

GUJARAT TECHNOLOGICAL UNIVERSITY
BE (CIVIL & INFRASTRUCTURE ENGINEERING)

DESIGN OF OFFSHORE STRUCTURES

SUBJECT CODE: 2184006

8th Semester

Type of course: Department Elective

Prerequisite: Nil

OBJECTIVES

The main learning objectives of the course are:

- Understand the application of basic principles in hydrodynamics, dynamics, and structural mechanics in the design of ships and offshore structures
- Understand the design spiral for ships and offshore structures
- Becoming familiar with the use of key design tools in naval architecture and marine engineering
- Becoming familiar with general procedures and issues in fabrication, manufacture, and installation

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
			ESE	PA(M)	Viva	PA (I)		
3	2	0	5	70	30	30	20	150

Syllabus (Theory)

Contents:

Sr. No	Topics	Hrs.	% Weightage
1	Types of offshore structures and conceptual development (Offshore Structural systems – Jacket, gravity, tension leg etc)- 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.	08	20
2	Concepts of Fixed Platform Jacket and Deck Jacket concepts, redundant framing arrangement; Launch and Lift jackets; Simple	08	20

	Deck configurations for Lift and float-over installations; In-service and Pre-service Loads and analysis		
3	Steel Tubular Member Design Principles of WSD and LRFD; Allowable stresses and Partial Safety Factors; Tubular Members, Slenderness effects; Column Buckling, Design for Hydrostatic pressure; Design for combined axial and bending stresses (API RP2A guidelines).	10	25
4	Tubular Joint Design for Static and Cyclic Loads Simple tubular joints, design using allowable loads; stress concentration factors; S-N curves and fatigue damage calculations. Offshore drilling Underwater welding.	06	15
5	Corrosion - Corrosion mechanism - Types of corrosion - Offshore structure corrosion zones – Biological corrosion - Preventive measures of Corrosion - Principles of cathode protection systems - Sacrificial anode method and impressed current method – Online corrosion monitoring - Corrosion fatigue.	08	20
	Total	40	100

LEARNING OUTCOMES

After completion of this course the student will be able to

- List and understand the classification of offshore structures
- Conceptual clarity in design of offshore structures
- Complete hydrodynamic studies
- Corrosion mechanism and its monitoring.

Tutorial and Assignments

Coursework consists primarily of a three-part term-length Design Project and three homework assignments, all designed to help students better comprehend the basic concepts taught in class. The goal is also to prepare the students for the use of the various pieces of software needed for the Design Project. The Design Project is to be completed in team with each individual responsible for the report and discussion of a separate subject; homework is to be done individually.

Preliminary calculations and drawing sketches of different ship views and internal subdivisions.

Structural analysis of a generic ship. From the framework of building a ship

Panel method of sea-keeping analysis to calculate the added mass and wave damping coefficients as well as wave excitation for a floating vertical circular cylinder.

List of Experiments: Nil

Design based Problems (DP)/Open Ended Problem: Tutorial sessions along with Expert Talk.

Text Books:

1. Hydrodynamics of Offshore Structures by S.K. Chakrabarti, Springer-Verlag
2. Handbook of Offshore Engineering by S.K. Chakrabarti, Elseviers, 2005.
3. Offshore pipelines by B. Gou, S. Song, J. Chacko and A. Ghalambor, GPP Publishers, 2006 Structural Stability

REFERENCES:

There is no required textbook for this class, but several references are recommended. Lecture notes also provide the key reading material. The readings were supplemented by select articles on specific topics, especially on the design of floating offshore structures.

The following three texts are particularly suggested as references:

1. Lewis, E. V., ed. *Principles of Naval Architecture*. Jersey City, NJ: Society of Naval Architects and Marine Engineers, 1988. ISBN: 9789991181417.

This reference provides general information on naval architecture.

2. Paik, Jeom Kee, and Anil Kumar. *Ship-shaped Offshore Installations: Design, Building, and Operation*. Cambridge University Press, 2007. ISBN: 9780521859219.

This reference gives some basic information on the design of special marine structures (i.e. FPSOs).

3. Faltinsen, O. M. *Sea Loads on Ships and Offshore Structures*. Cambridge, UK: Cambridge University Press, 1993. ISBN: 9780521458702.
4. Sarpkaya and Issacson - "Fluid loading on offshore structures "
5. DNV – Rules for design, construction and inspection of fixed offshore structures
6. Dawson, T. H., *Offshore Structural Engineering*, Prentice Hall, 1983.
7. API RP 2A., *Planning, Designing and Constructing Fixed Offshore Platforms*, API.
8. McClelland, B & Reifel, M. D., *Planning & Design of fixed Offshore Platforms*, Van Nostrand, 1986.
9. Graff, W. J., *Introduction to Offshore Structures*, Gulf Publ. Co.1981.
10. Reddy, D. V & Arockiasamy, M., *Offshore Structures Vol.1 & 2*, Kreiger Publ. Co.1991.
11. Morgan, N., *Marine Technology Reference Book*, Butterworths, 1990.
12. B.C Gerwick, Jr. *Construction of Marine and Offshore Structures*, CRC Press, Florida, 2000. *This reference helps with understanding of sea-keeping analysis and mooring-system design.*

The following resources may also be helpful:

1. Gillmer, T. C., and Bruce Johnson. *Introduction to Naval Architecture*. Naval Institute Press, 1982. ISBN: 9780870213182.
2. Lamb, Thomas. Chapter 30 in *Ship Design and Construction Vol. 1*. 1st Impression Publishing, 2003. ISBN: 9780939773404.
3. Terpstra, T., B. B. d'Hautefeuille, and A. A. MacMillan. "FPSO Design and Conversion: A Designer's Approach." Offshore Technology Conference, 2001.

Tutorial Calendar

SES #	TOPICS	PROJECT ACTIVITIES	KEY DATES
1	Introduction	Work on design 1	
2	Ship Design Tool: PARAMARINE		Design 1 (ship sizing and hydrostatics) out; HW 1 out
3	Ship Hydrostatics and Structures		
4	Ship Hydrostatics and Structures (cont.)		HW 1 due
5	Seakeeping		
6	Seakeeping (cont.)		
7	Seakeeping (cont.)		
8	Seakeeping (cont.)		Design 1 due; HW 2 out
9	Drift Loads/Motions	Work on design 2	Design 1 feedback; Design 2 (seakeeping analysis) out
10	Slowly-Varying Loads/Motions		HW 2 due

SES #	TOPICS	PROJECT ACTIVITIES	KEY DATES
11	Slowly-Varying Loads/Motions (cont.)		
12	Ocean Environment		
13	Ocean Environment (cont.)		
14	Mooring Dynamics		Design 2 due; HW 3 out
15	Mooring Dynamics (cont.)	Work on design 3	
16	Mooring Design		HW 3 due; Design 3 out
17	Manufacturing/Fabrication		
18	Manufacturing/Fabrication (cont.)		
19	Ship Resistance		
20	Ship Resistance (cont.)		Design 3 due
21	Ship Slamming	Integrate final report and prepare for final presentation	Design 3 feedback; practice presentation
22	Roll Control		
23	Propulsion		
24	Advanced Topics	Final presentations	Final presentation due
25	Advanced Topics (cont.)	Work on final report	
26	Summary and Conclusion		Final report due

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point

slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.