Master of Technology
in
Offshore Technology
(UOP for L&T)

CURRICULUM AND COURSE CONTENTS
(Applicable from 2016 Batch)

INDIAN INSTITUTE OF TECHNOLOGY MADRAS
CHENNAI 600 036

M.Tech in Offshore Technology

SEMESTER I

No.	Subject	L	T	E	P	O	C
OE6320	Marine Hydrodynamics	3	1	0	0	6	10
OE5070	Statics and Dynamics of Marine Vehicles	3	0	0	1	6	10
OE5200	Dynamics of Ocean Structures	3	0	0	0	6	9
OE6003	Analysis of Offshore and Ship Structures	3	0	0	0	6	9
OE6360	Ships and Offshore Technology Lab	0	0	0	4	0	4
DPE1	Department Elective I	3	0	0	0	6	9
	TOTAL						**51**

SEMESTER II

No.	Subject	L	T	E	P	O	C
OE5500	FEM applied to Ocean Engineering	3	0	0	0	6	9
OE6001	Materials and Fabrication of Ships & Offshore Structures	3	0	0	0	6	9
OE6004	Modeling of Ships & Offshore Structures	2	0	0	3	4	9
DPE2	Department Elective II	3	0	0	0	6	9
DPE3	Department Elective III	3	0	0	0	6	9
	TOTAL						**45**

SUMMER

No.	Subject	L	T	E	P	O	C
OE6009	Practical Training	0	0	0	0	3	**3**

SEMESTER III

No.	Subject	L	T	E	P	O	C
OE6006	Structural Design of Ships & Floating Offshore Systems	3	0	0	0	6	9
DPE4	Department Elective IV	3	0	0	0	6	9
DPE5	Department Elective V	3	0	0	0	6	9
OE6902*	Thesis Project (Part I)	0	0	0	0	25	25
	TOTAL						**52**

 # Practical training for 4 weeks will be conducted during summer vacation at the end of second semester.

SEMESTER IV

No.	Subject	L	T	E	P	O	C
OE6902	Thesis Project (Part II)	0	0	0	0	52	52
	TOTAL						**52**

** Grade assigned in fourth Semester.*

Total = 51 + 45 + 3 + 52 + 52 = 203.

List of Electives

Course No.	Subject	L	T	E	P	O	C
OE6200	Design of Offshore Structures	3	1	0	0	6	10
OE5300	Dynamics of Floating Bodies	3	0	0	0	6	9
OE5230	Foundations for Offshore Structures	3	1	0	0	6	10
OE6002	Installation of offshore Structures	3	0	0	0	6	9
OE6201	Structural Integrity Assessment of Offshore structures	3	0	0	0	6	9
OE5110	Experimental Methods & Measurements	3	0	0	0	6	9
OE5320	Nonlinear Problems in Ocean Engineering	3	0	0	0	6	9
OE6007	Pipeline and Riser Engineering	3	0	0	0	6	9
OE5400	Port and Harbour Structures	3	0	0	0	6	9
OE6310	Powering and Propulsion of Marine Vehicles	3	1	0	0	6	10
OE6330	Sea keeping and Maneuvering of Marine Vehicles	3	0	0	0	6	9
OE6340	Ship and Undersea Vehicle Design	3	1	0	0	6	10
OE6350	Advanced Marine Vehicles	3	0	0	0	6	9
OE5999	Special Topics in Ship Design and Construction	3	0	0	0	6	9
OE6980	Comp. Aid. Surface Dev. For Marine Vehicles	3	0	0	0	6	9
OE5300	Dynamics of Floating Bodies	3	0	0	0	6	9
OE5320	Nonlinear Problems in Ocean Engineering	3	0	0	0	6	9
OE5110	Experimental Methods & Measurements	3	0	0	0	6	9

Any other elective approved by Faculty Advisor - IIT Madras.

Note :
L-Lecture
T-Tutorial
E-Extended Tutorial
P-Practical
O-outside class hours
C- Credits

Course Contents

OE6001 Materials and Fabrication of Ships and Offshore Structures 3 0 0 0 6

COT

Steel : Steel manufacturing processes; Tempered and quenched steel; Thermo-Mechanically Controlled Process(TMCP); Low carbon steel, high strength alloys, duplex and super duplex steels; ASTM / ABS / API steel products, chemical composition, carbon equivalent, mechanical properties, through thickness requirements, weldability, supplementary requirements, low temperature service, Charpy V-notch test and energy requirements, properties of steel at elevated and low temperature;

Welding: American Welding Society (AWS) guidelines, standard prequalified welds, Welding processes; SMAW and FCAW process; full penetration / fillet welds, heat affected zone (HAZ), Welding electrodes; Hydrogen induced cracking; Crack Tip Opening Displacement (CTOD) tests, fabrication tolerances, residual stresses; inspection and quality control requirements; NDT of welds; Ultrasonic tests; Magnetic particle inspection; X-rays methods; Aluminum and Bi-metallic welding;

Fabrication and Assembly: Rolling and fabrication of tubular and TKY joints, typical jacket fabrication and rollup procedure; Ship building process; Fabrication and assembly of ship hulls; Modular fit-ups; Ship lifts and launch ways.

Corrosion and Control : Corrosion Mechanism; Types of corrosion; Seawater corrosion; corrosion allowance, cathodic protection design, impressed current method, sacrificial anodes design, protective coatings, splash zone protection, cathodic protection monitoring system.

Concrete / composites : Underwater concrete, mix design, quick setting compounds, high strength grout, fiber reinforced plastics, special composite materials for under water repairs.

Underwater repair: Underwater welding, repair schemes for tubular members, grouted sleeve connections, and stressed – grouted connections for tubular joints.

OE6003 Analysis of Ships and Offshore Structures 3 0 0 0 6

C O T

Finite element analysis of beam and framed structures: static analysis, buckling analysis and free vibration analysis.

Bending and shear deformation of unsymmetric beams, Theory of elasticity solutions. Saint Venant torsion of open and closed section beams, Warping deformation of beams, Warping and torsion constants, Finite element solution.

Plate bending theory, Plates under combined lateral and in-plane loads, Large deflection of plates, Thermal stresses in plates, Anisotropic plates. Unidirectional, bidirectional and shear buckling of plates.

Thin shell theory: Bending and membrane stresses in shells, Circular cylindrical shells under general loads, Buckling under axial compression, lateral pressure, torsion and combined loading, Effect of imperfections.

Stress analysis and buckling of ring stiffened pressure hulls with imperfections: Interframe and overall collapse, Stiffener tripping, Effect of residual stresses, Role of fatigue and effect of shock. Vibration analysis of plates and shell.

OE6004 Modeling of Ships and offshore Structures

2 0 0 3 4 *COT*

Ships : Computer modeling of hull forms. Static and dynamic stability calculations. Motion response analysis of ships in irregular seaway and calculation of various dynamic effects, e.g. slamming, shipping of green water, added resistance etc. Forward speed effects on ship motion. Maneuvering simulation. Introduction to CFD applications to problems of ship hydrodynamics. Examples problems and case studies, tutorial problems.

Offshore Structures: Introduction to structural modeling and analysis of jacket structures; Main piled and skirt pile jacket models, In-service analysis for storm wave loads, load-out and launch analysis, sea transportation loads generation and analysis; Seismic and fatigue analysis;

Basics of motion analysis of floating structures; Motion analysis of flat bottom barges, heavy lift vessels and other floating systems such as SPAR, Tension leg platforms and semi-submersible; Generation of Response Amplitude Operators (RAOs); Case studies and tutorial problems;

OE6006 Structural Design of Ships & Floating Offshore Systems 3 0 0 0 6

COT

Ships: Structural arrangements and configurations of various ship types.Longitudinal strength of ships, still water and wave induced bending moment calculations and design estimates, combined vertical and horizontal bending moment during rolling and in beam sea condition. Bending and shear strength requirements. Midship section design. Loading guidance in harbor and at sea. Transverse strength of ships. Longitudinal and transverse framing systems.

Structural design principles: loading conditions, strength of hull girder, local vibrations, fatigue, buckling strength, impact strength, large deformations under local loads. Wave slamming and whipping loads.

Design of stiffened panels and girders, end connections, effective flange and web of girders, effective width and effective breadth estimates.

Design of deck structure, side structure, bulkhead structure and bottom structure. Design of superstructure and deckhouse structure. Design for buckling control and fatigue control.

Use of classification rules in structural design.

Floating offshore systems : Introduction to floating structures- Semisubmersible, TLPs, FPSOs, Spars and other examples; General concepts on estimation of loads and Hydrostatic Stability; Semi-submersible; column stabilized structures; design of pontoons; Tension leg platforms; Tethers selection and design; Spar hulls; classic, truss and cell spar; Spar hull compartments and design of shell structures; code compliance; FPSOs; Turret and spread moored units; Selection of mooring system for floating structures; design and installation of moorings;

OE6340 Design of Ships and Undersea Vehicles 3 1 0 0 6

Mission analysis, Owners requirements and transportation studies, Staff requirements for naval vessels. Concept, preliminary, contract and detailed designs. Ship design methods:

design using basic type ships, design using coefficients, design using iteration methods; design spiral. Ship parameters: displacement equation, volume equation. Ship dimensions, hull form, form coefficients, conventional method of lines, distortion of existing forms, stem and stern contours, bulbous bow. Mass estimation: lightship weight, steel weight, outfit weight, engine weight, deadweight, capacity estimates and plan.

Powering estimates, propulsive efficiency estimates, machinery selection criteria and methods. Design of lines. Seakeeping and maneuverability criteria.

Freeboard and subdivision. Probabilistic rules for passenger ships, cargo ships and naval ships. Stability and trim. Damaged stability standards. Statutory rules: MARPOL, IMO and tonnage rules, SOLAS requirements. Factors influencing warship design. General arrangement of various ship types. Accommodation arrangements. Arrangement of spaces, tanks, superstructure, deckhouses and engine plants. Cargo handling capacity, hold capacity and stowage factor.

Ship specification and tender. Economic criteria, operating costs life-cycle costs. Conversions: increase in deadweight or capacity.

Cargo handling equipments, anchoring and mooring systems. Access systems: hatches, manholes, doors, gangways and ladders. Emergency and life saving equipments, steering gear systems, navigational systems.

Design of undersea vehicles: environment-physical properties of sea water and dynamical processes. Structural and buoyancy/ballast materials; Structural principles: pressure hull design and exo-structure design; Hull form design – mono hull, multi hull, surface effect ship and SWATH hull; Vehicle support systems – transportation system, maintenance and repair facilities, navigational and positional aids, handling systems and motion compensating techniques; Design and operating safety – Design examples and safety considerations.

OE6002 Installation of Offshore Structures 3 0 0 0 6

COT

Concepts of offshore installations : Fixed and floating structures; Spars and TLP's; Modular topsides and integrated topsides; deck levels and jacket configurations; Spar and TLP hull arrangements;

Loadout : Fabrication yard, grillage and foundation conditions; Fabrication sequence of Launch jacket, lift jackets, topsides and modules; Weighing and weight control; Skidded, Trailer and lifted Loadout methods;

Transportation : Cargo barges; Launch barges; layout of cargo arrangement; Sea fastening layout and design; Static and dynamic stability of barge; Motion analysis of barge – cargo system; Transportation analysis. Transportation fatigue analysis;

Installation Schemes : Lifting and launch schemes for jackets, upending and setting, on bottom stability; Float-over installations; Dynamics of barge – cargo system;

Installation aids : Launch cradle design; Buoyancy tank design; Lift points – padeyes and trunnions; spreader frame and spreader bar concepts; Mudmat concepts and design methods; Lifting topside modules and towers; Bumpers and guides; Grouting and leveling of jackets;

Pile Driving and Monitoring : Pile driveabililty; Pile stickup design; main and skirt piles concepts; Vertical and batter piles; Dynamics of vertical piles; Pile driving stresses; Pile driving monitoring system; Pile capacity prediction from driving records.

OE6320 Marine Hydrodynamics 3 1 0 0 6

Fluid dynamics equations: Continuity, Euler, Navier-Stokes (NS), Bernoulli and vorticity transport equations in vector and tensor forms; Potential flow problems and elementary solutions; Circulation, Stokes theorem, Kelvin's circulation theorem and Helmholtz's vorticity theorems.

Boundary value problem of gravity waves and its solution, dispersion and group velocity; Wave force on slender structures: Morison equation; Introduction to deep and shallow water nonlinear gravity waves; Kelvin wave pattern and wave resistance of thin ships.

Lifting surfaces: Flow around a foil; Kutta-Joukowski theorem, Generation of lift and Kutta condition; Linearised lifting surface theory of thin hydrofoil, thickness and camber problems and their solutions, lift and moment coefficients.

NS equations to boundary layer (BL) equations; Laminar flow, BL displacement and momentum thicknesses; BL separation, Bluff and streamlined bodies; Vortex shedding by cylinders and vortex induced vibration; Skin friction of a flat plate and Blasius formula; Momentum integral equation of BL.

Unsteady flow past circular cylinder and sphere: added mass of simple forms; Application to floating and submerged bodies, Hydrodynamic damping. Boundary value problem of linear ship motion. Hydrodynamics of slender bodies.

Characteristics of turbulent flow; Drag crisis; Transition to turbulent flow and roughness effect; NS equations to RANS equations; Turbulence models; Role of CFD.

Applications of all the above in design and analysis of surface and undersea vehicles.

OE6200 Design of Offshore Structures 3 1 0 0 6

C O T

Loads on offshore structures

Wind Loads; Wave and Current Loads; Calculation based on Maximum base Shear and Overturning Moments; Design Wave heights and Spectral Definition; Hydrodynamic Coefficients and Marine Growth; Fatigue Load Definition and Joint Probability distribution; Seismic Loads;

Steel Tubular Member Design

Principles of WSD and LRFD; Allowable stresses and Partial Safety Factors; Tubular Members, Slenderness effects; Column Buckling, Design for combined axial and bending stresses (API RP 2A guidelines);

Tubular Joint Design for Static and Cyclic Loads

Simple tubular joints; stress concentration factors; S-N curves and fatigue damage calculations.

Jackup Rigs

Configuration and operation of jackups; Simplified analysis; Spudcan penetration and extraction; Spudcan – pile interaction; Design of jackup legs;

Design against Accidental Loads (Fire, Blast and Collision)

Behaviour of steel at elevated temperature; Fire Rating for Hydrocarbon fire; Design of structures for high temperature; Blast Mitigation-Blast walls; Collision of Boats and energy absorption; Platform survival capacity and Plastic design methods

Example tutorial problems on design of tubular members, Stress concentration factors, fatigue estimation, wave load on structures;

OE6201 Structural integrity assessment of offshore structures

3 0 0 0 6

Introduction : Data Collection; Platform classification; Risk Levels; Met-ocean criteria; Platform initiators; Assessment criteria; Long and short term sea state; Estimation of Wave height and period for reduced design life;

Assessment Procedure : Overview of existing assessment procedures from API RP 2A; Initial screening by design level analyses; load reduction; ultimate strength principles; Reserve Strength ratio;

Ultimate Strength Analysis: Basics of ultimate strength analysis; M-P-ϕ relationship; Ultimate strength of circular hollow sections; Global plastic collapse analysis; Ultimate strength of Tubular connections; Limit state principles; Ultimate and fatigue limit states;

Risk and Reliability: Introduction to probability distribution functions; Application of probability theory to wave hydrodynamics; Weibull and Gumbel distributions; Wave force modelling; Modelling uncertainties; Load and Resistance Factors; Code Calibration; Reliability Index; Probability of failure;

Fatigue and Risk Based Inspection: Paris law; Crack propagation; Fatigue Reliability; Inspection procedure and interval; Updated inspection methods; Fatigue crack measurement; Mitigation methods;

OE5070 Statics and Dynamics of Marine Vehicles 3 0 0 1 6

Fluid pressure and centre of pressure - estimation of weight and centre of gravity - conditions of equilibrium - definition of meta-centre - hydrostatic particulars - stability at small angles of inclinations - problems of heel and trim-free surface effect - inclining experiment - stability at large angles - dynamic stability allowable KG - stability criteria - capacity stowage, trim and stability booklet - freeboard - damaged stability.

Oscillations of floating bodies - equations of motion - added mass and moment of inertia, damping coefficients - exciting forces and moments due to waves, effect of forward speed - heave, pitch and roll oscillations - strip theory for ship like forms - prediction of motion in irregular seas - method of model tests.

OE6360 Ship and Offshore Technology Lab 0 0 0 4 0

Materials Testing Lab : Measurement of vibration and damping; Charpy V-notch testing; Crack Tip Opening Displacement (CTOD) testing;

Hydrodynamic Lab : Measurement of regular and random waves; Setup for wave forces on fixed and floating structures; Experimental measurements using scale models; Measurement of floating system responses;

Towing Tank : Setup for Towing tank experiments; Model Testing - Resistance, powering, sea keeping and Maneuvering. high speed towing tank experiments for VIV of slender structures;

OE5230 Foundation for Offshore Structures 3 1 0 0 6

Basic Soil Mechanics: Basic soil properties, correlation between engineering parameters, geotechnical investigation, bore log.

Pile foundation: Jacket main piles, skirt piles, driven piles, drilled and grouted piles, steel and concrete piles, axial capacity, point bearing and skin friction, factor of safety, lateral load on piles, p-y, t-z and q-z curves, pile group effect, scour around piles, seabed subsidence and design of piles against seabed movement, negative skin friction, cyclic degradation, main pile to jacket connections, skirt pile to jacket connections, API RP 2A provisions.

Pile Installation: Minimum pile wall thickness, pile handling stresses, static and dynamic stresses, pile stickup, stresses during stick up, wave and current loads, hammer selection, pile driving stresses, wave equation analysis, pile driving fatigue, API RP 2A guidelines.

Pile Testing: Working load test, ultimate load test, pile monitoring during driving, pile integrity testing, high strain dynamic testing, rebound method.

Special foundations: Mud-mats: bearing capacity, sliding stability, over-turning stability, short term and long term settlements, factor of safety; Bucket foundation; Suction anchors; Gravity foundation.

Example problem and tutorial on axial capacity of piles, lateral capacity and load deflection of laterally load piles; Mudmat bearing capacity; group effect;

OE5200 Dynamics of Ocean Structures 3 0 0 0 6

C O T

Free and forced vibrations of SDOF systems, time and frequency domain approaches - Formulation of equations of motion, Hamilton's principle, Lagrange equations of motions, continuous and discrete systems - Study of MDOF systems - Rayleigh - Ritz, Stodola and Holzer methods - Matrix methods for dynamic analysis, Eigen solution - Mode superposition.

Vibrations of structures involving fluid - structure - solid interaction, dynamic behaviour of offshore towers - stochastic dynamics of offshore structures, frequency domain response - Narrow band systems, fatigue predictions - Response to wave, and earthquake loadings.

OE5300 Dynamics of Floating Bodies 3 0 0 0 6

Equations of motion for SDOF systems, time and frequency domain solutions - oscillations of floating bodies, added mass and moment of inertia, and hydrodynamic damping - Exciting forces and moments due to waves - Strip theory for slender bodies - Symmetric & unsymmetric coupled motions - Effect of forward speed-3D effects - Dynamic effects - Roll and pitch damping devices - probabilistic approach- Introduction to random response theory - Random response of linear systems under wave loading, directional spectra for waves Probabilistic design criteria - General motion analysis of floating bodies, time and frequency domain approaches.

OE5500 FEM Applied to Ocean Engineering 3 0 0 0 6

C O T

Introduction - Different approaches to finite element formulation - Different types of elements and interpolation functions, Language & Hermite Polynomials, natural co-ordinates - Derivation of element property matrices - Assembly - solution of finite element equations - Structural and geotechnical problems - Nonlinear analysis.

Application to fluid mechanics problems, Fluid - structure interaction - Diffraction of waves, 2D formulation using mild - slope equation - use of infinite elements - Added mass and damping matrices for floating bodies, 2D formulation - Harbour resonance, Liquid sloshing - Vibrations of underwater structures - Introduction to Boundary Element Techniques.

OE6310 Powering and Propulsion of Marine Vehicles 3 1 0 0 6

C O T

Components of resistance of surface and undersea vehicles; Dimensional analysis and model tests; Model-ship correlation and extrapolation; Effects of shallow water and confined waterways; Surface roughness effect; Effect of hull forms; Appendage resistance of undersea vehicles; Resistance of bodies of revolution; CFD applications.

Propeller types and characteristics; Screw propeller geometry; Numerical methods for propeller analysis - blade element theory, circulation theory, VLM; CFD applications; Hull-propeller interaction; Similitude analysis; Experiments - open water and self-propulsion; Cavitation; Design of screw propellers; Strength of propellers and manufacturing process.

Powering of ships and main engine selection criteria. Types of propulsion systems and applications.

OE6330 Sea keeping and Maneuvering of Marine Vehicles 3 0 0 0 6

C O T

Seakeeping of marine vehicles in regular and random waves: boundary value problems and equations of motion. Frequency and time domain solutions of coupled motions: response amplitudes operators and memory effects. Dynamic effects in a seaway: local and relative motions, shipping of green water, slamming, broaching, added resistance etc. Nonlinear roll motion.

Motion control techniques: passive stabilizer, bilge keel, sail, free surface tank, U-tank, moving weight, active stabilizers such as fin, gyro and active tank; rudder stabilization, pitch control.

Seakeeping performance and design aspects. Effect of hull form on seakeeping qualities. Guidelines for design. Introduction to seakeeping features of catamarans, SWATH, planning craft, hydrofoil craft, ACV/SES and submarines.

Maneuvering of marine vehicles: control loop, path keeping, equations of motion, linearised equations and control fixed stability indexes. Role of model tests. Stability and control in the horizontal and vertical planes. Definitive maneuvers.

Rudder geometry. Flow around rudder. Rudder design: location and orientation, number of rudders, type of rudder, geometric properties of rudder, maximum rudder deflection angle and deflection rate, rudder stock location.

Experimental determination of hydrodynamic derivatives - straight line test, rotating arm technique, planar motion mechanism. IMO rules. Maneuvering trials.

OE6350 Advanced Marine Vehicles 3 0 0 0 6
C O T

Hydrodynamics of small high-speed craft including planing hulls; Air cushion vehicles; Surface effect ships, and Wing in Ground Effect; Theoretical and empirical methods for resistance propulsion and attitude prediction; Nonlinear dynamics and stability of high-speed marine vehicles; Nonlinear dynamics and stability of high-speed marine vehicles; Effect of hull form on resistance and dynamic performance; Structural design considerations including bottom plating strength and frame loading; Discussion of various types of framing and rule requirements; Material choices

OE5999 Special Topics in Ship Design 3 0 0 0 6
C O T

Hull girder vibration; Propeller induced vibrations; Machinery induced vibrations; Vibration responses of local areas (mast, shaft bracket, stiffened panels, etc.); Palliatives for eliminating vibration;

Finite element analysis for hull girder response;

Structural Integration ship-board machinery – Propulsion system, deck equipment, etc.

Hull girder strength, Super structure efficiency, Shear lag, buckling, fatigue and fracture, structural compensations and discontinuities, etc.

Design of shaft brackets, mast, flight deck design, etc.

Ship launching and docking.

OE5110 Experimental Methods and Measurements 3 0 0 0 6
C O T

Dimensional Analysis with special reference to Model Studies in Hydrodynamic and coastal Engineering problems. Design of Models and Fabrication. Hydrodynamic test facilities, Wave makers, Wave absorbers 2-D and 3-D Wave generation.

Static and Dynamic load application methods with reference to model and prototype testing transducers and Instrumentation for Measurement of Force, Pressure, Strain, Displacement, Vibration and Flow. Data Acquisition Systems.

Measurement Techniques for Drag and Inertia Forces, Cavitation, Water Entry and Exit problems.

Wave, Current and Tide Data collection methods

Field Instrumentation for Geotechnical Engineering

Monitoring of Marine Structural Systems, Non Destructive Testing Techniques and ecaluation.

OE5320 Non Linear Problems in Ocean Engineering 3 0 0 0 6

Conservative and nonconservative systems, Quadratic and cubic nonlinearities, Nonlinear damping, Forced oscillations, Sub and Superharmonic responses, Parametrically excited systems, Chaotic motion, System identification.

Nonlinear wave theories and wave loading, Nonlinear models of compliant platforms and soil-structure interaction, Risers and moorings, Nonlinear wave loading on large floating systems, Slow drift oscillation, Random response and statistical analysis.

OE6007 Pipeline and Riser Engineering 3 0 0 0 6

COT

Introduction to subsea pipelines; Pipeline arrival and discharge conditions; Pipeline hydraulics; Pipeline sizing; Friction loss; Temperature profile; Slug formation and control;

Installation of pipelines in shallow and deep water; S and J lay methods; Pipe lay barges and vessels; Pipeline initiation and termination;

Pipeline design for stresses in service conditions; Static and dynamic Stability; Pipeline flexibility and span analysis; Cathodic protection design.

Rigid and flexible risers; Design and installation of risers; Intelligent pigging; Pipeline corrosion monitoring; Pipeline crossings; Bonded and unbonded flexibles.

OE5400 Port and Harbour Structures 3 0 0 0 6

COT

Estimation of loads, Analysis, design and construction of Post Structures - Breakwaters, Jetties, Wharves, Quays, Diaphragm Walls, Slipways, Docks. Offshore terminals and islands - fenders and Mooring Facilities.

Limit state and working stress method of design, crack width calculations. Integrity analysis of berthing structures. Case studies of breackwater failures and other types of structures. Partial safety Factors. Codal Requirements.