; Matrix methods for dynamic analysis eigensolution and mode superposition.
4. Vibrations of structures involving fluid-structure soil interaction, dynamic behaviour of offshore structures.
5. Stochastic response of offshore structures, frequency domain response of linear systems, time domain response Narrow band systems, spectral fatigue analysis for offshore structures; Response to wave, wind and earth quake.

References:

1. Meirovitch, L., Elements of VibrationAnalysis, McGraw Hill, New Delhi., 1975
2. Den Hartog, J.P. Mechanical Vibration, McGraw Hill New York. 2007
3. Clough, R.W and Penzien, J. Dynamics of Structures, McGraw Hill, New York, 1975
4. Mario Paz, "Structural Dynamics – Theory and Computation", Van Nostrand Reinhold Ltd., New York, 1987
5. G.B.Warburton, "The Dynamical Behaviour of Structures" Pergamon Press., 1976
6. Roy R., Gaig Jr., "Structural Dynamics – An Introduction to Computer Methods", John Wiley and Sons, Inc , 1981
7. MinooH.Patel, "Dynamics of offshore structures", Butterworths, 1989.
8. Walter C Hurty and Moshe FR: *Dynamics of Structures*, Prentice Hall of India, 2007.
9. Anil K Chopra: *Dynamics of Structures, Theory and applications in earth quake engineering*, PHI, 2002.
10. W.T. Thomson, *Theory of vibration with its applications*, CRC Press,1996

11. Michael Geradin and Daniel J. Rixen. *Mechanical Vibrations: Theory and Applications to Structural Dynamics*, Wiley, 3rd. Ed., 2015.
12. Eduardo Kausel. *Advanced Structural Dynamics*, Cambridge University Press, 2017.

ST18 3202 FINITE ELEMENT METHODS APPLIED TO OFFSHORE ENGINEERING

1. Introduction to fem, definitions, General Procedure of Finite Element Analysis – Variational formulations
2. Shape functions, Convergence Criteria, derivation of property matrix for truss, beam, plane stress, plane strain, axisymmetric and solid elements.
3. Computer implementation of fem, Organisation of Computer Code, Numerical methods for various property matrix calculation, Fundamentals of stability and dynamic analysis using fem.
4. Soil structure Interaction problem, Fluid Structure Interaction Problem – Heat conduction problems.
5. Structural Application Multistorey frames, Stiffened plated Structure, Pressure vessels, Offshore Jackets.

References:

1. O.C.Zienkiewicz– *Finite Element Method*, Fourth edition, McGraw Hill, 2006
2. R.D.Cook "*Concepts and Application of FE Analysis* – John Wiley & Sons., 2011
3. C.S.Krishnamoorthy, *Finite Element Analysis* TMH New Delhi., 2010
4. S.Rajasekaran – *Finite Element Analysis*, Wheeler publishing Company
5. K.J.Bathe – *Finite Element Procedure in Engineering Analysis*, Prentice Hall, 2009
6. J.N.Reddy – *An Introduction to the Finite Element Method*, Tata McGraw Hill, 2005.
7. Thomas J.R.Hughes – *The Finite Element Method – Linear static and Dynamic Finite Element Analysis*, Dover publications, New York, 2007.
8. Desai & Abel- *Introduction to FEM*, CBS Publications, 2005.
9. P Seshu-*Textbook of Finite element Analysis*, Prentice Hall India ,2003
10. Kwon, Young W., and Hyochoong Bang. *The finite element method using MATLAB*. 2nd Ed., CRC press, Third Indian Reprint 2015.

ST18 3203 OCEAN WAVES AND EFFECTS

1. Waves in Open Sea

   Origin and propagation, classification of sea state, elements of probability theory and random process, short-term model with constant amplitude components, generation theory of ocean waves, characteristics of point and directional spectra, wave slope spectrum, encounter frequency spectrum, ocean wave data analysis, idealised spectral families.
2. Forces and Response in Regular Waves

   Formulation of diffraction and radiation problem for potential flow simplified head sea case, motion of regular waves strip theory, panel method and finite element method to compute hydrodynamic forces and coefficients.
3. Forces and Response in a seaway

   Linear random theory, long crested sea with and without forward speed, short-crested sea case, statistics of maximum long-term performance predictions, local and relative motions, added resistance, wave loads.
4. Hydrodynamic Exciting Forces

   Excitation forces due to steady flow, linearised wave forces inviscid fluid, influence of viscosity on wave excitation forces, wave drift forces.
5. A minor project on determination of forces on Ocean Structures. [Computational and programming software packages may be utilized for implementing the project.

References:

1. Heoft, J.P. *Advanced dynamics of Marine Structure*, Wiley-Interscience, New York., 1982.
2. Beck R.F., Cummins. W.E. Dalzell J.F., Mandel and Webster, W.C. "*Motions in waves*" *Principles of Naval Architecture*, Second Revision (Ed.) Lewis E.V. SNAME, Jersey City, New Jersey., 1988.
3. Price, W.G. and Bishop, R.E.D. *Probabilistic Theory of Ship Dynamics*, Chapman and Hall, London, 1974.
4. Peter Janssen ,*The interaction of ocean waves and wind*, 2004
5. TrilochanSahoo, *Mathematical techniques for waves interaction with flexible structures*, IIT Kharagpur research monograph series, 2012.
6. Michel k Ochi, *Ocean waves: The stochastic approach*, 2005.

7. R. Bhattacharya, *Dynamics of Marine Vehicles*, A Wiley-Interscience Publication.
8. S. K. Charabarti, *Hydrodynamics of Offshore Structures*, Computational Mechanics Publication, 1987.
9. Srinivasan Chandrasekaran. *Dynamic Analysis and Design of Offshore Structures*, Springer, 2015.
10. Rajeev Dubey, *Dynamics of Offshore Structures*, Scitus Academics, 2016.

ST18 3204 ANALYSIS OF SPECIAL STRUCUTRES

1. Plated Structures –Theory of thin plates, Buckling of plates. Analysis of stiffened plates, Buckling of stiffened plates.

2. Thin walled Structures – Torsion of Thin walled beams, Theory of restrained torsion, Application to containerships.

3. Shear walls and grillages :- Analysis of shear walls- design loads, structural behaviour of shear walls, equivalent stiffness method, shear walls without opening, shear walls with opening, the continuum method. Analysis of grillages:- design loads, effective sections, simple grillage analysis, application of matrix method.

4 Shell structures:- Cylindrical shell roofs- classification of shells, components of shell roof, membrane theory equations for stress resultants, bending theory of cylindrical shells, beam method of analysis Pressure vessels- Types of pressure vessels and design loads, stresses and deformations of axisymmetric shells subjected to axisymmetric loads, analysis of stiffened cylindrical shells.

5 Cranes and suspension bridges:- Cranes- Cranes used in dry-docks, onboard and in industrial structures; design loads, methods of analysis, Suspensionbridges- Classification of cable supported bridges, components of suspension bridges and their structural behaviour, analysis of main tower, cables and suspended structure, scope of dynamic analysis.

References:

1. L.H.Donnel, Beam, plates and Shells, McGraw Hill, New York, 1976.
2. Timoshenko SP and Kruger.W.*Theory of Plates and Shells*McGraw Hill, 1976.
3. Srinath L.S. – *Advanced Mechanics of Solids* TMH, New Delhi, 2003

4. G.S.Ramaswami – *Design and Construction of Concrete shell roofs*, CBS, 1986
5. Kazimi – *Analysis of shear wall structures*. Technical report, IIT Delhi, 1984.
6. Johan Blaauwendraad and Jeroen H. Hoefakker, *Structural Shell Analysis*, Springer, 2013.

ST18 3205 DESIGN OF OFFSHORE STRUCTURES

1. Types of offshore structures – Bottom supported structures, compliant structures, Floating platforms. New-generation Offshore Platforms – Buoyant Leg Structures (BLS), Triceratops, Floating Storage and Regasification Units (FSRU) etc.
2. Planning of Offshore structures; Design criteria and procedures – WSD and LRF, Design loads – dead loads and live loads, load combinations; Determination of Environmental loads - wave, wind and current loads.
3. Structural Design of tension and compression members, stiffened plates and built up beams.Design of cylindrical members - axial compression, biaxial bending and combined load; Hydrostatic implosion
4. Design of Tubular joints – Punching shear method and calculation of allowable joint capacity; Stress Concentration Factor, Fatigue analysis and Design – SN curve method
5. Pile Design – Pile Capacity for axial bearing loads and axial pull out loads; Soil reaction for axially loaded piles and laterally loaded piles; structural design of piles. Design of spud cans and anchors

References:

1. API RP 2A WSD 1993
2. API RP 2A LRFD 2000
3. T.H. Dawson, *Offshore Structural Engineering*, PHI, USA, 1986
4. Teng H. *Applied Offshore structural Engineering*, PHI, 1996
5. K. Rajagopalan*Offshore Jacket structures*, Oxford and IBH, 1988
6. S.K.Chakrabarti, Hand book of Offshore Engineering (Vol I & II), Elsevier, 2005.
7. S.K.Chakrabarti, *Hydrodynamics of Offshore structures*, Southampton computational mechanics, 1989.
8. Ben C.Gerwick. *Construction of Mari-ne and Offshore structures*, CRC Press, London, 1999

9. W.J.Graff, *Introduction to Offshore structures – Design Fabrication, Installation*, Gulf Publishing, London, 1981.
10. Reddy, D. V. and Swamidas, A. S. J. *Essentials of Offshore Structures: Framed and Gravity Platforms*, CRC Press, Taylor & Francis Group, 2013.
11. Chandrasekaran, S. *Advanced Marine Structures*, CRC Press, Taylor & Francis Group, 2016.