Course code	Course Name	L-T-P-Credits	Year of Introduction
SB401	SHIP DESIGN -II	3-1-0-4	2016

Prerequisite : SB302 Ship design - I

Course Objectives:

- To provide an understanding of basic design methodologies and the components of the ship design process
- To impart knowledge on importance of safety considerations within the ship design process and its impact on operational considerations.
- To impart knowledge on Applying design tools and synthesise information in ship design

Syllabus:

Standardisation; Cargo Handling Equipments, Anchor Installations, Mooring Systems; Accommodation, Access Equipments; Steering Gear ,Mast & Riggings; Equipments in Tanks & Holds ,Ventilation, Panelling & Deck Covering; Life-saving System; Fire-fighting system

Expected Outcome:

Upon successful completion of the course, the student will be able to :

i. Apply the methodology and tools used in the ship design process.
ii. Integrate safe design and operation of cargo handling, Anchor and mooring arrangements within the ship design process.
iii. Interpret and apply statutory regulations and classification rules in providing Accommodation and access.
iv. Provide Lightings and other signal arrangements meeting statutory regulations and classification rules.
v. Demonstrate knowledge and understanding of various fire protection arrangements and other supporting equipments.
vi. Provide Life-saving and Fire-fighting arrangements for a new ship design meeting regulations.

Text Books:

1. D.G.M. Watson; Practical Ship Design; Elsevier Ocean Engineering Book Series.
2. Robert Taggart; Ship Design & Construction; SNAME.

Reference Books:

1. Apostolos Papanikolaou et al; Risk-Based Ship Design - Methods, Tools and Applications; Springer.
2. E.C. Tupper; Introduction to Naval Architecture, Butterworth-Heinemann.
3. Lewis, E.U; Principles of Naval Architecture; (2nd Rev.) Vol. III, 1989; SNAME .
4. MARPOL Consolidated Edition.
5. Rawson and Tupper; Basic Ship Theory Vol I and II; Butterworth-Heinemann.
6. S. C. Misra; Design Principles of Ships and Marine Structures CRC Press, 2015
7. Schneekluth H.; Ship Design for Efficiency and Economy; II; Butterworth-Heinemann., 1998
8. Thomas Lamb; Ship Design & Constructio, SNAME, 2003

Course Plan			
Module	**Content**	**Hours**	**Sem. Exam Marks**
I	**Standardization:** Process and Product Standard; Rules and Regulations.	8	15%
II	**Cargo Handling Equipments**: Cargo Hatches, Lifting Devices.	4	15%
	Anchor Installations: Types of Anchors, Anchor Handling System, Anchor Chain & Storage.	4	
	Mooring Systems: Deck Fittings & Structural Arrangement, Mooring Machinery, Mooring Operations.	4	
FIRST INTERNAL EXAM			
III	**Accommodation**: Crew Size, Accommodation Standards, Space Allocation, Habitability, Access, Materials, Standardisation and Modular Arrangement.	4	15%
	Access Equipments: Hatches, Manholes, Doors, Other Closing & Opening Devices, Load Line Rules, Gangways and Ladders.	4	
IV	**Steering Gear**: Types, Design Aspects, Connections.	4	15%
	Mast & Riggings: Railings & Awnings; Sound and Light Signals.	4	
SECOND INTERNAL EXAM			
V	**Equipments in Tanks & Holds**: Air Vents, Sounding Tubes, Cleaning Devices, Fire Protection Devices.	5	20%
	Ventilation, Paneling & Deck Covering, Painting.	5	
VI	**Life-saving System:** Life Saving Equipments, International Rules.	5	20%
	Fire-fighting Systems: Rules And Regulations, Equipment, Fire Fighting methods	5	
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration: 3 hours

PART A

- Answer all 8 questions of 3 marks each.
- 1 question each from modules I to IV and 2 questions each from modules V & VI.

PART B

- Answer any 2 full questions out of 3 for each module.
- Each question from module I to IV carries 6 marks.
- Each question from module V & VI carries 7 marks.
- Each full question can have maximum of 4 sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
SB402	JOINING TECHNIQUES IN SHIP BUILDING TECHNOLOGY	3-0-0-3	2016

Prerequisite : Nil

Course Objectives:

- To impart basic knowledge on various joining techniques used in ship building technology.
- To impart knowledge on application of various joining techniques in fabrication of ship structures.

Syllabus:

Introduction to Joining Techniques in Shipbuilding Technology, Science of Welding, Electric Arc Welding, Welding Parameters and their Effects, Welding Metallurgy, Gas Metal Arc Welding, Mechanized System in Shipbuilding, SAW, Gravity Welding, CO_2 Welding, Panel Line Production, MIG & TIG Welding, Welding in Building Berth, Electro Slag welding, Electro Gas Welding, Comparison of European, Japanese & Indian Welding Process, Weld Defects, Distortion, NDT, Welding Quality Control, Robotic Welding**,** Structural Adhesive Bonding as a Joining Technique.

Expected Outcome:

Upon successful completion of the course, the student will be able to demonstrate knowledge of:

i. Effects of various welding parameters in weld quality.
ii. Types of welding in ship production and their procedure.
iii. Welding practices and methods used at various ship building stages.
iv. Purpose and procedure of QA / QC in ship building.
v. Concepts of robotic welding and its application in ship production.
vi. Application of structural adhesives bonding, types and various methods used as joining technique in ship production.

Text Books:

1. D. J.Eyres; Ship Construction, Butterworth Heinemann, 2001
2. O.P. Khanna; A Textbook of Welding Technology; Dhanpat Rai & Sons.
3. Robert Taggart; Ship Design & Construction, SNAME.

Reference Books:

1. AWS Welding Handbooks, AWS, New York, 1995.
2. Davies, A.C.; Welding, Cambridge University Press, Low Price Edition, 1996.
3. R M Newton; Practical Construction of Warships, Longmans, 1970
4. Richard, Little; Welding Technology; McGraw Hill Publications, New Delhi.
5. Rossi, Welding Technology, McGraw Hill.

Course Plan

Module	Content	Hours	Sem. Exam Marks
I	**Introduction to Joining Techniques in Shipbuilding Technology**	1	15%
	Welding: Development in Welding, Science of Welding, Weldability, Electric Arc Welding, Welding Parameters and their Effects.	2	

	Welding Metallurgy: Introduction, Structure of Metals, Crystallization of a Pure Metal, Phase Transformation in Iron-Carbon Diagram, Weldability of Steel, Effect of Presence of Alloy Elements, Effect of Welding Process & Nature of Base Metal, Preheating, HAZ.	4	
II	**Gas Metal Arc Welding:** Process, Different Metal Transfers, Power Source, Electrodes, Shielding Gas, Uses of Gas in Metal Arc Welding.	3	15%
	Mechanized System in Shipbuilding: Introduction, Philosophy of Automation in Welding, Different Welding Systems in Shipyards.	3	
FIRST INTERNAL EXAM			
III	**Welding in Production Shop:** SAW, Gravity Welding, Auto Contact Welding, CO_2 Welding. Panel Line Production, One-Sided Welding - SAW, MIG Welding TIG Welding, Welding of Stiffeners.	4	15%
	Welding in Building Berth: External Welding on the Berth, Electro-Slag Welding, Electro-Gas Welding, One-Sided Welding (Flux Asbestos Backing, Ceramic Backing etc.); Internal Welding on The Berth.	4	
	Comparison of European, Japanese & Indian Welding Process		
IV	**Welding Problems:** Weld Defects, Distortion, Accuracy Control; Non-Destructive Tests.	3	15%
	Welding Quality Control: Welding Standards, Welding Procedure Qualification, Effect of Variables on Qualification of Tests, Performance Qualification of Welders & Operators, Test Reports, Acceptance Standards, Quality Assurance and Audit, Consumable Classification & Coding.	4	
SECOND INTERNAL EXAM			
V	**Robotic Welding:** Introduction, Application of Robotic Welding in Ship Production, Robotic Welding System, Types of Welding Robots.	7	20%
VI	Analysis of Joints for Strength, Edge Preparation for Steel, Aluminium and Other Materials used.	3	20%
	Structural Adhesive Bonding as a Joining Technique: Adhesives and Adherands, Bonding Methods and Joint Design.	4	
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration: 3 hours

PART A

- Answer all 8 questions of 3 marks each.
- 1 question each from modules I to IV and 2 questions each from modules V & VI.

PART B

- Answer any 2 full questions out of 3 for each module.
- Each question from module I to IV carries 6 marks.
- Each question from module V & VI carries 7 marks.
- Each full question can have maximum of 4 sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
SB403	MARINE ENGINEERING	3-0-0-3	2016

Prerequisite : Nil

Course Objectives:

- To impart basic knowledge on Marine Engineering.
- To impart basic knowledge on the layout of an Engine Room.
- To familiarize Marine Machinery and various systems used onboard ships.

Syllabus:

Introduction; Role of Marine Engineers; General Arrangement of Machinery spaces; Various Types & Functions of Main Propulsion System; Various Auxiliary Machinery & its Functions; Layout of an Engine Room; Engine Room Piping Arrangements; Cargo Piping Arrangements in Case of Tankers; Deck Machinery; Cargo Handling Equipments; Construction & Operation of Steering Gear; Propeller & its Types; Propeller Shafting Arrangements.

Expected Outcome:

Upon successful completion of the course, the students will be able to:

i. Demonstrate knowledge of various marine machineries and marine systems.
ii. Understand the importance and functions of various machineries onboard ships.
iii. Make an efficient engine room arrangement.
iv. Understand the problems faced by marine engineers and rectify them by efficient design & construction.

Text Books:

1. Harrington; R.L. Marine Engineering; SNAME; New York.
2. Taylor D.A.; Introduction to Marine Engineering; Butterworths; London.

Reference Books:

1. D.K.Sanyal; Principles & Practices of Marine Diesel Engines, A Bhantarkar Pub., 1981.
2. H.D. Mc George; Marine Auxiliary Machinery, Elsevier,1999
3. Reed's General Engineering Knowledge for Marine Engineers, Adlard Coles Nautical , 1986

Course Plan

Module	Content	Hours	Sem. Exam Marks
I	**Introduction to Marine Engineering**: Role of Marine Engineers; Need of Knowledge on Marine Engineering for a Naval Architect; Relation between Marine Engineering & Naval Architecture; General Arrangement of Machineries Onboard Various Ship Types.	5	15%
II	**Types and Functions of Main Propulsion System**: Main Engine-Diesel Engine, Steam Turbine, Electric Propulsion; Diesel Engine Components; Scavenging; Supercharging; Starting & Reversing; Hazards and Maintenance of Diesel Engine.	7	15%

FIRST INTERNAL EXAM			
III	**Auxiliary Machinery:** List & Functions; Auxiliary Engines; Air Compressor; Pumps; Boilers; Purifiers; Valves; Heat Exchangers; Oily Water Separators; Incinerators; Sewage Treatment Plant; Fresh Water Generator.	7	15%
IV	**Pumps & Piping System:** Types of Pumps for Various Requirements, their Characteristics and Application in Ships; Centrifugal Pumps; Gear Pumps; Screw Pumps and Reciprocating Pumps; Care and Maintenance of Pumps; Piping Arrangement for Steam; Bilge; Ballast and Oil Fuel Systems; Lube Oil and Cooling System with Various Fittings; Domestic Fresh Water and Sea Water Hydrophore System.	8	15%
SECOND INTERNAL EXAM			
V	**Deck Machineries:** Deck Cranes; Windlasses; Mooring Winches; Anchors and Anchor Chains; Lifeboats Lowering Mechanism; Cargo Handling Equipments.	5	20%
	Steering Gear: Operation and Constructional Details of Various Types of Steering Machinery.	2	
VI	**Shafting and Propellers:** Stern Tubes and Glands, Oil Lubricated Stern Tubes; Shaft Seals; Shaft Alignment; Thrust Block; Reduction Gearing; Propeller Types and Construction Details; Maintenance and Operation of Marine Propellers; Ship Stabilizers.	6	20%
	Engine Room Layout: Layout of Main and Auxiliary Machinery in Engine Rooms of Different Ships.	2	
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration: 3 hours

PART A

- Answer all 8 questions of 3 marks each.
- 1 question each from modules I to IV and 2 questions each from modules V & VI.

PART B

- Answer any 2 full questions out of 3 for each module.
- Each question from module I to IV carries 6 marks.
- Each question from module V & VI carries 7 marks.
- Each full question can have maximum of 4 sub questions, if needed.

Course code	Course Name:	L-T-P-Credits	Year of Introduction
SB404	SHIP SURVEY, ESTIMATION AND REPAIR	3-0-0-3	2016

Prerequisite : Nil

Course Objectives:

- To study various types of surveys and certifications concerning ship design, Construction and Operation.
- To Understand various types of repair works carried out onboard ships and their monitoring and certification by survey agencies.

Syllabus: Introduction to Marine Survey, Types of Survey, Marine Surveying Agencies, Ship Classification Societies, Activities of Classification Society, Comparison of Ship Classification Rules by IRS and ABS, Repair of Ship's Hull, Testing for Water Tightness and Hull Continuity, Dry-Docking, Underwater Welding, Safety During Repair, Marine Cargo Survey, Warship Overseeing Team, Costing and Estimation, Approximate Costing Techniques of Ships, Work Estimation, Shipbuilding Contracts, Dry-Docking Works, Steel Works.

Expected Outcome:

Upon successful completion of the course, the students will be able to:

i. Understand various Safety measures to be taken for repair and maintenance of a Merchant Navy Ship.
ii. Understand the role of ship survey agencies and various types of surveys.
iii. Have knowledge of maintenance and repair of ship's hull and deck at various stages of operation.
iv. Familiarise with techniques of cost estimation and work estimation in design and repair of ships.

Text Books:

1. Don Butler; Guide to Ship Repair Estimates; Butterworth-Heinemann.
2. Jan O Fischer; Gerd Holback, Cost Management in Shipbuilding; GKP Publishing.
3. Robert Taggart; Ship Design and Construction; SNAME.

Reference Books:

1. David J Eyres; Ship Construction, 6th Edition; Butterworth-Heinemann, Amsterdam.
2. John H. Nixon; Underwater Repair Technology; Gulf Publishing Company, 2000.
3. Lloyds Register; 'Rules and Regulations for the Classification of Ships', Part 1, Regulations, Chapters 2 and 3.
4. N.E.Chell; Operation & Maintenance of Machinery in Motorships; 1999, IMarEST.
5. Piero Caridis; Inspection Repair and Maintenance of ships structure; Witherby Seamnship International Ltd, February, 2009.
6. Rules and Regulations for the Construction and Classification of Inland Waterways ships - January 1997; IR Class, Mumbai.
7. Rules and Regulations for the Construction and Classification of Steel Ships - July 2015; IR Class, Mumbai.
8. Rules for Bulk Carriers and Oil Tankers - July 2015; IRS, Mumbai.

Course Plan			
Module	**Content**	**Hours**	**Sem. Exam Marks**
I	**Introduction to Marine Survey**: Definition of Elementary Terminologies like Survey Authority, Recognized Organisation, Port State control, Flag State control.	2	15%
	Various Types of Marine Surveys - Initial Survey, Annual Survey, Periodic Survey, Intermediate Survey, Renewal Survey, Additional Survey. Survey During Transfer of Ships.	2	
	Marine Surveying Agencies- Roles and Responsibilities , Statutory Surveys – Role of MMD, IWAI.	2	
II	**Ship Classification Societies**- Historical Development, Major Activities of Classification Societies; Rules and Class Notations.	2	15%
	IACS and Joint Projects, Comparison of Ship Class Rules by IRS and ABS, Activities of Classification Societies and Surveying Agencies.	2	
	Activities of Classification Society – Design Approval; Construction Survey; Survey on Operation, Repair Conversion.	1	
	Industrial Surveys, Third Party Accreditation.	1	
FIRST INTERNAL EXAMINATION			
III	**Repair of Ship Hull.**		15%
	Introduction, Causes of Wear and Damage in Ship's Hull.	2	
	Comparison Between Different Types of Repair Activities (Afloat, Berthed etc.)	1	
	Testing for Water Tightness and Hull Continuity.	2	
	Repair of hull and Other Parts While Afloat.	1	
IV	**Dry-docking-** Steps to be Taken Before, During and After Drydocking.	2	15%
	Replacement of Hull Plates and Stiffeners, Decks and Bulkheads, Repair of Stem and Stern Frames and Shaft Bracket, Propeller Shaft Sealing Equipment.	2	
	Rudder– Pintle Clearances, Maintenance of Sea Water Suction and Overboard Valves.	2	
SECOND INTERNAL EXAMINATION			
V	**Underwater Welding –** Welding Equipment, Quality Control and Standards; Degree of Automation.	2	20%
	Safety During Repair – Various Operations Involving Risk, Safety Devices and Plans.	2	
	Marine Cargo Survey- Dry, Liquid and Container Cargoes.	3	

	Warship Construction, Warship Overseeing Team, Inspection During Construction; Lineout Inspection.	2	
VI	**Costing and Estimation.**		20%
	Difference between Cost and Price, Top Down and Bottom Top Approaches in Costing, Demarcations and Subdivisions of Costs, Structural Costs, Outfit Costs, Labour Costs, Machinery Costs.	3	
	Shipbuilding Contracts.	2	
	Work Estimation.		
	Dry-docking Works - Docking and Undocking, Hull Preparation, Hull Painting, Propeller Works, Chain Lockers.	3	
	Steel Works, Planning Charts.	1	
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration: 3 hours

PART A

- Answer all 8 questions of 3 marks each.
- 1 question each from modules I to IV and 2 questions each from modules V & VI.

PART B

- Answer any 2 full questions out of 3 for each module.
- Each question from module I to IV carries 6 marks.
- Each question from module V & VI carries 7 marks.
- Each full question can have maximum of 4 sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
SB405	DESIGN OF MACHINE COMPONENTS	2-1-0-3	2016

Prerequisite :

Course Objectives:

- To introduce the student to the fundamentals of machine design.
- To impart knowledge that enables the student to carry out engineering design of the basic components of a mechanical system.

Syllabus:

Fundamentals of Machine Design- Definitions, Principles, Factor of Safety, Endurance, Fatigue; Theories of Failure; Selection of Materials; Stress Concentration Factor; Design of Detachable and Non-Detachable Joints; Design of Shafts for Bending and Torsion; Design of Rigid and Flexible Couplings; Design of Springs; Design of Sliding Bearings; Selection of Roller Bearings; Design of Spur, Helical and Bevel Gears.

Expected Outcome:

Upon successful completion of the course, the students will be able to:

i. Carry out design of Joints, Couplings, Shafts, Springs, Bearings and Gears
ii. Select appropriate components from commercially available standard components based on the required specifications.
iii. Carry out material selection based on the application requirements.

Text Books:

1. M. F. Spotts, T. E. Shoup, Design of Machine Elements, Pearson Education.
2. R.K.Jain, Machine Design, Khanna Publications, New Delhi.

Data Book (Approved for use in the examination):

Machine Design Data Handbook (one standard hand book of any author).

Reference Books:

1. C.S. Sarma, Kamlesh Purohit; Design of Machine Elements; Prentice Hall of India.
2. J.E.Shigley; Mechanical Engineering Design; McGraw Hill.
3. V.B. Bhandari, Design of Machine Elements, McGraw Hill.

Course Plan

Module	Content	Hours	Sem. Exam Marks
I	**Fundamentals of Machine Design:** Definitions, Design Process, Design Principles, Design Criteria; Stresses in Machine Parts, Working Stress, Safe Stress, Factor of Safety, Endurance Limits, Fatigue Factors.	2	15%
	Theories of Failure: Guest's Theory, Rankine's Theory, St. Venant's Theory , Haigh's Theory, Von Mises & Hencky Theory.	2	
	Stress Concentration: Methods to Reduce Stress Concentration, Theoretical Stress Concentration Factor.	2	
II	**Joints:** Design of Detachable Joints (Pins, Keys, Splines and Bolted Joints).	4	15%
	Non-Detachable Joints; Welded, Riveted Joints; Strength of Welded and Riveted Joints.	4	

FIRST INTERNAL EXAM			
III	**Drive Elements:** Shafts, Torsion and Bending of Shafts, Design of Shafts for Strength and Deflection, Effect of Key Way.	5	15%
	Design of Couplings: Rigid and Flexible Couplings.	3	
IV	**Elastic Springs:** Classification and uses of Springs, Allowable Stresses and Deflections.	2	15%
	Springs: Stresses and Design of Helical Springs with Axial and Fluctuating Loads.	4	
SECOND INTERNAL EXAM			
V	**Bearings**: Slide Bearings, Introduction to Lubrication, Hydrodynamic Bearings, Bearing Materials, Design of Slide Bearings.	4	20%
	Roller Bearing Types, Static & Dynamic Load, Capacity, Bearing Life and Selection of Bearing.	3	
VI	**Gears**: Classification, Gear Nomenclature, Tooth profiles, Materials of Gears; Design of Spur, Helical and Bevel Gears.	5	20%
	Beam Strength, Lewis Equation, Buckingham's Equation for Dynamic Load, Wear Load, Endurance Strength of Tooth.	2	
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration: 3 hours

PART A

Three questions of 15 marks each uniformly covering Modules 1 & 2, out of which 2 questions are to be answered.

PART B

Three questions of 15 marks each uniformly covering Modules 3 & 4, out of which 2 questions are to be answered.

PART C

Three questions of 20 marks each uniformly covering Modules 5 & 6, out of which 2 questions are to be answered.

Note: Each question can have maximum of 4 sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
SB407	SHIP PRODUCTION	3-0-0-3	2016

Prerequisite: Nil

Course Objectives:

- To provide an overview on layout of shipyard & various activities.
- To impart knowledge on shipbuilding practices and sequence of ship production.

Syllabus:

Introduction to Ship Production, Characteristics of Ship Building, Layout of a Shipyard, Shipyard Organization Structure, Product Oriented Work Breakdown Structure, Storage and Preparation of Material; Fabrication of Component Parts, Machining Processes in Shipbuilding; Assembly of Ship's Structures; Sub-Assemblies; Erection of Ship's Hull, Hull Assembly, Activities in Shipyard Pipe, Machine and Shipwright's Shops**;** Technological Process in the Hull Installation Work, Launching.

Expected Outcome:

Upon successful completion of the course, the students will be able to:

i. Understand a typical shipyard organization and components of integrated approach in planning ship production.
ii. Demonstrate knowledge and understanding of various machining process in fabrication of prepared plates from storage area to units.
iii. Understand the practice of prefabrication prior to erection and sequence of erection of hull.
iv. Demonstrate knowledge and understand various technologies involved during erection of hull.
v. Understand the different ways of launching a vessel, and various outfitting process following launching.

Text Books:

1. Richard Lee Storch, Colin P. Hammon.& Bunch H.M. Richard C. Moore; Ship Production, Cornell Maritime Press, 1988
2. D. J.Eyres; Ship Constructio, Butterworth, Heinemann, 2001..

Reference Books:

1. Dormidontov V.K. &et.al.;Shipbuilding Technology; Mir Publishers, Moscow.
2. R. M. Newton; Practical Construction of War ships, Longmans, 1970.
3. Robert Taggart; Ship Design & Construction, SNAME.

Course Plan

Module	Content	Hours	Sem. Exam Marks
I	**Introduction to Ship Production & Characteristics of Ship Building.** **Layout of a Shipyard**- General Principles- Location, Area and Other Sources, Special Aspects of Transport, Relation with Supply Industry, Subcontractors, Management of a Shipyard- Organization Structure.	8	15%

	Product Oriented Work Breakdown Structure- Planning for Production, Zone Construction Method, Pipe Piece Family Manufacturing.		
	Data Generation for Shipbuilding Process – Generation of Hull Forms, Frame Plan, Shell Plate Development, Generation of Hull Components, Lofting, Nesting.		
	Storage and Preparation of Material- Material Handling and Storage, Transport System in Steel Stockyard, Material Preparation- Straightening of Plates and Rolled Sections, Shot Blasting, Prepainting, Material Preparation, Flow Line Devices and their Control Systems.		
II	**Fabrication of Component Parts** - Cutting Process – Tools, Mechanical Cutting, Devices for Thermal Cutting, General Description of the Various Machines, Photoelectric and NC-Control Devices, Edge Preparation, Problems of Accuracy.	3	15%
	Bending of Rolled and Built Up Sections - General Description of Bending, Control of the Bending Process, Automation of Bending, Plate Bending, Uniaxial Bending, Biaxial Bending (Devices, Cold Bending, Heat-Line Bending), Possibilities of Automated Plate Bending.	3	
FIRST INTERNAL EXAM			
III	**Welding in Shipbuilding, Welding Methods, Standards, Symbols.**	2	15%
	Assembly of Ship's Structures- Prefabrication – General Considerations, Basic Problems of Prefabrication, Pattern of Prefabrication, Welding in Prefabrication.	4	
IV	**Sub-Assemblies**- Built Up T-Bars, Web Frames, Machine Foundations etc.; Welding Deformation and Straightening; Prefabrication of Flat Sections – Panels, Panel Production Line, Preassembly of Biaxial Stiffened Panels – Welding Procedures.	8	15%
	Assembly of Flat and Corrugated Sections, Flat Sections with Curvature – Assembly Jigs, Welding Process, Strengthening of Flat Sections.		
	Preassembly of Volume Units – Preassembly of Double Bottom Sections – Different Structural Arrangements, Variants of the Assembly Process, Welding Problems; Preassembly of Side Shell – Structural Arrangement; Special Assembly Systems, Preassembly of the Fore and Aft End Structure, Preassembly of Superstructures.		
SECOND INTERNAL EXAM			
V	**Erection of Ship's Hull**- Handling of Preassembled Units in the Erection Area – Cranes, Heavy-Duty Trucks; Preassembly of Blocks – Special Types, Advantages and Disadvantages.	8	20%

	Hull Assembly- Different Methods of Hull Assembly, Welding in Ship's Hull Assembly – Welding Methods Used, Defects, Welding Deformation; Quality Control, Quality Assurance, Scaffoldings.		
	Technological Process in the Hull Installation Work– Technological Process in Installing the Main Machinery, Shafting and Propeller, Auxiliary Machinery and Boilers, Piping Systems, Electrical Installation and Hull Equipments.		
VI	**Pre And Advanced Outfitting-** Activities in Shipyard Pipe, Machine and Shipwright's Shops, Mechanical Workshop, Machine Shop, Other Workshops (Electrical Installation, Painting, Insulation, Etc.).	3	20%
	Launching- General Methods, Launching by Floating Off (Building Dock, Floating Dock), Mechanical Launching Methods (Slip, Lift), Launching from Inclined Building Berths – Stern Launching, Side Launching; Tipping, Pivoting.	3	
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration: 3 hours

PART A

- Answer all 8 questions of 3 marks each.
- 1 question each from modules I to IV and 2 questions each from modules V & VI.

PART B

- Answer any 2 full questions out of 3 for each module.
- Each question from module I to IV carries 6 marks.
- Each question from module V & VI carries 7 marks.
- Each full question can have maximum of 4 sub questions, if needed.

Course code	Course Name:	L-T-P-Credits	Year of Introduction
SB409	ELECTRICAL SYSTEMS IN SHIPS & SHIPYARDS	3-0-0-3	2016

Prerequisite: EE214 Electrical technology & Instrumentation

Course Objectives:

- To impart basic knowledge on Electrical Systems in ships.
- To impart knowledge on various Power supply systems used in ships.
- To understand the importance of Electrical systems used in Ships and Shipyards.

Syllabus:

Overview of a Ship's Electrical System, Electrical System and Major Components, AC Distribution Systems, Alternators, Emergency Power and Shore Supply, Direct Current Machines, DC Generators, Types of Direct Current Generators, DC Motors, Principle of DC Motors, Automatic Voltage Regulators, Paralleling of Alternators, Manual Synchronising, Auto-Synchronising, Starters for Alternating Current Motors, Electrical Propulsion Systems, Bridge Equipments, Starters for AC Machines, Electrical system in Shipyards, Relevant SOLAS Regulations.

Expected Outcome:

Upon successful completion of the course, the student will be able to:

i. Understand the fundamental concepts of electrical technology.
ii. Recognize component symbols and their construction, functioning and applications.
iii. Identify symbols, trace and analyze circuit diagrams and troubleshoot electric systems logically.
iv. Gain the confidence to tackle direct current, shore power and communications installations.

Text Books:

1. Elstan A. Fernandez; Marine Electrical Technology, Shroff Publishers, 2014
2. Harrington L Roy; Marine Engineering, SNAME Publications.

Reference Books:

Watson G.O.; Marine Electrical Practice, ELSEVIER, 6th Ed.

Starr A.T.; Generation, Transmission and Utilisation of Electrical Power, Pitman Publishing; 4th Revised edition edition (December 1957)

Sonnenberg G.J. & Newnen Butterworth; Radar Electronic Navigation. *Butterworth*-Heinemann; 6 edition (May 1988)

Course Plan

Module	Content	Hours	Sem. Exam Marks
I	**Overview of a Ship's Electrical System:** The Marine Environment, General Provisions, Systems and Major Components, Load Analysis, Power Management Systems, Electrical Diagrams, Relevant SOLAS Regulations.	6	15%

II	**AC Distribution Systems:** The General Concept, Alternators, Specific Systems for distribution of AC power in Ships, General Distribution Scheme Onboard a Ship, Relevant Regulations. **Emergency Power and Shore Supply:** The Method of Supplying Emergency Power, Actions by Engineers during a Blackout Situation, Shore Supply, Relevant Rules.	6	15%
FIRST INTERNAL EXAM			
III	**Direct Current Machines:** Introduction to DC Generators, Types of Direct Current Generators, Series Wound Generator, Shunt Wound Generator, Compound Wound Generators. Introduction to DC Motors, Principle of DC Motor Operation, Shunt Wound Motor, Series Wound Motor, Compound Motors.	6	15%
IV	**Automatic Voltage Regulators:** Performance Requirements of Alternators, Operating Principle of an AVR, Thyristor-based Static Automatic Voltage Regulator, Effect of kW Loading, Effect of kVAr Loading. **Paralleling of Alternators:** The Basics, Manual Synchronising, Auto-Synchronising, Parallel Operation, Load Sharing, Speed Droop and Power Generation.	8	15%
SECOND INTERNAL EXAM			
V	**Electrical Propulsion Systems:** Layout and Principle of Electrical Propulsion, Advantages & Disadvantages of Electrical Propulsion, Turbo-electric Propulsion, AC Single-Speed Drive with a Controllable Pitch Propeller, Advanced Diesel-electric Propulsion Systems.	5	20%
	Bridge Equipments: Communication Equipments & their function, Navigational Equipments & their function, Lighting Arrangements, Cable Specifications, Testing of Cables.	3	
VI	**Starters for Alternating Current Motors:** The Basics of Starters, The Direct-on-line or D.O.L. Starter, Star-delta Starter, Autotransformer Starter.	4	20%
	Electrical system in shipyards: Power factor improvement, power tariff calculation, essential regulations, and main loads. Potential Hazards, Maritime Labor/Industry Recommendations.	4	
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration: 3 hours

PART A

- Answer all 8 questions of 3 marks each.
- 1 question each from modules I to IV and 2 questions each from modules V & VI.

PART B

- Answer any 2 full questions out of 3 for each module.
- Each question from module I to IV carries 6 marks.
- Each question from module V & VI carries 7 marks.
- Each full question can have maximum of 4 sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
SB431	MARINE ENGINEERING LAB	0-0-3-1	2016

Prerequisite : SB403 Marine Engineering

Course Objectives:

- Familiarization with setting up of experiments in a laboratory environment.
- Provide an environment to enable correlation of theoretical knowledge gained in the class room with the physical world.
- Provide experience on testing of marine IC engine performance.
- To introduce engine room machinery.

List of Exercises/ Experiments (Minimum 12 are Mandatory)

1. Study of Internal Combustion Engine and its Components.
   Equipment: Internal Combustion Engine.

2. Study of Boilers, Preparation for Firing Up of Boiler.
   Equipment: Water Tube Boiler

3. Valve Timing Diagram of Four Stroke Vertical Diesel Engine & Post Timing Diagram of 2S Petrol Engine.
   Equipment: Internal Combustion Engine.

4. Load Test on Four Stroke Single Cylinder Vertical Diesel Engine.
   Equipment: Four Stroke Single Cylinder Vertical Diesel Engine.

5. Morse Test on Four Stroke Four Cylinder Petrol Engine.
   Equipment: Four Stroke Four Cylinder Petrol Engine.

6. Load Test on Four Stroke Single Cylinder Horizontal Diesel Engine.
   Equipment: Four Stroke Single Cylinder Horizontal Diesel Engine.

7. Speed Variation Test on Four Stroke Horizontal Diesel Engine.
   Equipment: Four Stroke Horizontal Diesel Engine.

8. Retardation Test on Four Stroke Single Cylinder Vertical Diesel Engine.
   Equipment: Four Stroke Single Cylinder Vertical Diesel Engine.

9. Load Test on Slow Speed Diesel Engine.
   Equipment: Four Stroke Single Cylinder Vertical Diesel Engine.

10. Testing of Fuels and Lubricants - Determination of flash and fire points of petroleum products - Determination of kinematic and absolute viscosity of lubricating oils - Determination of calorific values.
    Equipment: Calorimeter, Redwood Viscometer Etc.

11. Energy Balance of a Diesel Engine.
    Equipment: Four Stroke Horizontal Diesel Engine.

12. Determination of the Characteristic Curves of Centrifugal Pumps.
    Equipment: Centrifugal Pump Test Rig.

13. Determination of the Characteristic Curves of Screw Pump.
    Equipment: Screw Pump Test Rig.

14. Overhauling of Gate Valve, Globe Valve
    Equipment: Gate Valve, Globe Valve.

15. Overhauling of Reciprocating Pump
    Equipment: Reciprocating Pump.

16. Study Boiler Safety Valve, Water Level Gauge Glass and Various Mountings.
    Equipment: Water Tube Boiler

17. Study of Fuel Injection Valve and Pump.
    Equipment: Fuel Injection Valve and Pump

18. Study of Various Types of Filters and Incinerator.
    Equipment: Fuel Oil Filters and Incinerator

Expected Outcome:

After successful completion of the course, the student will be:

i. Able to explain the importance of various machinery parts.
ii. Familiar with various machineries used in the ship.
iii. Able to Dismantle & Assemble Various Marine Auxiliary Machineries.

Text Books:

1. Harrington; Marine Engineering, SNAME Publications.
2. Taylor, C. Fayette, and Edward S. Taylor; The Internal Combustion Engine; International Textbook Company.

Course code	Course Name	L-T-P-Credits	Year of Introduction
SB461	SHIPBUILDING MATERIALS, CORROSION PREVENTION AND PROTECTION	3-0-0-3	2016

Prerequisite : Nil

Course Objectives:

- To study the mechanism of corrosion occurring in various shipbuilding materials.
- To understand different types of corrosion attack onboard ships.
- To familiarise with various corrosion prevention strategies.
- To familiarise with corrosion control methods during various stages of ships life cycle.

Syllabus:

Introduction, Corrosion Triangle, Corrosion Losses, Types of Corrosion in Marine Environment, Materials and Corrosion, Corrosion of Steel, Titanium, Nickel, Zinc and Aluminium Alloys, Surface preparation of steel, Marine Paints and Paint schemes in Ships, Pollution from paints and methods to minimize them, Anticorrosion paints and corrosion monitoring, Antifouling paints, Corrosion Control, Cathodic protection, Sacrificial anode system, Impressed Current System, Anodic protection of stainless steel.

Expected Outcome:

Upon successful completion of the course, the student will be able to:

i. Understand types of corrosion likely to occur at various locations in a ship.
ii. Suggest effective methods of corrosion prevention and material preservation.
iii. Formulate decisions in design stage to minimise corrosion in ships.
iv. Suggest methods to detect areas and types of corrosion and thereby improve safety and reduce losses.

Text Books:

1. Fontana M. G, Greene N. D, 'Corrosion Engineering', McGraw Hill.
2. Ramesh Singh, Corrosion Control for Offshore Structures, Gulf Publishing Company.
3. T. Howard Rogers, "Marine Corrosion", first Edition, George Newnes Ltd., London.

Reference Books:

1. Diamont, The Chemistry of Building Materials, Business Books Limited, London.
2. Jayanta Kumar Saha, Corrosion of Constructional Steels in Marine and Industrial Environment, Springer.
3. Jones D. A, 'Principles and Prevention of Corrosion', 2nd Edition, Prentice Hall, K A Chandeler, Marine and Offshore Corrosion, Butterworths Heinemann.
4. Raj Narayan, 'An Introduction to Metallic Corrosion and its Prevention', Oxford and IBH, 1983.
5. Robert Taggart, Ship Design and Construction, SNAME.
6. S A Campbell, N. Campbell, F C Walsh, Developments in Marine Corrosion, Royal Society of Chemistry.

Course Plan			
Module	**Content**	**Hours**	**Sem. Exam Marks**
I	**Introduction.**		15%
	Chemistry of Corrosion, Corrosion Losses, Economic Impact of Corrosion.	2	
	Corrosion Triangle, Theories of Corrosion, Erosion Corrosion. Galvanic series of metals, Formation of Corrosion Cell. Stress Concentrations and Difference in Surface Condition leading to Formation of Corrosion Cells.	3	
	Types of Corrosion in Marine Environment, Corrosion Identification, Factors affecting Corrosion.	3	
II	**Materials and Corrosion.**		15%
	Types of Steel and Tendency of Corrosion, Use of HTS, Stainless Steel	2	
	Corrosion of Titanium and Nickel alloys, Copper and Copper Based Alloys, Zinc, Aluminium and its Alloys.	2	
	Corrosion on Propeller, Marine machinery and Deck fittings.	3	
FIRST INTERNAL EXAMINATION			
III	**Surface Preparation of Steel.**		15%
	Material Storage and Preservation in Shipyard, Treatment of Steel in Shipyards.	1	
	Degreasing, Weathering, Mechanical Surface Cleaning, Pickling, Blast Cleaning, Flame Cleaning.	3	
	Rust Converters, Chemical Pretreatment and Comparison of Pretreatment Methods.	2	
IV	**Marine Paints and Paint Schemes in Ships.**		15%
	Classification of Paints- Common Paint Vehicles: Drying Oils, Oleo-Resins, Alkyd Resins, Polymerizing Chemicals and Bitumen.	2	
	Role of Constituents of Paints. Suitability of Each for Various Applications.	2	
	Typical Paint Schemes for Underwater Areas, Boot Topping, Top sides, Weather Decks, Superstructures and Tank Interiors.	2	
SECOND INTERNAL EXAMINATION			
V	**Paints and Corrosion Monitoring**		20%
	Mechanism of Anticorrosive Paint, Paint Types and Selection.	1	
	Antifouling paints- Effect of Fouling on Ships, Factors Affecting Growth and Settlement Principles of Antifouling Paints.	2	
	Pollution from Paints and Methods to Minimize Them, Painting Tools, Methods.	3	
	Surface Preparation for Painting, Safety Precautions While Using Paints.	2	

VI	**Corrosion Control.**		20%
	Importance of Corrosion Protection, Measures to Minimise Corrosion, Corrosion Control by Design, Corrosion Inhibitors.	3	
	Cathodic Protection- Mechanism of Cathodic Protection, Sacrificial Anode, Design of Sacrificial Anode System for Ships, Advantages and Disadvantages of Sacrificial Anode system.	3	
	Impressed Current Cathodic Protection System in Ships, Advantages and Disadvantages.	2	
	Principle of Anodic Protection.	1	
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration: 3 hours

PART A

- Answer all 8 questions of 3 marks each.
- 1 question each from modules I to IV and 2 questions each from modules V & VI.

PART B

- Answer any 2 full questions out of 3 for each module.
- Each question from module I to IV carries 6 marks.
- Each question from module V & VI carries 7 marks.
- Each full question can have maximum of 4 sub questions, if needed.

Course code	Course Name:	L-T-P-Credits	Year of Introduction
SB462	SHIP PRODUCTION MANAGEMENT	3-0-0-3	2016

Prerequisite : Nil

Course Objectives:

- To introduce the concept of systemic approach to ship production.
- To familiarize with Forecasting, Scheduling and Quality Measurement techniques used in production.
- To develop understanding about the different production procedures, design techniques, process planning and operations planning in ship production.

Syllabus:

Overview of Ship Production Systems, Production Planning and Production Control- Production and Process Analysis, Introduction to Forecasting, Work Study, Cost Estimation, Time Study, Operation Planning and Control, Production Standards, Production Inventory System, Quality Assurance and Quality Control.

Expected Outcome:

Upon successful completion of the course, the student will be able to**:**

i. Describe the various activities involved in production of a ship as a system with further subsystems.
ii. Understand the planning stage for various operations leading to construction of a ship.
iii. Measure work, time and cost involved in production of ships and calculate production efficiency and productivity.

Text Books:

1. Arthur C.Laufer; Operations Management, South-Western Publishing Co.
2. Dormidontov V.K. & et.al.; Shipbuilding Technology, Mir Publishers, Moscow.
3. Storch R. Lee, Hammon C.P. & Bunch H.M.; Ship Production, Cornell Maritime Press, Maryland, USA.
4. Taggart; Ship Design and Construction, SNAME.

Reference Books:

1. Chary, Production & Operations Management, TMH, New Delhi.
2. Joseph W. Curmxmnskey: Report on United States Commercial shipbuilding productivity: An International view, Naval Post Graduate School, California, 1990.
3. Khanna, O.P.; Industrial Engineering and Management, Dhanpat Rai Publication.
4. R Sharma, O.P Shah- Development of an ERP Model for Modularly Designed Ships – I: Manufacturing Management, *[Part A: Proceedings of the IMarEST]*, **A10, pp. 17-43** (2007) IIT Kharagpur.
5. Report on Producibility in Ship Design, 1989 Ship Production Symposium, and NSRP, U.S. Department of the Navy.

Course Plan

Module	Content	Hours	Sem. Exam Marks
I	**Overview of Ship Production Systems** - The Systems Approach-Subsystems, Comprehensive System Model - The	4	15%

	Ship as a System.		
	Product Standardisation and Work Simplification, Product Mix.	2	
II	**Production Planning and Production Control -** Planning for Operations – Interconnection between Production Design and Process Planning.	2	15%
	Production and Process Analysis - Assembly Charts, Operation Process Charts, Flow Process Charts; Process Selection.	3	
	Application of Models for Process Planning, Scheduling and Control – Gantt charts, CPM & PERT, Transportation Models.	2	
FIRST INTERNAL EXAMINATION			
III	**Introduction to Forecasting** - Simple & Weighted Moving Average Methods.	2	15%
	Work Study - Various Methods of Measurement, Man-hour Determination, Definition of Productivity, Factors affecting Productivity, Strategies for Improving Productivity.	3	
	Cost Estimation -Methods in Ship Production. **Time Study** - Determining Time, Work Sampling.	2	
IV	**Operation Planning and Control** - Production Planning, Scheduling, Network Models (PERT, CPM), Introduction to JIT, Maintenance Analysis.	3	15%
	Production Standards – Production Standards in Several Stages of the Ship Production Process.	3	
SECOND INTERNAL EXAMINATION			
V	**Information Exchange During Ship Production** - Communication between Departments and other Stakeholders - Classification Society, Regulatory Body, Ship Owner, Design Office.	3	20%
	Database Management Systems (DBMS) in Ship Production.	3	
	Production Inventory System - The Inventory Problem, Functions of Inventory, Inventory Costs Inventory Concepts.	3	
VI	**Quality Assurance and Quality Control** - Definition and Scope.	2	20%
	Problems of Accuracy – Tolerances, Standards.	2	
	Measuring Techniques Used - Theodoilite & Laser.	2	
	Ship Production Management Software.	1	
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration: 3 hours

PART A

- Answer all 8 questions of 3 marks each.
- 1 question each from modules I to IV and 2 questions each from modules V & VI.

PART B

- Answer any 2 full questions out of 3 for each module.
- Each question from module I to IV carries 6 marks.
- Each question from module V & VI carries 7 marks.
- Each full question can have maximum of 4 sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
SB463	SHIP RECYCLING	3-0-0-3	2016

Prerequisite: Nil

Course Objectives:

- To impart knowledge on procedures of recycling an obsolete vessel.
- To provide awareness of rules and regulation governing ship recycling.

Syllabus:

Introduction to Ship Recycling, Factors Contributing to Sustainable Development, Ship Life Cycle Stages, Recycling Methods, Operations in Ship Recycling, Concept of Recycling, Rules and Regulations governing Ship Recycling, Inventory List and Disposal.

Expected Outcome:

Upon successful completion of the course, the students will be able to demonstrate knowledge and understanding of:-

i. Ship Recycling as a sustainable industry.
ii. Lifecycle management of a ship.
iii. Various methods of ship recycling.
iv. Various operations in ship recycling.
v. International and governmental authorities governing Ship Recycling.
vi. Hazardous materials and methods of their disposal.

Text Books:

1. A Guide for Ship Scrappers, Tips for Regulatory Compliance, United States Environmental Protection Agency, Summer 2000.
2. Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, 8 October, 2005.
3. Purnendu Misra, Anjana Mukharjee; Ship Recycling- A Hand Book for Mariners; Narosa Publication.

Reference Books:

1. Code on Regulations for Safe and Environmentally Sound Ship, MoS, GoI, 2010
2. IMO guidelines on Ship Recycling, Resolution A. 962(23), 2004.
3. Industry Code of Practice on Ship Recycling; Marisec, London, August 2001.
4. Safety and Health in Shipbreaking- Guidelines for Asian countries and Turkey; International Labour Office, 2004.U.K
5. Ship Recycling Strategy; Department for Environment Food and Rural Affairs, February 2007.

Course Plan

Module	Content	Hours	Sem. Exam Marks
I	**Introduction to Ship Recycling**: Definition, Relevance of Ship Recycling, Concept of Sustainable Development of the World, Factors Contributing to the Sustainable Development, Role of Maritime Industrial Sector, Statistics of Global Shipping and Ship Building.	7	15%

II	**Ship Life Cycle Stages:** Various Stages of Life Cycle of Ships, Operations in Life Stages and Effective Management of the Stages, Importance of Ship Recycling in Life Cycle Management.	7	15%
FIRST INTERNAL EXAM			
III	**Recycling Methods:** Decision on Decommissioning of Ships, Preparations for Transferring Obsolete Vessels to Recycling Yards, Planning, Commercial Matters, Transportation Methods, Survey before Positioning, Legal Issues, Positioning of Obsolete Ships, Beaching, Buoy and Dock Methods of Recycling.	7	15%
IV	**Operation in Ship Recycling:** Ship Dismantling Process, Access, Cleaning, Marking, Cutting, Handling, Lifting, Sorting, Stacking, Storing, Marshall, Concept of Recycling, Reuse and Land filling in Ship Recycling.	5	15%
	Design for Ship Recycling, Vessel Specific Dismantling, Safety Issues.	2	
SECOND INTERNAL EXAM			
V	**Rules and Regulations in Ship Recycling:** Rule of Various International and National Agencies, IMO, UNEP (BASEL CONVENTION), Gujarat Maritime Board (, ILO, Classification Bodies.	4	20%
	Statutory Certificates for Ship Recycling, Green passport and Green ship, Role of NGOs (Green Peace foundation, Ban Asbestos Network).	4	
VI	Inventory List, Safety Matters / Requirements, Chances of Environmental pollution, Effect on Life / Organisms at Sea.	6	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration: 3 hours

PART A

- Answer all 8 questions of 3 marks each.
- 1 question each from modules I to IV and 2 questions each from modules V & VI.

PART B

- Answer any 2 full questions out of 3 for each module.
- Each question from module I to IV carries 6 marks.
- Each question from module V & VI carries 7 marks.
- Each full question can have maximum of 4 sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
SB464	REFRIGERATION & AIR CONDITIONING OF SHIPS	3-0-0-3	2016

Prerequisite: Nil

Course Objectives:

- To impart basic knowledge on Refrigeration Cycle & Systems.
- To impart knowledge on various Refrigerants used in ship's refrigeration system.
- To impart knowledge on operation of HVAC systems used in ships.
- To understand the importance of Refrigeration & Air conditioning systems in ships.

Syllabus:

Introduction; Marine Applications of Mechanical Refrigeration; Vapor Compression Cycle; Refrigerants & their properties; Types & Working of Compressors, Evaporators, Condensers & Expansion Devices used in the Refrigeration System; Psychrometry; Heating, Ventilation & Air Conditioning (HVAC) Systems and Components used in Ships; Cooling and Heating Load Calculations.

Expected Outcome:

Upon successful completion of the course, the student will :

i. Have knowledge of Refrigeration & Air conditioning terms used in ships.
ii. Acquire knowledge on various types of Compression Cycle.
iii. Understand the operation of various components in the Refrigeration system & HVAC system in ships.

Text Books:

1. Earl S. Shulters; Marine Air Conditioning and Refrigeration; Cornell Maritime Press.
2. James A. Harbach; Marine Refrigeration and Air-Conditioning; Cornell Maritime Press, 2005.

Data Book (Approved for use in the examination):

- Refrigeration tables with charts.
- Steam Tables with mollier diagram.

Reference Books:

1. Shan K. Wang; Handbook of Air Conditioning and Refrigeration, McGrawq Hill, 2000
2. R.S. Khurmi, J. K. Gupta; Textbook of Refrigeration and Air Conditioning; S. Chand.

Course Plan

Module	Content	Hours	Sem. Exam Marks
I	Introduction; Marine Applications of Mechanical Refrigeration; Refrigerated Ship's Stores; Air-Conditioning of Ships; Refrigerated Cargo Spaces; Reversed Carnot Cycle; Vapor-Compression Cycle; Ideal Saturated Vapor-Compression Cycle; Multiple Evaporators with One Compressor.	6	15%
II	Refrigerant Properties; Safety; Lubricants; Refrigerant Numbering System; Refrigerant Blends; Ozone Depletion and the Montreal Protocols; Alternative Refrigerants; Secondary Refrigerants.	6	15%

	FIRST INTERNAL EXAM		
III	Reciprocating Compressors; Rotary Compressors; Centrifugal Compressors (Only Theory).	2	15%
	Evaporators; Condensers; Liquid Chillers and Secondary Refrigerants; Sizing of Evaporators and Condensers; Expansion Devices (Only Theory).	4	
IV	Psychrometry and HVAC Processes- Dry-Bulb Temperature; Wet-Bulb Temperature; Dew Point Temperature; Relative Humidity; Humidity Ratio; Specific Volume; Enthalpy; Calculation of Properties of Air-Water Vapor Mixtures; The Psychrometric Chart; HVAC Processes.	6	15%
	SECOND INTERNAL EXAM		
V	Cooling and Heating Load Calculations: Design Conditions; Components of the Cooling and Heating Load; Thermal Transmission Load; Ventilation and Infiltration Load; Solar Load; Equipment and Lighting Load; Occupant Load; Product Load; Heating and Cooling Load Sizing.	9	20%
VI	HVAC Systems and Components; Single Zone System; Multiple Zone Systems; Terminal Reheat System; Dual Duct System; Variable Air Volume Systems; Water Systems; Unitary Systems; Cargo Hold Dehumidification Systems; HVAC System Components; System Testing and Balancing; Absorption Systems; Multi-Pressure Systems; Low-Temperature Systems (Only Theory).	9	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration: 3 hours

PART A

- Answer all 8 questions of 3 marks each.
- 1 question each from modules I to IV and 2 questions each from modules V & VI.

PART B

- Answer any 2 full questions out of 3 for each module.
- Each question from module I to IV carries 6 marks.
- Each question from module V & VI carries 7 marks.
- Each full question can have maximum of 4 sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
SB465	DESIGN OF FISHING VESSELS	3-0-0-3	2016

Prerequisite: Nil

Course Objectives:

- To impart basic knowledge on the design and construction of fishing vessels.
- To impart knowledge on the performance characteristics of fishing vessels.
- To familiarize with characteristics of fish ground and fishing gears.

Syllabus:

Introduction to Fishing Vessel Design, Classification of Fishing Vessels, Fish Production in India, Fishery, Fishing Techniques; Design Procedure of Fishing Vessels , Estimation of Main Dimensions, General Arrangement, Propulsion System, Seakeeping and Maneuvering Considerations, Fish Holds and Preservation Facilities, Protection of Fishing Vessels from Corrosion and Biofouling.

Expected Outcome:

Upon successful completion of the course, the student will be able to:

i. Understand the functions and setup organization for fishing.
ii. Understand the traditional fishing techniques and recent developments in fishing.
iii. List main parameters of fishing vessels and understand the design sequence of vessel.
iv. Fix main dimension of fishing vessels taking into special consideration of Sea keeping/Maneuvering performance of fishing vessel.
v. Classify various materials used in construction of fishing vessel and its application.
vi. Understand fundamentals of preservation of fish, and protection of vessel from corrosion and biofouling.

Text Books:

1. Dag Pike; Fishing Boats and Their Equipment, Wiley Pub, 1992.
2. John F. Fyson; Design of Small Fishing Vessels; Food and Agriculture Organization of the United Nations.
3. John F. Fyson; Fishing Boat Designs- 3 Small Trawlers, Issues 188-191, Food and Agriculture Organization of the United Nations, 1980.

Reference Books:

- Meenakumari, B., Boopendranath, M.R., Pravin, P., Thomas, S.N. and Edwin, L.; Handbook of Fishing Technology, (Eds) (2009) Central Institute of Fisheries Technology, Cochin.

Course Plan

Module	Content	Hours	Sem. Exam Marks
I	**Introduction to Fishing Vessel Design**: Definitions of Fishing Vessel; Special Features of Fishing Vessels; Regulations For The Safety of Fishing Vessels.	3	15%
	Classification of Fishing Vessels; Fish Production in India; Organizational Setup and Shore Facilities; Fisheries Organizations. and Activities; Administrative Systems on Fishing Vessels.	4	

II	**Fishery:** Characteristics of Fish Ground, Fishing Gear and Methods, Drift Net, Long Line, Drag Net, Siene Net, Dredging, Electric Light Harpoon/Whale Catching Trawling (Side And Stern Trawlers, Single and Pair Trawling, Pelagic & Bottom Trawling), Dressing, Processing and Freezing.	7	15%
FIRST INTERNAL EXAM			
III	**Design Procedure of Fishing Vessels:** Owner's Specifications, Economy, Fuel Efficiency, Hull Form, Investment Cost Operating Revenues and Costs.	6	15%
IV	Estimation of Main Dimensions, Space Requirement of Whole Ship, Arrangement of Fish Holds and General Arrangement, Propulsion Systems, Equipments for Fish Finding, Seakeeping and Maneuvering Considerations.	8	20%
SECOND INTERNAL EXAM			
V	**Material and Construction Methods:** Mechanical Properties of Materials, Comparison of Hulls of Different Material; Type of Construction; Details of Steel Construction; Construction Methods Using FRP/GRP, Aluminium, Ferrocement.	7	20%
VI	**Fish Holds and Preservation Facilities:** Insulation Materials and Properties; Methods of Fish Preservation; Protection of Fishing Vessels from Corrosion and Biofouling.	7	15%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration: 3 hours

PART A

- Answer all 8 questions of 3 marks each.
- 1 question each from modules I to IV and 2 questions each from modules V & VI.

PART B

- Answer any 2 full questions out of 3 for each module.
- Each question from module I to IV carries 6 marks.
- Each question from module V & VI carries 7 marks.
- Each full question can have maximum of 4 sub questions, if needed.

Course code	Course Name:	L-T-P-Credits	Year of Introduction
SB466	OCEAN WAVE HYDRODYNAMICS	3-0-0-3	2016

Prerequisite : Nil

Course Objectives:

- To provide a basic understanding of small amplitude wave motion, wave loads and wave deformations.
- To introduce the finite amplitude wave theories.
- To introduce the concept of random waves.

Syllabus:

Introduction- Continuity equation-Velocity Potential- Euler's Equation of Motion- Bernoulli Equation- Wave Motion- Dispersion relationship- Fluid Particle Kinematics- Pressure Distribution Under Progressive Waves- Wave Energy & Power- Wave Loads- Morrison Equation- Froude Krylov Forces- Diffraction Regime-Wave Deformation- Wave Breaking- Finite Amplitude Waves- Stokes, Cnoidal & Solitary Waves-Random Waves- Analysis of Ocean Waves- Wave Spectrum.

Expected Outcome:

Upon successful completion of the course, the student shall be able to:

i. Derive the velocity potential and determine wave parameters from given data.
ii. Apply knowledge of water particle kinematics under a small amplitude wave and solve simple problems.
iii. Describe the pressure distribution under small amplitude waves and solve simple problems.
iv. Determine the force regime to be considered for wave load calculations.
v. Solve simple problems pertaining to wave loads on different cylinder configurations.
vi. Demonstrate understanding of Froude –Krylov force and the diffraction regime.
vii. Demonstrate understanding of wave deformation and wave breaking and solve simple problems.
viii. Demonstrate understanding of finite amplitude waves and the associated wave theory.
ix. Demonstrate understanding of the concept of random waves and wave spectra.

Text Books:

1. D. Sundar; Course Notes on Wave Hyrdodynamics ; Associated NPTEL Videos; IIT-Madras.
2. Robert G. Dean, Robert A. Dlarymple; Water Wave Mechanics of Engineers and Scientists; Allied Publishers Limited.

Data Book (Approved for use in the examination): Wave Data Book.

Reference Books:

1. Daugherty R.L, Franzini J.B and Finneemore E.J; Fluid Mechanics with Engineering Applications; McGraw Hill.
2. Prof. Alexandra Techet; Hydrodynamics (13.012); MIT Open Courseware.
3. Sir Horace Lamb; Hyrdodynamics; University Press.

Course Plan			
Module	**Content**	**Hours**	**Sem. Exam Marks**
I	**Basics:** Introduction; *Types of flow*; Continuity Equation and Conservation of Mass; Forces Acting on Fluids in Motion; Euler's Equation of Motion; Path lines and Streamlines; Velocity Potential; Stream Function; Bernoulli Equation (Theory Only).	6	15%
II	**Wave Motion :** *Classification of Waves*; Derivation of the Velocity Potential; Dispersion Relationship; Celerity in Different Water Depth Conditions; Local Fluid Particle Velocities and Acceleration Under Progressive Waves; Water Particle Displacement Under Progressive Waves; Pressure Distribution Under Progressive Waves; Group Celerity; Wave Energy; Wave Power; Simple Problems on Wave Motion.	10	15%
FIRST INTERNAL EXAM			
III	**Wave Loads:** Force Regimes; Design Wave Approach; Morison Equation- Fixed Cylinder in Waves, Fixed Cylinder in Waves and Current, Flexible Cylinder in Waves, Wave Forces on an Inclined Cylinder, Wave Force on a Vertical Cylinder in Deep water, Wave Forces on Piles in Shallow Water, Submarine Pipelines; Froude-Krylov Forces; Diffraction Regime; Simple Problems on Wave Loads.	10	15%
IV	**Wave Deformation:** Wave Refraction; Wave Diffraction; Wave Breaking- Types of Wave Breaking; Waves on Currents; Simple Problems on Wave Deformation.	4	15%
SECOND INTERNAL EXAM			
V	**Finite Amplitude Waves:** Stoke's Wave Theory- Comparison Between Wave Theories; Solitary Wave Theory; Cnoidal Wave Theory; Stream Function Theory; Simple Problems on Finite Amplitude Waves.	6	20%
VI	**Random Waves:** *Generation of Ocean Waves*; Importance of Study of Wave Data; *Collection of Wave Data*; Analysis of Ocean Waves- Statistical Method, Spectral Method, Fast Fourier Transform Method; Irregular Sea Way- Wave-Wave Spectrum Relationship (Theory Only).	6	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration: 3 hours

PART A

- Answer all 8 questions of 3 marks each.
- 1 question each from modules I to IV and 2 questions each from modules V & VI.

PART B

- Answer any 2 full questions out of 3 for each module.
- Each question from module I to IV carries 6 marks.
- Each question from module V & VI carries 7 marks.
- Each full question can have maximum of 4 sub questions, if needed.

Course code	Course Name:	L-T-P-Credits	Year of Introduction
SB467	COMPUTER AIDED SHIP DESIGN	3-0-0-3	2016

Prerequisite : Nil

Course Objectives:

- To give an overview of 2D & 3D operations performed by CAD software.
- To introduce the concept of parametric curve representation, curve fitting and curve fairing.
- To introduce concepts of surface representation in CAD.
- To provide an overview of computer aided ship design

Syllabus:

Introduction- Computer as a Design Medium- Software Tools- Programming Languages for CAD- 2D Transformations- Transformation of Points & Lines- 3D Transformations- Curve Representation- Non Parametric & Parametric Curves- Plane Curves- Space Curves- Cubic Splines- Bezier & B-Spline Curves- Surface Representation- Computer Aided Ship Design- Geometric Modelling and Hull Form Fairing- Rapid Prototyping- Computer Aided Welding Design & Analysis- Welding Robots.

Expected Outcome:

Upon successful completion of the course, the student shall be able to:

i. Demonstrate an understanding of, and appreciate the advantages of the computer aided design process.
ii. Differentiate between the various types of modelling in CAD.
iii. Demonstrate awareness of major Naval Architecture software packages used in the industry.
iv. Demonstrate basic understanding of 2D and 3D transformations.
v. Appreciate the mathematical representation of plane curves in parametric form and solve simple problems.
vi. Demonstrate an understanding of curve fitting and curve fairing techniques and solve simple problems.
vii. Demonstrate an understanding of surface representation in CAD.
viii. Demonstrate an understanding of the application of computers in ship design.

Text Books:

1. Roger, D.F &Adams, J.A., Mathematical Elements of Computer Graphics; McGraw Hill International Editions.
2. Vera B. Anand; Computer Graphics and Geometric Modelling for Engineers; John Wiley & Sons Inc.

Reference Books:

1. Donald Hearn, Pauline M. Baker; Computer Graphics; Prentice Hall.
2. Horst Nowacki; Journal Paper: Computer Aided Ship Design; Elsevier.
3. Krishnamoorthy, C.S, Rajeev S.; Computer Aided Design-Software and Analytical Tools; Narosa Publishing House.
4. O.P Khanna; Welding Technology; Dhanpat Rai.
5. Tien-Chien Chang, Richard A. Wysk, Hsu-Pin Wang; Computer Aided Manufacturing; Pearson.

Course Plan:			
Module	**Content**	**Hours**	**Sem. Exam Marks**
I	**Computer Aided Design & Drafting:** Overview, Engineering Design, Designer Vs Computer; Computer as Design Medium, Software Tools, Analytical Tools, Development of CAD Software, Programming Languages for CAD.	6	15%
II	**Two Dimensional Transformations:** Transformation of Points and Lines-Scaling, Reflection, Shearing, Rotation, Translation & Homogenous Co-ordinates, Combined Transformations. **Three Dimensional Transformations:** Scaling, Shearing, Reflection, Rotation, Translation, Multiple Transformations, Projections-Orthographic, Axonometric, Oblique & Perspective.	5	15%
FIRST INTERNAL EXAM			
III	**Curve Representation:** Non Parametric & Parametric Curves; Plane Curves- Circle, Ellipse, Hyperbola, Parabola; Space Curves- Cubic Spline, Analogy with the Draughtsman's Spline, Matrix Representation, Blending Functions, End Conditions; Bezier Curves; B Spline Curves.	9	15%
IV	**Surface Representation:** Surface of Revolution; Sweep Surfaces; Piecewise Surface Representation; Bilinear Surfaces; Ruled and Developable Surfaces; Bezier and B Spline Surfaces.	9	15%
SECOND INTERNAL EXAM			
V	**Computer Aided Ship Design:** Developments in the field of Computer Aided Ship Design; Systems Analysis Approach; Optimisation and Non Linear Programming; Principal Characteristics; Geometric Modelling and Hull form Fairing; Application in Ship Structural Analysis and Design.	7	20%
VI	**Rapid Prototyping:** Introduction; Design Modelling for Rapid Prototyping; Choosing a System. **Computer Aided Welding:** Computer Aided Welding Analysis; Computer Aided Welding Design; Welding Robots; Application in Ship building.	6	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration: 3 hours

PART A

- Answer all 8 questions of 3 marks each.
- 1 question each from modules I to IV and 2 questions each from modules V & VI.

PART B

- Answer any 2 full questions out of 3 for each module.
- Each question from module I to IV carries 6 marks.
- Each question from module V & VI carries 7 marks.
- Each full question can have maximum of 4 sub questions, if needed.

Course code	Course Name:	L-T-P-Credits	Year of Introduction
SB468	FINITE ELEMENT METHODS	3-0-0-3	2016

Prerequisite : Nil

Course Objectives:

- To learn the mathematical background of finite element analysis.
- To solve structural mechanics problems using finite element approach.
- To apply finite element method in analysis of ship structures.

Syllabus:

Introduction to Concept of Finite Element Method; Mathematical Background of Finite Element Method; Representing Various Unknowns Using Shape Functions; Derivation of Stiffness Matrix; Computer Implementation of Finite Element Method; Numerical Methods for the Evaluation of Various Property Matrices; Dynamic Analysis; Formulation of Thin and Thick Plate Element for the Analysis of Ship Structures; Static and Free Vibration Analysis of Offshore Jacket Structures.

Expected Outcome:

Upon successful completion of the course, the student will be able to:

i. Understand the concept of finite element method.
ii. Understand the concept of shape functions, elements and the property matrices.
iii. Analyze simple structures using finite element method.
iv. Understand the concept of dynamic finite element analysis.
v. Appreciate the application of finite element method in analysis offshore and ship structures.

Text Books:

1. C.S.Krishnamoorthy; Finite Element Analysis; TMH New Delhi.
2. O.C.Zienkiewicz; Finite Element Method, Fourth Edition; Mc Graw Hill.
3. R.D.Cook; Concepts and Application of FE Analysis; John Wiley & Sons.

Reference Books:

1. J.N. Reddy; Introduction to Finite element Method, McGraw-Hill.
2. K.J. Bathe; Finite Element Procedure in Engineering Analysis; Prentice Hall.
3. S. Rajasekaran; Finite Element Analysis; Wheeler publishing Company.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Introduction to Finite Element Method- Scope of Finite Element Method in Analysis of Structures.	1	15%
	Historical Development of Finite element – General Steps in Finite Element Procedures.	1	
	Variational Formulations and Weighted Residual Method- The Strong Form and Weak Form Concept.	4	
II	Shape functions- Piecewise Polynomial Functions, Lagranges's Interpolation Function, Hermition Interpolation Function, Serendipity Function.	2	15%
	General Steps in the Formulation of Element Stiffness Matrix.	1	

	Equilibrium and Compatibility Conditions, Convergence Criteria.	1	
	Derivation of Element Stiffness Matrix for Truss, Beam, Plane Stress, Plane Strain and Axisymmetric Elements.	5	
FIRST INTERNAL EXAM			
III	Isoparametric Formulation of Element Stiffness Matrices- Bar Element, Rectangular and Triangular Plane Stress Elements.	3	15%
	Computer Implementation of FEM- Numerical Methods for the Derivation of Element Stiffness Matrices, Gauss Quadrature.	2	
	Static Condensation, Element Instabilities, Parasitic Shear.	2	
IV	Ship Structural Analysis Using FEM.	1	15%
	Formulation of Plate Finite Elements- Kirchhoff Plate Element, Mindlin Plate Element.	3	
	Numerical Examples on Simple Plate Analysis.	2	
	One Dimensional and Two Dimensional Finite Element Modeling of Ship Structure.	2	
SECOND INTERNAL EXAM			
V	Finite Elements in Dynamics and Vibrations-Dynamic Equations.	1	20%
	Mass and Damping Matrices- Consistent and Lumped Matrices.	2	
	Natural Frequencies and Mode Shapes- Eigen solution.	3	
VI	Analysis of Offshore Jacket Structures Using FEM-Static and Free Vibration Analysis Including Foundation.	3	20%
	Analysis of Jack-up Structures Using Stick Model; Numerical Examples of Simplified Structures.	3	
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration: 3 hours

PART A

- Answer all 8 questions of 3 marks each.
- 1 question each from modules I to IV and 2 questions each from modules V & VI.

PART B

- Answer any 2 full questions out of 3 for each module.
- Each question from module I to IV carries 6 marks.
- Each question from module V & VI carries 7 marks.
- Each full question can have maximum of 4 sub questions, if needed.