SEMESTER VII

SBT401	SHIP DESIGN- II	CATEGORY	L	T	P	CREDIT
		PCC	2	1	0	3

Preamble: The course is designed to provide an understanding of design methodologies and the components of the ship design process to students. Other objectives are to impart knowledge on importance of safety considerations within the ship design process and its impact on operational considerations and also application of design tools.

Prerequisite: SB301 SHIP DESIGN-I

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the rules and regulation and apply the methodology and tools used in the ship design process and to develop general arrangement of ship.
CO 2	Acquire the knowledge for safe design and operation of cargo handling, Anchor and mooring arrangements within the ship design process.
CO 3	Identify and apply statutory regulations and classification rules in providing accommodation and access.
CO 4	Convey the knowledge of lightings and other signal arrangements meeting statutory regulations and classification rules.
CO 5	Demonstrate knowledge and understanding of various fire protection arrangements and other supporting equipments.
CO 6	Discern information's of Life-saving and Fire-fighting arrangements for a new ship design meeting regulations.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3		1									3
CO 2	3		2		1	1			2	1		3
CO 3	3		2		1	1			2	1		3
CO 4	3		2		1	3	1		2	1		3
CO 5	3		2		1	3	1		2	1		3
CO 6	3		2		1	3	1		2	1		3

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	30
Apply	20	20	60
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 3 questions from each module of which student should answer any two. Each question can have maximum 3 sub-divisions and carry 7 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What are the goals and objectives of standardisation in shipbuilding sector?
2. What are the five important instruments of IMO?
3. Write down the classification of ship building standard based on level of implementation.

Course Outcome 2 (CO2):

1. What are the environmental conditions where we can operate the anchor system of ship?
2. What is equipment number? What is its significance?
3. Draw a sketch showing the anchoring arrangement of a ship clearly indicating the layout of anchor windlass/capstan, hawse pipe, naval/spurting pipe, chain locker, cable stopper etc.

Course Outcome 3 (CO3):

1. What are the three vital parts of load line marking and how it should be?
2. What is the requirement for the accommodation spaces of master in a ship as per MLC?
3. Where should be the location of accommodation spaces in ships as per MLC? If there

any exceptions from standards means what are they?

Course Outcome 4 (CO4):

1. What are the different types of masts? Explain with sketches.
2. Draw the schematic diagram of steering gear compartments.
3. Explain the navigational lights on board with neat sketches.

Course Outcome 5 (CO5):

1. Explain the working of sounding pipe with a neat diagram.
2. Explain the underwater paint scheme of ships.
3. Describe HVAC system components on ships.

Course Outcome 6 (CO6):

1. What are the characteristics of rocket parachute flares used in ships?
2. Explain about different life saving appliances in ships
3. Describe with sketches, the division of the ship into main vertical and horizontal zones with structural and thermal boundaries.

Model Question Paper

APJ Abdul Kalam Technological University
Seventh Semester B.Tech Degree Examination
SBT401 SHIP DESIGN II

PART A

Answer ALL questions. Each question carries 3 marks.

(3x10 = 30Marks)

1. Differentiate between conventions, protocols and amendments in IMO.
2. Differentiate between international standards and national standards in ship building industry with example.
3. What are the reasons for choosing stockless anchors in ship building industry instead of stock anchors?
4. What are the environmental conditions where we can operate the anchor system of ship?
5. What are the importances's of marking load lines in ships?
6. List down various types of hatches and doors in ships.
7. What are the advantages of using sound signals in ships?
8. Differentiate between directed spray mast cleaning and impingement cleaning of tank.
9. Differentiate between life buoy with line and life buoy with light
10. What is fire retardant bulkhead and how it is classified?

PART B

Answer any two complete questions from each module.

MODULE I

(7x2=14 Marks)

11. Explain the five important instruments of IMO?
12. Explain the classification of ship building standard based on level of implementation
13. Explain the classification of ship building standard based on function

MODULE II

(7x2 = 14 Marks)

14. (a) Draw a sketch showing the anchoring arrangement of a ship clearly indicating layout of anchor windlass/capstan, hawse pipe, naval/spurting pipe, chain locker, cable stopper etc
    (b) Draw a sketch showing the different part of stockless anchor
15. (a) List the various categories of cargo carried in ships and indicate the various types of cargo handling equipment suitable for each category
    (b) What are the specialities of Danforth anchor and where it is used?
16. (a) Explain the different components and its functions of mooring system in ships
    (b) Why the mooring system in ships is important?

MODULE III

(7x2=14 Marks)

17. Explain the different types of freeboard in ships
18. What is load line? What is its importance? Draw a sketch showing standard load line marking of ship
19. (a) What is the requirement for the accommodation spaces of master in a ship as per MLC?
    (b) Where should be the location of accommodation spaces in ships as per MLC? If there any exceptions from standards means what are they?

MODULE IV

(7x2=14 Marks)

20. What are different types of masts? Explain with sketches.
21. Draw the schematic diagram of steering gear compartment
22. Explain the navigational lights on board with neat sketches.

MODULE V

(7x2=14 Marks)

23. Describe HVAC system components on ships.
24. Explain about different life saving appliances in ships.
25. Explain the underwater paint scheme of ships.

SYLLABUS

Module – I

Standardization: Process and Product Standard; Rules and Regulations.

Module – II

Cargo Handling Equipments: Cargo Hatches, Lifting Devices.

Anchor Installations: Types of Anchors, Anchor Handling System, Anchor Chain & Storage.

Mooring Systems: Deck Fittings & Structural Arrangement, Mooring Machinery, Mooring Operations.

Module – III

Accommodation: Crew Size, Accommodation Standards, Space Allocation, Habitability, Access, Materials, Standardisation and Modular Arrangement.

Access Equipments: Hatches, Manholes, Doors, Other Closing & Opening Devices, Load Line Rules, Gangways and Ladders.

Module – IV

Steering Gear: Types, Design Aspects, Connections.

Mast & Riggings: Railings & Awnings; Sound and Light Signals.

Equipments in Tanks & Holds: Air Vents, Sounding Tubes, Cleaning Devices, Fire Protection Devices.

Module –V

Life-saving System: Life Saving Equipments, International Rules.

Fire-fighting Systems: Rules and Regulations, Equipment, Fire Fighting methods Ventilation, Paneling, Deck Covering & Painting.

Text Books

1. D.G.M. Watson; Practical Ship Design; Elsevier Ocean Engineering Book Series 2002.
2. Robert Taggart; Ship Design & Construction; SNAME,1980

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 & Construction, SNAME, 2003

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Module – I**	
1.1	**Standardization**: Process and Product Standard; Rules and Regulations.	7
2	**Module – II**	
2.1	**Cargo Handling Equipments**: Cargo Hatches, Lifting Devices.	2
2.2	**Anchor Installations**: Types of Anchors, Anchor Handling System, Anchor Chain & Storage.	2
2.3	**Mooring Systems**: Deck Fittings & Structural Arrangement, Mooring Machinery, Mooring Operations.	3
3	**Module – III**	
3.1	**Accommodation**: Crew Size, Accommodation Standards, Space Allocation, Habitability, Access, Materials, Standardisation and Modular Arrangement.	3
3.2	**Access Equipments**: Hatches, Manholes, Doors, Other Closing & Opening Devices, Load Line Rules, Gangways and Ladders.	4
4	**Module – IV**	
4.1	**Steering Gear**: Types, Design Aspects, Connections	2
4.2	**Mast & Riggings**: Railings & Awnings; Sound and Light Signals.	2
4.3	**Equipments in Tanks & Holds**: Air Vents, Sounding Tubes, Cleaning Devices, Fire Protection Devices.	3
5	**Module – V**	
5.1	**Life-saving System**: Life Saving Equipments, International Rules.	3
5.2	**Fire-fighting Systems**: Rules and Regulations, Equipment, Fire Fighting methods	3
5.3	Ventilation, Paneling, Deck Covering & Painting.	2

SBL411	MARINE ENGINEERING LAB	CATEGORY	L	T	P	CREDIT
		PCC	0	0	3	2

Preamble: This lab is mainly focused to provide a basic training on the testing of a marine IC engine performance and introduce engine room machinery.

Prerequisite: SBT306 Marine Engineering.

Course Outcomes: After the completion of the course the student will be able to:

CO 1	Explain the importance of various machinery parts.
CO 2	Familiar with various machineries used in the ship.
CO 3	Dismantle & Assemble Various Marine Auxiliary Machineries.
CO 4	Analyse the results to understand the performance characteristics of engines.
CO 5	Learn about the advanced technologies and research areas in engines.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2			1							1
CO 2	3	2		1	2							1
CO 3	3	2		1	2							1
CO 4	3	2		1	2							1
CO 5	3	2		1	2							1

Assessment Pattern

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	75	75	2.5 hours

Continuous Internal Evaluation Pattern:

Attendance : 15 marks
Continuous Assessment : 30 marks
Internal Test (Immediately before the second series test) : 30 marks

End Semester Examination Pattern: The following guidelines should be followed regarding award of marks

(a) Preliminary work : 15 Marks
(b) Implementing the work/Conducting the experiment : 10 Marks
(c) Performance, result and inference (usage of equipments and trouble shooting) : 25 Marks
(d) Viva voce : 20 marks
(e) Record : 5 Marks

General instructions: Practical examination to be conducted immediately after the second series test covering entire syllabus given below. Evaluation is a serious process that is to be conducted under the equal responsibility of both the internal and external examiners. The number of candidates evaluated per day should not exceed 20. Students shall be allowed for the University examination only on submitting the duly certified record. The external examiner shall endorse the record.

SYLLABUS

LIST OF 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/ Centrifugal Pump/ Screw Pump
    Equipment: Reciprocating Pump/ Centrifugal Pump/ Screw Pump.

16. Overhauling of Diesel Engines
    Equipment: Four Stroke Horizontal Diesel Engine.

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

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

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

20. Study of Cold starting of diesel engines techniques
    Equipment: Diesel Engine.

TEXT BOOKS

1. Harrington; Marine Engineering, SNAME Publications, 1992.
2. Taylor, C. Fayette, and Edward S. Taylor; The Internal Combustion Engine; International Textbook Company, 1985.

SBQ413	SEMINAR	CATEGORY	L	T	P	CREDIT
		PWS	0	0	3	2

Preamble: The course 'Seminar' is intended to enable a B.Tech graduate to read, understand, present and prepare report about an academic document. The learner shall search in the literature including peer reviewed journals, conference, books, project reports etc., and identify an appropriate paper/thesis/report in her/his area of interest, in consultation with her/his seminar guide. This course can help the learner to experience how a presentation can be made about a selected academic document and also empower her/him to prepare a technical report.

Course Objectives:

- To do literature survey in a selected area ofstudy.
- To understand an academic document from the literate and to give a presentation about it.
- To prepare a technical report.

Course Outcomes [COs] : After successful completion of the course, the students will be able to:

CO1	Identify academic documents from the literature which are related to her/his areas of interest (Cognitive knowledge level: **Apply**).
CO2	Read and apprehend an academic document from the literature which is related to her/ his areas of interest (Cognitive knowledge level: **Analyze**).
CO3	Prepare a presentation about an academic document (Cognitive knowledge level: **Create**).
CO4	Give a presentation about an academic document (Cognitive knowledge level: **Apply**).
CO5	Prepare a technical report (Cognitive knowledge level: **Create**).

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1		2	1					3
CO2	3	3	2	3		2	1					3
CO3	3	2			3			1		2		3
CO4	3				2			1		3		3
CO5	3	3	3	3	2	2		2		3		3

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work
PO4	Conduct investigations of complex problems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Life long learning

General Guidelines

- The Department shall form an Internal Evaluation Committee (IEC) for the seminar with academic coordinator for that program as the Chairperson/Chairman and seminar coordinator & seminar guide as members. During the seminar presentation of a student, all members of IEC shall be present.
- Formation of IEC and guide allotment shall be completed within a week after the University examination (or last working day) of the previous semester.
- Guide shall provide required input to their students regarding the selection of topic/ paper.
- Choosing a seminar topic: The topic for a UG seminar should be current and broad based rather than a very specific research work. It's advisable to choose a topic for the Seminar to be closely linked to the final year project area. Every member of the project team could choose or be assigned Seminar topics that covers various aspects linked to the Project area.
- A topic/paper relevant to the discipline shall be selected by the student during the semester break.
- Topic/Paper shall be finalized in the first week of the semester and shall be submitted to the IEC.
- The IEC shall approve the selected topic/paper by the second week of the semester.
- Accurate references from genuine peer reviewed published material to be given in the report and to be verified.

Evaluation pattern

Total marks: 100, only CIE, minimum required to pass 50

Seminar Guide: 20 marks (Background Knowledge – 10 (The guide shall give deserving marks for a candidate based on the candidate's background knowledge about the topic selected), Relevance of the paper/topic selected – 10).

Seminar Coordinator: 20 marks (Seminar Diary – 10 (Each student shall maintain a seminar diary and the guide shall monitor the progress of the seminar work on a weekly basis and shall approve the entries in the seminar diary during the weekly meeting with the student), Attendance – 10).

Presentation: 40 marks to be awarded by the IEC (Clarity of presentation – 10, Interactions – 10 (to be based on the candidate's ability to answer questions during the interactive session of her/his presentation), Overall participation – 10 (to be given based on her/his involvement during interactive sessions of presentations by other students), Quality of the slides – 10).

Report: 20 marks to be awarded by the IEC (check for technical content, overall quality, templates followed, adequacy of references etc.).

SBD415	PROJECT PHASE I	CATEGORY	L	T	P	CREDIT
		PWS	0	0	6	2

Preamble: The course 'Project Work' is mainly intended to evoke the innovation and invention skills in a student. The course will provide an opportunity to synthesize and apply the knowledge and analytical skills learned, to be developed as a prototype or simulation. The project extends to 2 semesters and will be evaluated in the 7th and 8th semester separately, based on the achieved objectives. One third of the project credits shall be completed in 7th semester and two third in 8th semester. It is recommended that the projects may be finalized in the thrust areas of the respective engineering stream or as interdisciplinary projects. Importance should be given to address societal problems and developing indigenous technologies.

Course Objectives

- To apply engineering knowledge in practical problem solving.
- To foster innovation in design of products, processes or systems.
- To develop creative thinking in finding viable solutions to engineering problems.

Course Outcomes [COs] : After successful completion of the course, the students will be able to:

CO1	Model and solve real world problems by applying knowledge across domains (Cognitive knowledge level: **Apply**).
CO2	Develop products, processes or technologies for sustainable and socially relevant applications (Cognitive knowledge level: **Apply**).
CO3	Function effectively as an individual and as a leader in diverse teams and to comprehend and execute designated tasks (Cognitive knowledge level: **Apply**).
CO4	Plan and execute tasks utilizing available resources within timelines, following ethical and professional norms (Cognitive knowledge level: **Apply**).
CO5	Identify technology/research gaps and propose innovative/creative solutions (Cognitive knowledge level: **Analyze**).
CO6	Organize and communicate technical and scientific findings effectively in written and oral forms (Cognitive knowledge level: **Apply**).

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	1	2	2	2	1	1	1	1	2
CO2	2	2	2		1	3	3	1	1		1	1
CO3									3	2	2	1
CO4					2			3	2	2	3	2
CO5	2	3	3	1	2							1
CO6					2			2	2	3	1	1

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work
PO4	Conduct investigations of complex problems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Lifelong learning

PROJECT PHASE I

Phase 1 Target

- Literature study/survey of published literature on the assigned topic
- Formulation of objectives
- Formulation of hypothesis/ design/ methodology
- Formulation of work plan and task allocation.
- Block level design documentation
- Seeking project funds from various agencies
- Preliminary Analysis/Modeling/Simulation/Experiment/Design/Feasibility study
- Preparation of Phase 1 report

Evaluation Guidelines & Rubrics

Total: 100 marks (Minimum required to pass: 50 marks).

- Project progress evaluation by guide: 30 Marks.
- Interim evaluation by the Evaluation Committee: 20 Marks.
- Final Evaluation by the Evaluation Committee: 30 Marks.
- Project Phase - I Report (By Evaluation Committee): 20 Marks.

(The evaluation committee comprises HoD or a senior faculty member, Project coordinator and project supervisor).

Evaluation by the Guide

The guide/supervisor shall monitor the progress being carried out by the project groups on a regular basis. In case it is found that progress is unsatisfactory it shall be reported to the Department Evaluation Committee for necessary action. The presence of each student in the group and their involvement in all stages of execution of the project shall be ensured by the guide. Project evaluation by the guide: 30 Marks. This mark shall be awarded to the students in his/her group by considering the following aspects:

Topic Selection: innovativeness, social relevance etc. (2)

Problem definition: Identification of the social, environmental and ethical issues of the project problem. (2)

Purpose and need of the project: Detailed and extensive explanation of the purpose and need of the project. (3)

Project Objectives: All objectives of the proposed work are well defined; Steps to be followed to solve the defined problem are clearly specified. (2)

Project Scheduling & Distribution of Work among Team members: Detailed and extensive Scheduling with timelines provided for each phase of project. Work breakdown structure well defined. (3)

Literature survey: Outstanding investigation in all aspects. (4)

Student's Diary/ Daily Log: The main purpose of writing daily diary is to cultivate the habit of documenting and to encourage the students to search for details. It develops the students' thought process and reasoning abilities. The students should record in the daily/weekly activity diary the day to day account of the observations, impressions, information gathered and suggestions given, if any. It should contain the sketches & drawings related to the observations made by the students. The daily/weekly activity diary shall be signed after every day/week by the guide. (7)

Individual Contribution: The contribution of each student at various stages. (7)

EVALUATION RUBRICS for PROJECT Phase I: Interim Evaluation						
No.	**Parameters**	**Marks**	**Poor**	**Fair**	**Very Good**	**Outstanding**
1-a	Topic identification, selection, formulation of objectives and/or literature survey. (Group assessment) [CO1]	10	The team has failed to come with a relevant topic in time. Needed full assistance to find a topic from the guide. They do not respond to suggestions from the evaluation committee and/or the guide. No literature review was conducted. The team tried to gather easy information without verifying the authenticity. No objectives formed yet.	The team has identified a topic. The originally selected topic lacks substance and needs to be revised. There were suggestions given to improve the relevance and quality of the project topic. Only a few relevant references were consulted/ studied and there is no clear evidence to show the team's understanding on the same. Some objectives identified, but not clear enough.	Good evidence of the group thinking and brainstorming on what they are going to build. The results of the brainstorming are documented and the selection of topic is relevant. The review of related references was good, but there is scope of improvement. Objectives formed with good clarity, however some objectives are not realistic enough.	The group has brainstormed in an excellent manner on what they were going to build. The topic selected is highly relevant, real world problem and is potentially innovative. The group shows extreme interest in the topic and has conducted extensive literature survey in connection with the topic. The team has come up with clear objectives which are feasible.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)
1-b	Project Planning, Scheduling and Resource/ Tasks Identification and allocation. (Group assessment) [CO4]	10	No evidence of planning or scheduling of the project. The students did not plan what they were going to build or plan on what materials / resources to use in the project. The students do not have any idea on the budget required. The team has not yet decided on who does what. No project journal kept.	Some evidence of a primary plan. There were some ideas on the materials /resources required, but not really thought out. The students have some idea on the finances required, but they have not formalized a budget plan. Schedules were not prepared. The project journal has no details. Some evidence on task allocation among the team members.	Good evidence of planning done. Materials were listed and thought out, but the plan wasn't quite complete. Schedules were prepared, but not detailed, and needs improvement. Project journal is presented but it is not complete in all respect / detailed. There is better task allocation and individual members understand about their tasks. There is room for improvement.	Excellent evidence of enterprising and extensive project planning. Gantt charts were used to depict detailed project scheduling. A project management/version control tool is used to track the project, which shows familiarity with modern tools. All materials / resources were identified and listed and anticipation of procuring time is done. Detailed budgeting is done. All tasks were identified and incorporated in the schedule. A well-kept project journal shows evidence for all the above, in addition to the interaction with the project guide. Each member knows well about their individual tasks.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)
Phase 1 Interim Evaluation Total Marks: 20						

EVALUATION RUBRICS for PROJECT Phase I: Final Evaluation						
Sl. No.	**Parameters**	**Marks**	**Poor**	**Fair**	**Very Good**	**Outstanding**
1-c	Formulation of Design and/or Methodology and Progress. (Group assessment) [CO1]	5	None of the team members show any evidence of knowledge about the design and the methodology adopted till now/ to be adopted in the later stages. The team has not progressed from the previous stage of evaluation.	The students have some knowledge on the design procedure to be adopted, and the methodologies. However, the team has not made much progress in the design, and yet to catch up with the project plan.	The students are comfortable with design methods adopted, and they have made some progress as per the plan. The methodologies are understood to a large extent.	Shows clear evidence of having a well- defined design methodology and adherence to it. Excellent knowledge in design procedure and its adaptation. Adherence to project plan is commendable.
			(0 – 1 Marks)	(2 – 3 Marks)	(4 Marks)	(5 Marks)
1-d	Individual and Teamwork Leadership (Individual assessment) [CO3]	10	The student does not show any interest in the project activities, and is a passive member.	The student show some interest and participates in some of the activities. However, the activities are mostly easy and superficial in nature.	The student shows very good interest in project, and takes up tasks and attempts to complete them. Shows excellent responsibility and team skills. Supports the other members well.	The student takes a leadership position and supports the other team members and leads the project. Shows clear evidence of leadership.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)
1-e	Preliminary Analysis/ Modeling / Simulation/ Experiment / Design/ Feasibility study [CO1]	10	The team has not done any preliminary work with respect to the analysis/modeling/ simulation/experiment/desig n/feasibility study/ algorithm development.	The team has started doing some preliminary work with respect to the project. The students however are not prepared enough for the work and they need to improve a lot.	There is some evidence to show that the team has done good amount of preliminary investigation and design/ analysis/ modeling etc. They can improve further.	Strong evidence for excellent progress in the project. The team has completed the required preliminary work already and are poised to finish the phase I in an excellent manner. They have shown results to prove their progress.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)

1-f	Documentation and presentation. (Individual & group assessment). [CO6]	5	The team did not document the work at all. The project journal/diary is not presented. The presentation was shallow in content and dull in appearance. The individual student has no idea on the presentation of his/her part.	Some documentation is done, but not extensive. Interaction with the guide is minimal. Presentation include some points of interest, but overall quality needs to be improved. Individual performance to be improved.	Most of the project details were documented well enough. There is scope for improvement. The presentation is satisfactory. Individual performance is good.	The project stages are extensively documented in the report. Professional documentation tools like LaTeX were used to document the progress of the project along with the project journal. The documentation structure is well-planned and can easily grow into the project report. The presentation is done professionally and with great clarity. The individual's performance is excellent.
			(0 – 1 Marks)	(2 – 3 Marks)	(4 Marks)	(5 Marks)
Total		**30**	**Phase - I Final Evaluation Marks: 30**			

EVALUATION RUBRICS for PROJECT Phase I: Report Evaluation						
Sl. No.	**Parameters**	**Marks**	**Poor**	**Fair**	**Very Good**	**Outstanding**
1-g	Report [CO6]	20	The prepared report is shallow and not as per standard format. It does not follow proper organization. Contains mostly Unacknowledged content. Lack of effort in preparation is evident.	Project report follows the standard format to some extent. However, its organization is not very good. Language needs to be improved. All references are not cited properly in the report.	Project report shows evidence of systematic documentation. Report is following the standard format and there are only a few issues. Organization of the report is good. Most of references are cited properly.	The report is exceptionally good. Neatly organized. All references cited properly. Diagrams/Figures, Tables and equations are properly numbered, and listed and clearly shown. Language is excellent and follows standard styles.
			(0 - 7 Marks)	(8 - 12 Marks)	(13 - 19 Marks)	(20 Marks)
Phase - I Project Report Marks: 20						

SEMESTER VII

PROGRAM ELECTIVE II

SBT413	SHIPBUILDING MATERIALS, CORROSION PREVENTION AND PROTECTION	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course is introduced in the curriculum for providing an overview on different types of corrosion attack onboard ships along with various corrosion prevention strategies.

Prerequisite: Nil

Course Outcomes: After completion of the course the student will be able to

CO 1	Understand types of corrosion likely to occur at various locations in a ship.
CO 2	Suggest effective methods of corrosion prevention and material preservation.
CO 3	Formulate decisions in design stage to minimise corrosion in ships.
CO 4	Suggest methods to detect areas and types of corrosion and thereby improve safety and reduce losses.
CO 5	Explain the mechanism of various corrosions occurring in various shipbuilding materials.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO4	PO5	PO 6	PO 7	PO8	PO9	PO10	PO11	PO12
CO1	2	1					1					2
CO2	3	1					1					1
CO3	2	1										1
CO4	2	2					1					1
CO5	2	2										1

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	20	20	40
Apply	20	20	40
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 3 questions from each module of which student should answer any two. Each question can have maximum 3 sub-divisions and carry 7 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Describe the criteria for selection of various grades of steels for specific areas in ship hull. Discuss the limitations in use of higher tensile steels. Compare their desirable mechanical properties and applications.

2. Describe various types of tests to determine the properties of steels used in shipbuilding. How these tests are conducted and how these test results are utilized? Discuss how you assess the ship building quality. Explain in detail with reference to the strength criterion.

3. List five major criteria for selecting materials for the following:

a) Bow region of an icebreaker
b) Propeller
c) Pressure vessel
d) High strength steel for deep submersibles.
e) Pipes.

Course Outcome 2 (CO2)

1. Explain heat treatment of steel and various processes involved, their effects and improvements, with reference to shipbuilding steels and their desirable properties.

2. Discuss the history of development of paint industry in India particularly with reference to marine paints. Assess the importance of paint quality and give an account of futuristic paints for different compartments of ships.

3. Discuss the effect of fouling growth on ships. Describe principle of antifouling paint performance, their developments starting from conventional type to antifouling paints of future.

Course Outcome 3(CO3):

1. Discuss the salient features of third generation antifouling paints.

2. Discuss the suitability of FRP as an engineering material for hull construction. Compare its strength characteristics with that of an aluminium hull construction bringing out their advantages and deficiencies in marine industry.

3. Describe the different processing techniques for fabrication of FRP structures along with tools and equipment used in FRP workshop.

Course Outcome 4 (CO4):

1. Discuss the advantages and deficiencies over C.P. based on galvanic system.

2. What is ICCP system? Explain the principle of ICCP system components and their role in the system.

3. Explain the steps involved in sacrificial anode system design.

Course Outcome 5 (CO5):

1. Explain the mechanism of crevice corrosion.
2. Explain the mechanism of cavitation corrosion.
3. Explain the mechanism of pitting corrosion.

Model Question paper

Total Pages: 3

Reg No.:_____ **Name:_____**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, XXXX 20XX

Course Code: SBT413

Course Name: SHIP BUILDING MATERIALS, CORROSION PREVENTION AND PROTECTION

Max. Marks: 100 **Duration: 3 Hours**

PART A

Answer all questions, each carries 3 marks.(3x10=30)

1.	Explain the chemistry behind corrosion on ferrous surface with proper chemical equations.	(3)
2.	Write short note on factors affecting corrosion rate and their influence on any two engineering metals used in ship building.	(3)
3.	What are high tensile steel? Explain their properties.	(3)
4.	Write short note on application of Iron-Carbon diagrams.	(3)
5.	Define flame cleaning. State its merits over other surface cleaning techniques.	(3)
6.	Describe the working of barrier pigments with figures.	(3)
7.	What are the features of Insoluble matrix anti fouling paints?	(3)
8.	Discuss the surface preparation methods for non ferrous metals.	(3)
9.	What is the role of geometry of a structure on controlling corrosion?	(3)
10.	Define ‘Cathodic poisons’.	(3)

PART B

Answer any two full questions from each module, each carries 7 marks. (7x10=70)

Module I

11.	How does corrosion affect the economy of the transportation sector? State prevention strategies to overcome it.	(7)
12.	Explain theories of corrosion with proper equations and diagrams.	(7)
13.	Describe the factors which directly influence erosion corrosion.	(7)

Module II

14.	(a)Differentiate between hot and cold corrosion. (b)Explain pitting corrosion in titanium alloys.	(7)
15.	Explain the effects of corrosion on the propeller of a ship.	(7)
16.	Explain methods to prevent corrosion on propellers.	(7)

Module III

17.	Explain the importance of mill scale removal in surface preparation process.	(7)
18.	What are the methods used in shipyards to remove mill scale from steel surface?	(7)
19.	(a)What are the painting schemes used in ship cargo tanks? (b)What is the role of solvents in paints?	(7)

Module IV

20.	(a) What are the different types of anti-fouling coatings used in ships? (b)What are the different methods used for painting on ships and offshore structures?	(7)
21.	Differentiate between barrier coating and sacrificial coating with figure. What is meant by hydro blasting process? How does it differ with simple water washing?	(7)
22.		(7)

Module V

23.	(a)Differentiate between flush mounted anode and Slender stand-off	(7)

anode with figures.

(b)Explain the following terms:

i) Mean current demand
ii) Anode utilization factor
iii) Current capacity of anode
iv) Coating break down factor

24. Explain the method of anodic protection with Paurbaix diagram. (7)

25. List the merits and demerits of ICCP system. (7)

***

Syllabus

Module 1

Introduction- Chemistry of Corrosion, Corrosion Losses, Economic Impact of Corrosion. 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. Types of Corrosion in Marine Environment, Corrosion Identification, Factors affecting Corrosion.

Module 2

Materials and Corrosion- Types of Steel and Tendency of Corrosion, Use of HTS, Stainless Steel Corrosion of Titanium and Nickel alloys, Copper and Copper Based Alloys, Zinc, Aluminium and its Alloys. Corrosion on Propeller, Marine machinery and Deck fittings.

Module 3

Surface Preparation of Steel. Material Storage and Preservation in Shipyard, Treatment of Steel in Shipyards. Degreasing, Weathering, Mechanical Surface Cleaning, Pickling, Blast Cleaning, Flame Cleaning. Rust Converters, Chemical Pre-treatment and Comparison of Pre-treatment Methods.

Module 4

Marine Paint Schemes in Ships. Classification of Paints- Common Paint Vehicles: Drying Oils, Oleo-Resins, Alkyd Resins, Polymerizing Chemicals and Bitumen. Role of Constituents of Paints. Suitability of Each for Various Applications. Typical Paint Schemes for Underwater Areas, Boot Topping, Top sides, Weather Decks, Superstructures and Tank Interiors.

Corrosion Monitoring -Mechanism of Anticorrosive Paint, Paint Types and Selection. Antifouling paints- Effect of Fouling on Ships, Factors Affecting Growth and Settlement Principles of Antifouling Paints. Pollution from Paints and Methods to Minimize Them, Painting Tools, Methods. Surface Preparation for Painting, Safety Precautions While Using Paints.

Module 5

Corrosion Control- Importance of Corrosion Protection, Measures to Minimise Corrosion, Corrosion Control by Design, Corrosion Inhibitors. Cathodic Protection- Mechanism of Cathodic Protection, Sacrificial Anode, Design of Sacrificial Anode System for Ships, Advantages and Disadvantages of Sacrificial Anode system. Impressed Current Cathodic Protection System in Ships, Advantages and Disadvantages. Principle of Anodic Protection.

Text Books

1. Fontana M. G, Greene N. D, "Corrosion Engineering", McGraw Hill, 2nd Edition, 1978.

2. Ramesh Singh, Corrosion Control for Offshore Structures, Gulf Publishing Company, 2014.

3. T. Howard Rogers "Marine Corrosion" first Edition, George Newnes Ltd London, 1968.

Reference Books

1. Diamont, The Chemistry of Building Materials, Business Books Limited, London,1970.

2. Jayanta Kumar Saha, Corrosion of Constructional Steels in Marine and Industrial Environment, Springer, 2013.

3.Raj Narayan, "An Introduction to Metallic Corrosion and its Prevention", Oxford and IBH,1983

4. Jones D. A, "Principles and Prevention of Corrosion", 2nd Edition, Prentice-Hall, 1965

5. Harvey P Hack, "Designing Cathodic Protection Systems for Marine structures and vehicles", SNAME, 2000.

6. Robert Taggart, Ship Design and Construction, SNAME, 1980.

7. S A Campbell, N. Campbell, F C Walsh, Developments in Marine Corrosion, Royal Society of Chemistry, 1998.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction**	
1.1	Chemistry of Corrosion, Corrosion Losses, Economic Impact of Corrosion.	2
1.2	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
1.3	Types of Corrosion in Marine Environment, Corrosion Identification, Factors affecting Corrosion.	2
2	**Materials and Corrosion.**	
2.1	Types of Steel and Tendency of Corrosion, Use of HTS, Stainless Steel	2
2.2	Corrosion of Titanium and Nickel alloys, Copper and Copper Based Alloys, Zinc, Aluminium and its Alloys.	2
2.3	Corrosion on Propeller, Marine machinery and Deck fittings.	3
3	**Surface Preparation of Steel.**	

3.1	Material Storage and Preservation in Shipyard, Treatment of Steel in Shipyards.	2
3.2	Degreasing, Weathering, Mechanical Surface Cleaning, Pickling, Blast Cleaning, Flame Cleaning.	3
3.3	Rust Converters, Chemical Pre-treatment and Comparison of Pre-treatment Methods.	2
4	**Marine Paint Schemes in Ships and Corrosion Monitoring**	
4.1	Classification of Paints- Common Paint Vehicles: Drying Oils, Oleo-Resins, Alkyd Resins, Polymerizing Chemicals and Bitumen. Role of Constituents of Paints. Suitability of Each for Various Applications.	2
4.2	Typical Paint Schemes for Underwater Areas, Boot Topping, Top sides, Weather Decks, Superstructures and Tank Interiors. Mechanism of Anticorrosive Paint, Paint Types and Selection.	2
4.3	Antifouling paints- Effect of Fouling on Ships, Factors Affecting Growth and Settlement Principles of Antifouling Paints.	2
4.4	Pollution from Paints and Methods to Minimize Them, Painting Tools, Methods. Surface Preparation for Painting, Safety Precautions While Using Paints.	2
5	**Corrosion Control and Cathodic Protection**	
5.1	Importance of Corrosion Protection, Measures to Minimise Corrosion, Corrosion Control by Design, Corrosion Inhibitors.	2
5.2	Mechanism of Cathodic Protection, Sacrificial Anode, Design of Sacrificial Anode System for Ships, Advantages and Disadvantages of Sacrificial Anode system.	3
5.3	Impressed Current Cathodic Protection System in Ships, Advantages and Disadvantages. Principle of Anodic Protection.	2

SBT423	SHIP RECYCLING	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: The objective of the course is to impart knowledge on best practices in ship recycling process, stages and various regulations governing recycling of ships.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explain the need and relevance of ship recycling.
CO 2	Explain various ship life cycle stages.
CO 3	Explain the different processed involved in ship recycling.
CO 4	Apply the concepts and develop an efficient recycling plan.
CO 5	Understand the application of national and international regulations pertinent to ship recycling.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	2				1	2					1
CO 2	2	1										1
CO 3	2	1										1
CO 4	3	2				2	2					1
CO 5	2											1

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	30	30	60
Apply	10	10	20
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 3 questions from each module of which student should answer any two. Each question can have maximum 3 sub-divisions and carry 7 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain why ship recycling is considered as dirty and unsafe industry
2. Explain the need for ship recycling
3. How ship recycling management can be done in effective manner explain.

Course Outcome 2 (CO2):

1. Explain the various life cycle stages of a ship
2. Illustrate ship recycling process with aid of flow chart.
3. What do you mean by concept design for recycling

Course Outcome 3 (CO3):

1. Explain the importance of hot work permit in ship recycling also indicate hazards associated with ship recycling
2. Explain the role of NGO's in ship recycling.
3. Suggest and explain the methods which can be done to minimise hazards associated with ship recycling.

Course Outcome 4 (CO4):

1. What are various international and national authorities involved in ship recycling explain their roles
2. Draw a layout of general ship recycling yard and mark all components.
3. Differentiate between primary and secondary cutting in ship recycling.

Course Outcome 5 (CO5):

1. Explain any two of the following regulations in detail

i. Hon Kong Convention
ii. GMB
iii. IMO
iv. MEPC.

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B. TECH DEGREE EXAMINATION, XXXX 20XX

Course Code: SBT423

Course Name: SHIP RECYCLING

PART A

Answer ALL questions. Each question carries 3 marks.

(3x10 = 30Marks)

1. Explain the relevance of ship recycling.
2. Explain the concept Design for recycling.
3. What are the different vessel positioning methods for recycling?
4. Explain the importance of Basel convention in ship recycling
5. List down the processes in ship recycling.
6. What is meant by Inventory of Hazardous Materials (IHM)?
7. Explain the importance of green recycling.
8. List down any five hazardous wastes in ship recycling.
9. Explain the development of Hong Kong Convention.
10. What is Green Passport in ship recycling?

PART B

Answer any two complete questions from each module.

MODULE I

(7x2=14 Marks)

11. Explain the role of maritime industrial sector in ship recycling.
12. Explain why ship recycling is considered as dirty and unsafe industry.
13. Explain the need for ship recycling.

MODULE II

(7x2 = 14 Marks)

14. Explain the various life cycle stages of a ship
15. How ship recycling management can be done in effective manner explain.
16. Illustrate ship recycling process with aid of flow chart.

MODULE III

(7x2=14 Marks)

17. Explain the importance of hot work permit in ship recycling also indicate hazards associated with ship recycling.

18. Explain the role of NGO's in ship recycling.
19. Suggest and explain the methods which can be done to minimise hazards associated with ship recycling.

MODULE IV

(7x2=14 Marks)

20. What are various international and national authorities involved in ship recycling explain their roles

21. Draw a layout of general ship recycling yard and mark all components.
22. Differentiate between primary and secondary cutting in ship recycling process.

MODULE V

(7x2=14 Marks)

23. Explain the important stakeholders in ship recycling industry.
24. Explain the role of IMO in ship recycling.
25. Explain the term "Green Ship Recycling".

SYLLABUS

Module – I (9 hours)
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.

Module – II (9 hours)
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.

Module – III (9 hours)
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

Module – IV (9 hours)
Operations 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. Recycling yard plan.

Module –V (9 hours)
Rules and Regulations in Ship Recycling
Rules of Various International and National Agencies, IMO, UNEP (BASEL CONVENTION), Gujarat Maritime Board, ILO, Classification Bodies and Hong Kong Convention.
Statutory Certificates for Ship Recycling, Green passport and Green ship, Role of NGOs (Green Peace foundation, Ban Asbestos Network).

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.
2. Industry Code of Practice on Ship Recycling; Marisec, London, August 2001.
3. Safety and Health in Shipbreaking- Guidelines for Asian countries and Turkey; International Labour Office, 2004.U.K
4. Ship Recycling Strategy; Department for Environment Food and Rural Affairs, February 2007.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Module – I**	
1.1	Definition, Relevance of Ship Recycling, Concept of Sustainable Development of the World, Factors Contributing to the Sustainable Development.	4
1.2	Role of Maritime Industrial Sector, Statistics of Global Shipping and Ship Building	3
2	**Module – II**	
2.1	Various Stages of Life Cycle of Ships, Operations in Life Stages and Effective Management of the Stages.	6
2.2	Importance of Ship Recycling in Life Cycle Management.	1
3	**Module – III**	
3.1	Decision on Decommissioning of Ships, Preparations for Transferring Obsolete Vessels to Recycling Yards, Planning, Commercial Matters, Transportation Methods, Survey before Positioning.	4
3.2	Legal Issues, Positioning of Obsolete Ships, Beaching, Buoy and Dock Methods of Recycling.	3
4	**Module – IV**	
4.1	Ship Dismantling Process, Access, Cleaning, Marking, Cutting, Handling, Lifting, Sorting, Stacking, Storing, Marshall, Concept of Recycling.	4
4.2	Reuse and Land filling in Ship Recycling, Recycling yard plan.	4
5	**Module – V**	
5.1	Rules of Various International and National Agencies, IMO, UNEP (BASEL CONVENTION), Gujarat Maritime Board, ILO, Classification Bodies, Hong Kong Convention.	4
5.2	Statutory Certificates for Ship Recycling, Green passport and Green ship, Role of NGOs (Green Peace foundation, Ban Asbestos Network).	3

SBT433	DESIGN OF FISHING VESSELS	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: The goal of this course is to impart basic knowledge on the design and construction of fishing vessels, performance characteristics of fishing vessels and familiarize with characteristics of fish ground and fishing gears.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explain the functions and setup organization for fishing and the traditional fishing techniques and recent developments in fishing.
CO 2	List main parameters of fishing vessels and understand the design sequence of vessel.
CO 3	Find out main dimension of fishing vessels taking into special consideration of Sea keeping/Maneuvering performance of fishing vessel.
CO 4	Classify various materials used in construction of fishing vessel and its application.
CO 5	Understand fundamentals of preservation of fish, and protection of vessel from corrosion and biofouling.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	1										1
CO 2	2	2										1
CO 3	3	2										1
CO 4	3	2										1
CO 5	3	2										1

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	40
Apply	20	20	50
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 3 questions from each module of which student should answer any two. Each question can have maximum 3 sub-divisions and carry 7 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain different shore facilities required for a fishing industry.

2. Write a short note about following types of fishing vessels

i. Purse seines

ii. Twin bottom otter trawl

3. Classify the fishing vessel according to their fishing method used.

Course Outcome 2 (CO2)

1 Explain the use of following deck equipment

i. Net drum

ii. Power block

iii. Winch system

2. What are the different types of stern forms used in fishing vessel? Which type of stern is more suitable for a stern trawler? Explain.

3. A fishing vessel is normally burning 3.2 tons of fuel /day. Through a new type of fuel treatment, it is expected that the fuel consumption might be lowered by 6%. The required additional equipment for it costs $ 15000 to purchase and has estimated running costs of $ 12/day. If the opportunity cost of capital (= interest rate) is 8%, estimate for a new vessel with the additional equipment:

(Assume: life cycle of 20 years, operation time 5000 hours/year, fuel cost $ 100/ton.)

Find NPV and NPVI of investment.

Course Outcome 3 (CO3)

1. What are the different types of fish detection method used? Explain

2. What are the different seakeeping and maneuvering consideration take part in the design of a fishing vessel.

3. Draw a deck plan of a purse seiner and mark different equipment on the deck.

Course Outcome 4(CO4):

1. Explain construction procedure of a small steel fishing vessel. Also explain advantages of a ferrocement vessel.

2. Explain various construction methods used in FRP hull constructions

3. Explain various considerations take care during aluminium hull construction. Also explain the merits and demerits of aluminium hull construction.

Course Outcome 5 (CO5):

1. Write brief note on fish preservation methods.

2. Explain different type of corrosion occurs in fishing vessels. Also explain different feasible solutions are used in the vessel to prevent these types of corrosions.

3. Why insulations are provided for a fish hold? Explain different types of insulations and its properties.

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B. TECH DEGREE EXAMINATION, XXXX 20XX

Course Code: SBT433

Course Name: DESIGN OF FISHING VESSELS

Max. Marks: 100 **Duration: 3 Hours**

PART A

(Answer all questions, each carries 3 Marks)

Question Number		Marks
1	List any six roles of a fishing organisation	(3)
2	Explain the use of net drum	(3)
3	What are the advantages of a V shaped forward hull?	(3)
4	What are the details needs to be specified in an owner's requirement for design a fishing vessel?	(3)
5	Explain basic principle of acoustic fish detection.	(3)
6	How fish hold volume is finalised?	(3)
7	Explain advantages of a Ferro cement vessel.	(3)
8	List out any three advantages of an aluminium hull over steel hull?	(3)
9	What you meant by Bi-metallic corrosion?	(3)
10	What are the various antifouling techniques used in fishing vessel?	(3)

PART B

(Answer any two full questions from each modules, each full question carries 7 Marks)

MODULE I

11	Explain the various techno-economic parameters effect fishing vessel design.	(7)
12	Explain different methods can adopt to save the fuel usage of a fishing trawler.	(7)
13	What are the different types of stern forms used in fishing vessel? Which type of stern is more suitable for a stern trawler? Explain.	(7)

MODULE II

14	What are the different types of stern forms used in fishing vessel? Which type of stern is more suitable for a stern trawler? Explain.	(4)
15	With the help of neat figure explain design spiral of a fishing vessel.	(7)
16	Can multihull design be recommendable for fishing vessels? Explain.	(7)

MODULE III

17	What are the different types of fish detection method used? Explain	(7)

any one of them

18	What are the different seakeeping considerations take part in the design of a fishing vessel?	(7)
19	Draw a deck plan of an outrigger trawler and mark different equipment on the deck.	(7)

MODULE IV

20	Explain construction procedure of a small steel fishing vessel.	(7)
21	With aid of neat figure explain construction procedures of a FRP fishing vessel.	(7)
22	Explain different materials used for the construction of a ferrocement hull. What are the different considerations need to be take care for the selection of materials used for constructions.	(7)

MODULE V

23	Explain chilling and salting fish preservation methods.	(7)
24	What are different desirable characteristics of insulation materials? Explain.	(7)
25	What are the various facilities are required on-board for the fish preservations? Explain.	(7)

SYLLABUS

Module 1

Introduction to Fishing Vessel Design: Definitions of Fishing Vessel; Special Features of Fishing Vessels; Regulations for the Safety of Fishing Vessels; Fish Production in India; Organizational Setup and Shore Facilities; Fisheries Organizations and Activities; Administrative Systems on Fishing Vessels.

Classification of Fishing Vessels: Characteristics of Fish Ground, Fishing Gear and Methods, Drift Net, Long Line, Drag Net, Seine Net, Dredging, Electric Light Harpoon/Whale Catching Trawling (Side and Stern Trawlers, Single and Pair Trawling, Pelagic & Bottom Trawling).

Module 2

Design Procedure of Fishing Vessels: Owner's Specifications, Economy, Fuel Efficiency, Hull Form, Investment Cost Operating Revenues and Costs.

Module 3

Estimation of Main Dimensions, Space Requirement of Whole Ship, Arrangement of Fish Holds and General Arrangement, Propulsion Systems, Equipment for Fish Finding, Seakeeping and Maneuvering Considerations.

Module 4

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.

Module 5

Fish Holds and Preservation Facilities: Insulation Materials and Properties; Methods of Fish Preservation; Protection of Fishing Vessels 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, 1985.
3. John F. Fyson; Fishing Boat Designs- 3 Small Trawlers, Issues 188-191, Food and Agriculture Organization of the United Nations, 1980.

Reference Books

1. 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 Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Module 1**	
1.1	**Introduction to Fishing Vessel Design:** Definitions of Fishing Vessel; Special Features of Fishing Vessels; Regulations for The Safety of Fishing Vessels; Fish Production in India; Organizational Setup and Shore Facilities; Fisheries Organizations and Activities; Administrative Systems on Fishing Vessels.	3
1.2	**Classification of Fishing Vessels:** Characteristics of Fish Ground, Fishing Gear and Methods, Drift Net, Long Line, Drag Net, Seine Net, Dredging, Electric Light Harpoon/Whale Catching Trawling (Side and Stern Trawlers, Single and Pair Trawling, Pelagic & Bottom Trawling).	5
2	**Module 2**: **Design Procedure of Fishing Vessels**	
2.1	Owner's Specifications	3
2.2	Economy, Fuel Efficiency, Hull Form,	2

2.3	Investment Cost, Operating Revenues and Costs.	1
3	**Module 3**	
3.1	Estimation of Main Dimensions, Space Requirement of Whole Ship	2
3.2	Arrangement of Fish Holds and General Arrangement,	2
3.3	Propulsion Systems, Equipment for Fish Finding,	2
3.4	Seakeeping and Maneuvering Considerations.	1
4	**Module 4: Material and Construction Methods**	
4.1	Mechanical Properties of Materials, Comparison of Hulls of Different Material;	3
4.2	Type of Construction; Details of Steel Construction; Construction Methods Using FRP/GRP, Aluminium, Ferrocement.	5
5	**Module 5: Fish Holds and Preservation Facilities**	
5.1	Insulation Materials and Properties	2
5.2	Methods of Fish Preservation	2
5.3	Protection of Fishing Vessels from Corrosion and Biofouling.	3

SBT443	SHIP PRODUCTION	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: Shipbuilding is a large, diverse, complex, multi-faceted industry. This course is added in the curriculum of Naval Architecture and Shipbuilding engineering students for imparting basic knowledge in various aspects of ship production such as production planning, layout designing, material handling, fabrication of various components etc.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand various types of shipyard layouts, material handling systems, production management methodologies in modern shipbuilding.
CO 2	Elucidate various types of surface preparation techniques, equipment used for surface preparation, their advantages and limitations.
CO 3	Explain various types of plate and frame cutting and bending techniques.
CO 4	Discern the various assembly techniques, welding symbols and standards used in shipbuilding.
CO 5	Understand and illustrate various processes involved in shipbuilding, and installation of various equipment and systems in ships.
CO 6	Explicate the various types of outfitting and launching methodologies adopted in modern shipbuilding.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	2				1						1
CO 2	3	3										1
CO 3	3	3										1
CO 4	3	3				2						1
CO 5	2	2										1
CO 6	3	3				2						1

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	20	20	40

Apply	20	20	40
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 3 questions from each module of which student should answer any two. Each question can have maximum 4 sub-divisions and carry 7 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain the role of heavy duty trucks in block assembly process in shipyards. Also name the different combinations of connecting these trucks and the available drive options in these trucks.

2. Explain the Product Work Breakdown Structure (PWBS) employed in ship building process.

3. Explain the different methodologies used for material storage systems in a modern shipyard.

Course Outcome 2 (CO2)

1. What is surface preparation in shipbuilding? What is the need for surface preparation?

2. What is the need of acid pickling of plates in shipbuilding? Also explain the acid pickling process?

3. Explain automated shot blasting technique employed in a modern shipyard with necessary sketches.

Course Outcome 3(CO3):

1. What is the use of guillotines and hydraulic presses in a shipbuilding yard?

2. Draw the sketch of a LASER beam cutting torch and mark its parts.

3. Explain the process of manual cold bending of frames in small shipyards with a neat sketch.

Course Outcome 4 (CO4):

1. What are the different sections used for prefabrication and write the different welding codes assigned to them?

2. With the help of neat sketch explain the process of Friction stir welding.

3. What are the different types of weld joints used in shipbuilding? Explain with sketches.

Course Outcome 5 (CO5):

1. Explain the installation of inert gas system in an oil tanker.

2. Explain the bilge piping arrangement with a neat sketch.

3. Explain the installation of a single screw propeller in ships with a neat sketch and installation sequence.

Course Outcome 6 (CO6):

1. Explain any three parameters which have to be ensured while launching a ship.

2. What are the advantages and disadvantages of a floating dry dock when compared to a graving dry dock?

3. With the aid of a neat sketch explain the arresting arrangements in launching a ship.

Model Question paper

Total Pages: 3

Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, XXXXX 20XX

Course Code: SBT443

Course Name: SHIP PRODUCTION

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions. Each question carries 3 marks Marks

1	Explain the terms nesting and lofting in ship production industry with the help of necessary sketches.	(3)
2	Explain the different factors influencing the selection of location for a shipyard.	(3)
3	What is the use of templates in shipbuilding? Explain with a neat sketch.	(3)
4	"Mill scale is a necessary evil in steel plates." Justify the given statement related to plate preparation in shipbuilding industry.	(3)
5	Draw the schematic diagram of Metal Inert Gas welding process.	(3)
6	Draw the schematic diagram of Tungsten Inert Gas welding process.	(3)
7	What is the use of assembly jigs in a shipyard? Explain with a neat sketch.	(3)
8	Name the areas of ship where stiffened flat sections with curvature are used. Also draw and mark longitudinal stiffening of such sections.	(3)
9	What is the use ship lifts? What are the merits and demerits of ship lifts?	(3)
10	Explain the installation of impressed current protection system with a neat sketch.	(3)

PART B

Answer any two full questions from each module. Each question carries 7 marks

Module 1

11	A	What is the need of acid pickling of plates in shipbuilding? Also explain the acid pickling process?	(3)
	B	What are the advantages and disadvantages of acid pickling of steel plates?	(2)
	C	Explain the equipment used for acid pickling and various factors affecting the pickling rate.	(2)
12		Explain the evolution of shipyard layouts with neat sketches.	(7)
13	A	How the hull plate-forms are generated for shipbuilding from the lines plan drawings? Explain.	(2)
	B	Explain the different methodologies used for material storage systems in a modern shipyard.	(2)

	C	Explain any one steel plate handling system in a modern shipyard with a neat sketch.	(3)

Module 2

14	A	What are universal hydraulic presses? Explain the working of a universal hydraulic press with a neat sketch.	(5)
	B	What are the challenges in frame bending compared to plate bending?	(2)
15	A	Explain any three different types of gap presses with neat sketches.	(3)
	B	How dimensional accuracy is maintained while doing plate and frame bending for ship structures? Explain any one technique employed for the accuracy control while doing fully automated bending.	(4)
16	A	What are the different types of plate cutting methods in a modern ship yard?	(2)
	B	Which cutting method is most economical for steel plates with thickness less than 16 mm? Justify your answer.	(2)
	C	With the help of neat sketch explain any one cutting method used for cutting thick steel plates.	(3)

Module 3

17	A	What are the advantages and disadvantages of a corrugated bulkhead when compared to a flat bulkhead?	(2)
	B	Distinguish between the prefabrication of uniaxial and biaxial stiffened panels with neat diagrams.	(3)
	C	What are the basic problems in prefabrication of ship's structures?	(2)
18	A	What are the different types of weld joints used in shipbuilding? Explain with sketches.	(3)
	B	Write down the different welding symbols used in shipbuilding.	(3)
	C	Distinguish between a seam line and a butt line.	(1)
19		Explain the various steps involved in shipbuilding from the owners requirement to delivery with the aid of necessary flow charts and sketches.	(7)

Module 4

20	A	What are the constructional difference between a cruiser stern and transom stern? Explain with neat sketches.	(4)
	B	What are balanced rudders and semi balanced rudders? Explain the construction of spade rudders.	(3)
21	A	What is the use of bilge keel in ships?	(1)
	B	Explain the construction of bilge keel with neat sketches.	(3)
	C	Explain the construction of flat plate keel, bar keel and duct keel with neat sketches.	(3)
22	A	With the help of a neat sketch explain the shaft tunnel construction in a ship.	(5)
	B	Why is the shaft tunnel offset from ship's central line?	(2)

Module 5

23	A	What are the merits and demerits of end launching and side launching of ships?	(2)
	B	Name the different types of dry-docks.	(2)

	C	Explain the constructional details of a slip way with a neat sketch.	(3)
24	A	Draw the diagram of a derrick rig and mark its major components.	(3)
	B	What are the different forces acting on a derrick rig?	(2)
	C	Explain the testing of derrick rigs in ships.	(2)
25	A	Explain the launching sequence of bulk carrier.	(3)
	B	With the aid of a neat sketch explain the arresting arrangements in launching a ship.	(4)

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SYLLABUS

Module 1 – Introduction to ship production & characteristics of shipbuilding.

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.

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, Pre-painting, Material Preparation, Flow Line Devices and their Control Systems.

Module 2 - Cutting, bending and welding of steel plates and frames

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.
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.
Welding in Shipbuilding, Welding Methods, Standards, Symbols.

Module 3 – Assembly of various components

Assembly of Ship's Structures - Prefabrication – General Considerations, Basic Problems of Prefabrication, Pattern of Prefabrication, Welding in Prefabrication.
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.
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.

Module 4 – Erection of ship hull and hull installation

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.

Hull Assembly- Different Methods of Hull Assembly, welding in Ship's Hull Assembly – Welding Methods Used, Defects, Welding Deformation; Quality Assurance & Quality Control, 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 Equipment.

Module 5 - Outfitting and launching

Pre and Advanced Outfitting- Activities in Shipyard Pipe, Machine and Shipwright's Shops, Mechanical Workshop, Machine Shop, Other Workshops (Electrical Installation, Painting, Insulation, Etc.).

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.

Text Books

1. D.J Eyres, "Ship construction", Elsevier Science and Technology, 7th edition, 2012.
2. Paul Anthony Russel, "Ship construction for marine Engineers", Thomas Reed, 6th edition, 2016.

Reference Books

1. Richard Lee Storch, "Ship Production", The SNAME, 2nd edition, 2007.
2. Robert Taggart, "Ship Design and Construction", Society of Naval Architects, 1st edition, 1980.
3. R. M. Newton; "Practical Construction of Warships", Prentice Hall Press, 3rd edition, 1970.
4. E.C. Tupper, "Basic Ship Theory", Elsevier Science and Technology, 5th edition, 2001.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**INTRODUCTION TO SHIP PRODUCTION & CHARACTERISTICS OF SHIP-BUILDING.**	
1.1	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.	2
1.2	Product Oriented Work Breakdown Structure- Planning for Production, Zone Construction Method, Pipe Piece Family Manufacturing.	2
1.3	Data Generation for Shipbuilding Process – Generation of Hull Forms, Frame Plan, Shell Plate Development, Generation of Hull Components, Lofting, Nesting.	2
1.4	Storage and Preparation of Material- Material Handling and	2

	Storage, Transport System in Steel Stockyard, Material Preparation- Straightening of Plates and Rolled Sections, Shot Blasting, Pre-painting, Material Preparation, Flow Line Devices and their Control Systems.	
2	**CUTTING, BENDING AND WELDING OF STEEL PLATES AND FRAMES**	
2.1	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
2.2	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.	2
2.3	Welding in Shipbuilding, Welding Methods, Standards, Symbols.	2
3	**ASSEMBLY OF VARIOUS COMPONENTS**	
3.1	Assembly of Ship's Structures - Prefabrication – General Considerations, Basic Problems of Prefabrication, Pattern of Prefabrication, Welding in Prefabrication.	2
3.2	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.	2
3.3	Assembly of Flat and Corrugated Sections, Flat Sections with Curvature – Assembly Jigs, Welding Process, Strengthening of Flat Sections.	1
3.4	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.	2
4	**ERECTION AND HULL INSTALLATION**	
4.1	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.	2
4.2	Hull Assembly- Different Methods of Hull Assembly, Welding in Ship's Hull Assembly – Welding Methods Used, Defects, Welding Deformation; Quality Assurance & Quality Control, Scaffoldings.	3
4.3	Technological Process in the Hull Installation Work– Technological Process in Installing the Main Machinery, Shafting and Propeller, Auxiliary Machinery and Boilers, Piping Systems, Electrical	2

	Installation and Hull Equipment.	
5	**OUTFITTING AND LAUNCHING**	
5.1	Pre And Advanced Outfitting- Activities in Shipyard Pipe, Machine and Shipwright's Shops, Mechanical Workshop, Machine Shop, Other Workshops (Electrical Installation, Painting, Insulation, Etc.).	4
5.2	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

SEMESTER VII

OPEN ELECTIVE

SBT415	DREDGERS AND HARBOUR CRAFTS	CATEGORY	L	T	P	CREDIT
		OEC	2	1	0	3

Preamble: The floating plant which is used for the process of excavating material from a water environment is called a Dredger. Dredging engineering is a combination of multiple engineering disciplines; mainly civil and mechanical engineering. Hence this course is added as an Open Elective Course and the major features of various harbour crafts which are assisting the dredgers for their operation were also included in this course.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand various types of dredging process, dredging equipment, their applications and limitations.
CO 2	Elucidate various types of mechanical dredgers and their technical construction.
CO 3	Explain various types of hydraulic dredgers and their technical construction.
CO 4	Discern the design and production(dredging) aspects of various types of dredgers.
CO 5	Illustrate various dredging equipment and their major parts.
CO 6	Explicate the major features, advantages and limitations of various harbour crafts.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	2				1						2
CO 2	3	3										1
CO 3	3	3										2
CO 4	3	3				2						2
CO 5	3	3										1
CO 6	3	3				2						2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	40
Apply	20	20	50

Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 3 questions from each module of which student should answer any two. Each question can have maximum 4 sub-divisions and carry 7 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What are the main equipment installed in a standard Trailer Suction Hopper Dredger (TSHD)?

2. Explain Barge Unloading Dredger's barge hauling installation.

3. Identify and explain the type of dredging associated with the construction of a new port?

Course Outcome 2 (CO2)

1. What are the advantages and disadvantages in using a Backhoe dredger in different working areas and conditions?

2. Explain the working method of a Backhoe dredger with necessary sketches.

3. Draw the general layout of a bucket ladder dredger and mark the major components.

Course Outcome 3 (CO3):

1. With the aid of necessary sketches differentiate between CTS (Constant Tonnage System) and CVS (Constant Volume System) systems in Trailer Suction Hopper Dredger (TSHD).

2. Explain the different types of spud systems used in the dredging operation using a Cutter Suction Dredger (CSD)

3. Explain the different loading systems that are used for the hopper loading of a Trailing Suction Hopper Dredger (TSHD).

Course Outcome 4 (CO4):

1. Draw the Concentration-time graph for the complete dredge cycle of a Barge Unloading Dredger.

2. Explain the productivity of different types of cutter edges used in dredging process using Cutter suction dredgers and also mention their applicability in different types of Soils?

3. With necessary sketches differentiate between CTS (Constant Tonnage System) and CVS (Constant Volume System) systems in Trailer Suction Hopper Dredger (TSHD).

Course Outcome 5 (CO5):

1. Illustrate the different types of dragheads used in a Trailing Suction Hopper Dredger (TSHD).

2. Draw the diagrams of the different bottom discharge systems equipped in a Trailing Suction Hopper Dredger (TSHD).

3. What are the different types of cutter teeth used in a Cutter Suction Dredger? Draw the figures of these teeth and mention the application area of these different teeth.

Course Outcome 6 (CO6):

1. What are the advantages and disadvantages of a tractor tug?

2. What are the advantages and disadvantages of a floating dry dock when compared to other types of dry docks?

3. Explain the specifications of class A, Class B and Class C fire-boats.

Model Question paper

Question Paper Code **Total Pages: 4**

Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, XXXXX 20XX

Course Code: SBT415

Course Name: DREDGERS AND HARBOURCRAFTS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions. Each question carries 3 marks Marks

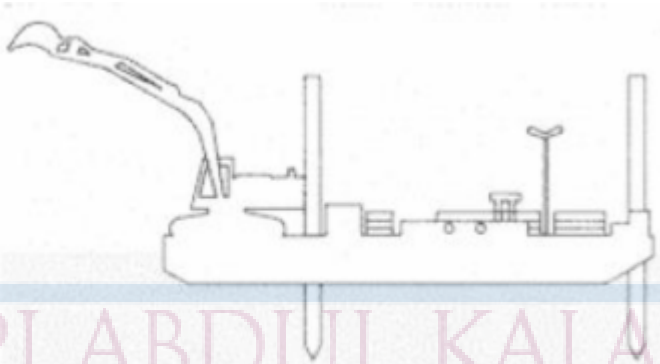
1	Identify and explain the type of dredging associated with the construction of a new port?	(3)
2	Define a booster station in dredge material transport to inshore via pipelines. What is the need for booster stations?	(3)
3	What are the different classifications of bucket ladder dredger?	(3)
4	What are the main limitations of dredging process using a bucket ladder dredger?	(3)
5	Why the maximum swing angle of a cutter ladder is limited to 60 degrees towards port and starboard side?	(3)
6	What are the different classifications of bucket ladder dredger?	(3)
7	Identify and explain the types of dredging equipment associated with the construction of a new port?	(3)
8	Barge Unloading Dredger is a special type of plain suction dredger. Justify.	(3)
9	What is marine salvage? Name different type of marine salvages.	(3)
10	Define water plane area coefficient and midship area coefficient of a Fire boat.	(3)

PART B

Answer any two full questions from each module. Each question carries 7 marks

Module 1

11	A	What are the different classifications of dredgers?	(4)
	B	What are the main applications of dredging process? Explain.	(3)
12	A	What are the main classification of sediments (soil) particles based on size?	(4)
	B	Explain the method to determine the particle size of a given soil sample.	(3)
13	A	Identify the given dredger.	(1)



	B	Mention any 6 major parts of the above given dredger.	(3)
	C	Explain the main characteristics of this Dredger.	(3)

Module 2

14	A	What are the advantages and disadvantages in using a Backhoe dredger in different working areas and conditions?	(4)
	B	For the following pair of parameters explain how the first quantity is depending on the second quantity for a Backhoe dredger? i) Bucket capacity, Installed power ii) Pontoon volume, Light weight iii) Crane weight, Bucket size	(3)
15	A	Draw the hoisting system of a clamshell dredger and mark its parts	(4)
	B	Explain the dredge cycle of a clamshell dredger	(2)
	C	What is the use of a Tag Wire in a clamshell dredger	(1)
16	A	Draw the general layout of a bucket ladder dredger and mark the major components.	(4)
	B	Explain the different types of winches used in a bucket ladder dredger.	(3)

Module 3

17	A	What are the different types of cutter teeth used in a Cutter Suction Dredger? Draw the figures of these teeth and mention the application area of these different teeth.	(3)
	B	Name different cutter adapter systems used in Cutter Suction Dredgers.	(2)
	C	What are the different types of cutter edges used in dredging process using Cutter suction dredgers and mention the applicability of these edges in different types of Soils?	(2)
18	A	Explain the dredging process using a Barge Unloading Dredger.	(4)
	B	Draw the following graphs for the complete dredge cycle of a Barge Unloading Dredger i) Concentration-time graph ii) Speed of dredge pump-time graph iii) Flowrate of Jet pump- time graph	(3)
19		Explain the different types of spud systems used in the dredging operation using a Cutter Suction Dredger (CSD).	(7)

Module 4

20	A	What are the main equipment installed in a standard Trailer Suction Hopper Dredger (TSHD)?	(3)
	B	What are the advantages of dredging using a Trailer Suction Hopper Dredger (TSHD)?	(2)
	C	What are the merits and demerits in using a fixed overflow system in a Trailer Suction Hopper Dredger (TSHD)?	(2)
21	A	Explain the dredging process of a Plain Suction Dredger (PSD) with the aid of necessary sketches.	(4)
	B	What are the main advantages and disadvantages of using a Plain Suction Dredger (PSD) in different types of soils?	(3)
22	A	Explain the different types of drag-heads used in a Trailing Suction Hopper Dredger (TSHD).	(4)
	B	Draw the diagrams and name the different bottom discharge systems equipped in a Trailing Suction Hopper Dredger (TSHD)	(3)

Module 5

23	A	What are floating dry docks? Explain with a sketch.	(2)
	B	What are the advantages and disadvantages of a floating dry dock when compared to other types of dry docks?	(5)
24	A	What are the different propulsion systems used in a towing vessel?	(3)
	B	Calculate the approximate shaft power in kilowatt for the tug having a displacement of 800 MT, the speed of 15 knots and Admiralty coefficient of 500.	(4)
25	A	What is girting of a tug? How it can be reduced?	(3)
	B	What are the advantages and disadvantages of a tractor tug?	(4)

****

SYLLABUS

Module 1 – Introduction to Dredging and Dredging equipment

Introduction to dredging and Applications of dredging, dredging process and their types, Role of sampling, Surveying, pre-treatment in dredging, Introduction to dredging equipment, Types of dredging equipment, Applications and limitations of various dredging equipment

Module 2 - Mechanical Dredgers

Bucket dredgers - General description, Area of application, method of working, design, Technical construction, Dredging process.
Grab or Clamshell dredgers – Working method, Areas of application, Design aspects, layout, production capacity
Backhoe or dipper dredgers - General considerations, Working method, Area of application, Main Layout, Production capacity

Module 3 – CSD and BUD

The cutter suction dredgers - General description, design, dredging equipment, Drives, Spud systems, technical construction, Dredging process.
Barge unloading dredgers - General description, design, layout, Technical construction, Dredging process

Module 4 – TSHD and PSD

Trailing suction hopper dredger– General description, design, technical construction, strength and stability, Dredging process, Disposal Techniques.
Plain suction dredgers – Types, working method, design, layout, Technical construction, Dredging process

Module 5 - Harbour crafts

Major features of following Harbour crafts: - Navigation Aid Vessels, Tugs and Towboats, Firefighting tugs, Barges, Pilot boats, Salvage/buoy vessels, Construction Support Vessels, Fireboats, Patrol and Rescue Vessels, Pollution Response Vessels, Floating docks.

Text Books

1. Bray R.N, “Dredging- A handbook for Engineers”, Elsevier Science and Technology, 2nd edition, 1996.

2. John. B. Herbich, “Handbook of Dredging Engineering”, McGraw Hill Publishers, 2nd edition, 2001.

Reference Books

1. Robinson AW, "Modern dredging machinery", Franklin Classics Trade Press, 1st edition, 2008.
2. John. B. Herbich, "Coastal and deep ocean dredging", Gulf publishing co., 1st edition, 1976.
3. Bray R.N, "Environmental Aspects of Dredging", CRC press, 1st edition, 2008.
4. John Huston, "Hydraulic Dredging: Theoretical and applied", Tidewater Pub, 1st edition, 1970.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**INTRODUCTION TO DREDGING AND DREDGING EQUIPMENT**	
1.1	Introduction to dredging and Applications of dredging	2
1.2	Dredging process and their types	1
1.3	Role of sampling, Surveying, pre-treatment in dredging	2
1.4	Introduction to dredging equipment, Types of dredging equipment	1
1.5	Applications and limitations of various dredging equipment	1
2	**MECHANICAL DREDGERS**	
2.1	Bucket dredgers - General description, Area of application, method of working, design, Technical construction, Dredging process.	3
2.2	Grab or Clamshell dredgers – Working method, Areas of application, Design aspects, layout, production capacity	2
2.3	Backhoe or dipper dredgers - General considerations, Working method, Area of application, Main Layout, Production capacity	2
3	**CSD AND BUD**	
3.1	The cutter suction dredgers - General description, design, dredging equipment, Drives, Spud systems, technical construction, Dredging process.	4
3.2	Barge unloading dredgers - General description, design, layout, Technical construction, Dredging process	3
4	**TSHD AND PSD**	
4.1	Trailing suction hopper dredger– General description, design, technical construction, strength and stability, Dredging process, Disposal Techniques.	4
4.2	Plain suction dredgers – Types, working method, design, layout, Technical construction, Dredging process	3
5	**HARBOUR CRAFTS**	
5.1	Major features of Navigation Aid Vessels	1
5.2	Major features of Tugs and Towboats, Firefighting tugs	1

5.3	Major features of Barges	1
5.4	Major features of Pilot boats, Salvage/buoy vessels	1
5.5	Major features of Construction Support Vessels	1
5.6	Major features of Fireboats, Patrol and Rescue Vessels	1
5.7	Major features of Pollution Response Vessels	1
5.8	Major features of Floating docks	1

SBT425	SHIPBUILDING TECHNOLOGY	CATEGORY	L	T	P	CREDIT
		OEC	2	1	0	3

Preamble: This course content has been developed to impart knowledge on shipyard layout, technological process involved in the hull/ machinery installation works, production planning and control. New topics such as Shipbuilding 4.0, IHOP Construction, 3D printing in shipbuilding, Solar and wind powered ships, Ballast free ships, Green Technology in Shipping etc. are also introduced.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to:

CO 1	Identify various operations carry out in different outfitting departments.
CO 2	Explain various technological process involved in the hull and machinery installation works.
CO 3	Understand the concept of design for production and need of quality control and assurance.
CO 4	Develop and explain typical shipyard layout and productivity.
CO 5	Explain the requirement of green technologies in shipbuilding and new trends such as Shipbuilding 4.0.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2										
CO 2	3	2										
CO 3	2	2										
CO 4	3	2										
CO 5	2	2										

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	40
Apply	20	20	50
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 3 questions from each module of which student should answer any two. Each question can have maximum 3 sub-divisions and carry 7 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain various outfitting activities in ship construction stage.

2. With the help of neat layout, explain the activities of a pipe shop in a shipyard

3. How zone outfitting method improves ship construction? Explain.

Course Outcome 2 (CO2):

1. Draw a neat diagram of an Engine foundation of a medium sized ocean going vessel. Explain the process of installing the main machinery on the foundation.

2. What are the functions of a thrust block? Explain its construction.

3. Discuss the pre and advanced outfitting processes in shipbuilding.

Course Outcome 3 (CO3):

1. Which are the important test and trials conducted during shipbuilding? Explain in details any three of these tests conducted.

2. Differentiate between product design and production design. Explain the process of product design and development in shipbuilding context.

3. Why quality control standards are strictly followed in shipyards? How production quality standards are maintained in shipyards? Explain.

Course Outcome 4 (CO4):

1. Draw a neat shipyard layout and explain various factors involved in the shipyard layout design.

2. How shipyard productivity improved with help of modern technology? Explain.

3. Explain various components of ship building cost estimation.

Course Outcome 5 (CO5):

1. Explain working of 3D printing technology. How shipbuilding can adopt these technology? What are limiting factors for adopting this technology?

2. Explain how IMO regulations transforms the shipbuilding industry towards eco-friendly environment.

3. What is shipbuilding 4.0? Explain the various features of Shipbuilding 4.0. How these features change the shipbuilding industry?

Model Question paper

Question Paper Code **Total Pages: 2**

Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, XXXXX 20XX

Course Code: SBT425

Course Name: SHIPBUILDING TECHNOLOGY

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions. Each question carries 3 marks Marks

1	Draw a neat layout of a pipe shop and mark various components.	(3)
2	Explain modular outfitting approach.	(3)
3	Draw the diagram of an Engine foundation of a medium sized ocean going vessel.	(3)
4	Draw a propeller shaft arrangement and mark various components of propeller shafts.	(3)
5	Differentiate between product design and production design.	(3)
6	Compare quality assurance and quality control.	(3)
7	List out all the components of the shipbuilding costs.	(3)
8	Differentiate between short term, medium term and long term plan.	(3)
9	Explain the concept of ballast free ship. List its advantages.	(3)
10	What is EEDI? Explain its significance.	(3)

PART B

Answer any two full questions from each module. Each question carries 7 marks

Module 1

11	Explain various outfitting activities in ship construction stage	(7)
12	With aid of neat diagram, explain various activities of a mechanical workshop.	(7)
13	Why IMO is more concerned about the paint selection of ships? Explain with help of historical regulations.	(7)

Module 2

14	What are the different processes involved in installation of the main machinery on the foundation? Explain.	(7)
15	Explain how design and construction phase of propeller shaft bearing ensures structural strength.	(7)
16	Discuss the pre and advanced outfitting processes in shipbuilding.	(7)

Module 3

17	Explain the process of product design and development in shipbuilding context.	(7)

18	Which are the important test and trials conducted during shipbuilding? Explain in details any of these tests conducted.	(7)
19	How production standards are maintained in shipyards? Explain.	(7)

Module 4

20	How shipyard productivity improved with help of modern technology? Explain.	(7)
21	A shipbuilder wishes to quote for a new ship with 5% profit over his total investment	(7)
	a) He has to draw up a contract with an owner for single ship who wishes to make 3 equal instalment payments t the beginning, at the middle (after time T) and at the time of delivery (after time 2T). What should be the contractual price in terms of total investment of 100? Assume 4% interest rate for each time period.	
	b) The owner wishes to order for 3 such ships, each such ship being built at T time interval. What should be the contractual price?	
22	What are the factors effects on the shipyard layout selection? Explain.	(7)

Module 5

23	Explain working of 3D printing technology. How shipbuilding can adopt these technology?	(7)
24	Explain the design and construction constraints of solar and wind powered ship.	(7)
25	What are the main features of shipbuilding 4.0? Explain.	(7)

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SYLLABUS

Module 1 - Outfitting of ships

Workshops, piping shop, fitters shop, Carpenters shop (wood, plastics), Mechanical workshop, Machine shop (preassembly of blocks), other workshops (electrical installation, painting, insulation, etc.).

Module 2 - Technological process in the hull and machinery installation work

Technological process in installing the main machinery, installation of shafting and propeller, installation of the main machinery, installing of auxiliary machinery and boilers, installation of piping systems, electrical installation, hull installation work, Pre and advanced outfitting.

Module 3 - Production planning and control in shipbuilding

Production design – application of the principles of design for production in shipbuilding – joining of parts, relations between structural design and prefabrication, simplifications in structural design (design for welding), quality control.

Module 4 - Capacity planning and Cost estimation

Capacity planning – Productivity in shipyard, measurement and monitoring, shipyard capacity estimation, role of process and procedure in shipyard capacity evaluation, Shipyard layout- factors affecting design of shipyard layout, production facility layout, some aspects of shipyard capacity augmentation, developing shipbuilding strategy, Cost Estimation methods in ship production.

Module 5 - Advanced Shipbuilding technology

Shipbuilding 4.0 – Stages of industrial revolution, Features of Shipbuilding 4.0, Implementation
IHOP Transformation of Shipyard Erection Block Construction, 3D printing in shipbuilding, Solar and wind powered ships, Ballast free ships
Green Technology in Shipping Industry – Need for Green Technology, Carbon Foot print, LNG Fuelled Engines, IMO regulations

Text Books

1. Antonnio Giallanza et.al., International Journal of Interactive Design and Manufacturing, Industry 4.0: smart test bench for shipbuilding industry, 2020.
2. https://marine-digital.com/article_green_ship, Green Technology in Shipping Industry,
3. Anna Balyuk, 2020 Shipbuilding Challenges and Trends, 2020. https://www.epicflow.com/blog/2020-shipbuilding-challenges-and-trends/ 2020.

4. Taggart; Ship Design and Construction, SNAME, 1980.
5. Storch R. Lee, Hammon C.P. & Bunch H.M.; Ship Production, Cornell Maritime Press, Maryland, USA, 1988.
6. Dormidontov V.K. & et.al.; Shipbuilding Technology, Mir Publishers, Moscow, 1966.

Reference Books

1. Ship Construction, 2007, Sixth edition, D. J. Eyres, Butterworth-Heinemann, ISBN 13: 9-78-0-75-06-8070-7.
2. Merchant Ship Construction, H. J. Pursey, Brown, Son & Ferguson, Ltd., Nautical Publishers, 1983.
3. Ship Production, 2nd edition, 1995, Richard Lee, The Society of Naval Architects and Marine Engineers, ISBN 0-939773-57-0.
4. Practical Construction of Ship, RM Newton.
5. Ship Construction-Sketches and Notes 2003, Kemp and Young, Elsevier, ISBN 0-7506-3756-0

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Outfitting of ships**	
1.1	workshops, piping shop, fitters shop, Carpenters shop (wood, plastics), Mechanical workshop, Machine shop (preassembly of blocks), Other workshops (electrical installation, painting, insulation, etc.);	5
2	**Technological process in the hull and machinery installation work**	
2.1	Technological process in installing the main machinery, installation of shafting and propeller, installation of the main machinery	3
2.2	Installing of auxiliary machinery and boilers, installation of piping systems, electrical installation, hull installation work	3
2.3	Pre and advanced outfitting.	2
3	**Production planning and control in shipbuilding**	
3.1	Production design – application of the principles of design for production in shipbuilding , joining of parts.	3
3.2	Relations between structural design and pre-fabrication, simplifications in structural design (design for welding).	3
3.3	Quality control	1
4	**Capacity planning and Cost estimation**	
4.1	Capacity planning – productivity in shipyard, measurement and monitoring, shipyard capacity estimation, role of process and procedure in shipyard capacity evaluation.	3
4.2	Shipyard layout- factors affecting design of shipyard layout,	3

	production facility layout, some aspects of shipyard capacity augmentation, developing shipbuilding strategy.	
4.3	Cost Estimation Methods in Ship Production.	2
5	**Advanced Shipbuilding technology**	
5.1	Shipbuilding 4.0 – Stages of industrial revolution, Features of Shipbuilding 4.0, Implementation.	2
5.2	IHOP Transformation of Shipyard Erection Block Construction.	1
5.3	3D printing in shipbuilding, Solar and wind powered ships, Ballast free ships.	3
5.4	Green Technology in Shipping Industry – Need for Green Technology, Carbon Foot print, LNG Fuelled Engines, IMO regulations.	2

SBT435	MARINE MATERIALS AND CORROSION	CATEGORY	L	T	P	CREDIT
		OEC	2	1	0	3

Preamble: This course deals with material selection and its corrosion that are used for various applications in marine industry. It starts with the concept of different types of Corrosion and the various losses that are caused in Marine Environment. The next section deals with various materials and its Corrosion properties. Then comes the concepts of Marine Paints and Paint schemes in Ships, Pollution from paints and methods to minimize them also gives an idea about Anticorrosion paints and Antifouling paints. Finally by the end of the course it deals with Corrosion Control and the different ways to minimize corrosion.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the various corrosions its theories that can be used in marine environment.
CO 2	Identify the uses of various steel and its alloy and their corrosion properties used in marine industry.
CO 3	Understand the concept of paints that can be used in ship building.
CO 4	Illustrate the role of paints for particular application and the ways to minimize the corrosion.
CO 5	Apply the various concepts for corrosion control.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2	2									1
CO 2	3	2	2									1
CO 3	3	1	2									
CO 4	3	1	2				1					1
CO 5	3	2	1				1					1

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	20	20	40

Apply	20	20	40
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 3 questions from each module of which student should answer any two. Each question can have maximum 3 sub-divisions and carry 7 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. State the various theories of corrosion.

2. Define corrosion triangle and its losses.

3. Explain the various types of corrosion in marine environment.

Course Outcome 2 (CO2)

1. State the various types of steels used in marine industry

2. List the applications of different steel and its alloys.

3. Define the steps used in surface preparation of steel.

Course Outcome 3(CO3):

1. Demonstrate the classification of paints

2. Illustrate the role of constituents of paints and its suitability for various applications.

3. Describe the paint schemes in ship.

Course Outcome 4 (CO4):

1. Demonstrate the mechanism of anticorrosive paint and its selection process.

2. Define the various factors affecting growth and settlement principles of antifouling paints.

3. Describe the safety precautions while using paints.

Course Outcome 5 (CO5):

1. Illustrate the measures to minimise corrosion.

2. Explain the design of sacrificial anode system for ships its advantages and disadvantages

3. Demonstrate the principle of anodic protection.

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, XXXX 20XX

Course Code: SBT435

Course Name: MARINE MATERIALS AND CORROSION

Max. Marks: 100 **Duration: 3hrs**

PART A

Answer all questions. Each question carries 3 marks.

1. Define electrochemical theory of corrosion.
2. What are the different types of corrosion cell?
3. Why stainless steel is is passive compared to mild steel?
4. How does rust converter protect the steel?

5. Write the role of constituents of paint.
6. Write the materials selection criteria for ship construction.
7. What is the use of antifouling paints and how it is selected?
8. What are the safety precautions to be taken while using paints?
9. Write the mechanism of sacrificial protection.
10. Explain the principle of anodic protection?

PART B

Answer any two complete questions from each module.

MODULE I

(7x2=14 Marks)

11. Discuss the mechanism of inter granular corrosion and how do you prevent it. Explain the activation polarization and how it differs from concentration polarization.
12. Describe the following with examples: (i) Evans theory of corrosion (ii) Stress corrosion cracking.
13. What are the factors affecting galvanic corrosion and how to avoid the galvanic corrosion?

MODULE II

(7x2 = 14 Marks)

14. Discuss the corrosion behaviour, mechanical properties and composition of stainless steel used in marine practice.
15. Explain three types of pre treatment with examples. Also discuss how steel corrodes in sea water.
16. Explain the different surface preparation methods and with advantages and disadvantages.

MODULE III

(7x2=14 Marks)

17. What are the uses of paints in ship construction and how are they classified? Explain in detail.
18. Explain the importance of paint schedule in ship building with various application
19. Compare and contrast the paint scheme for new and old ships.

MODULE IV

(7x2=14 Marks)

20. Describe the mechanism of anti corrosive paints. Also explain the effect of fouling on ships and the principle of anti fouling paints.

21. Describe how different antifouling paint releases the toxicity in their service life.
22. What are the coating failures in different types of paint systems and how to avert the failure?

MODULE V

(7x2=14 Marks)

23. a) Write briefly the following with examples: (i) Marine use of copper alloys (ii) Corrosion inhibitor.
    b) Explain how corrosion protection of metal is attained by conversion coating.
24. Describe briefly the mechanism of cathodic protection as used for ships.
25. Write the advantages and disadvantages of the sacrificial anode and ICCP system in shipbuilding.

SYLLABUS

Module 1

Introduction: Chemistry of Corrosion, Corrosion Losses, Economic, Impact of Corrosion, 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, Types of Corrosion in Marine Environment, Corrosion Identification, Factors affecting Corrosion.

Module 2

Materials and Corrosion: Types of Steel and Tendency of Corrosion, Use of HTS, Stainless Steel, Corrosion of Titanium and Nickel alloys, Copper and Copper Based Alloys, Zinc, Aluminium and its Alloys, Corrosion on Propeller, Marine machinery and Deck fittings.

Surface Preparation of Steel: Material Storage and Preservation in Shipyard, Treatment of Steel in Shipyards, Degreasing, Weathering, Mechanical Surface Cleaning, Pickling, Blast Cleaning, Flame Cleaning, Rust Converters, Chemical Pre-treatment and Comparison of Pre-treatment Methods.

Module 3

Marine Paints and Paint Schemes in Ships: Classification of Paints- Common Paint Vehicles: Drying Oils, Oleoresins, Alkyd Resins, Polymerizing Chemicals and Bitumen, Role of Constituents of Paints, Suitability of Each for Various Applications. Typical Paint Schemes for Underwater Areas, Boot Topping, Top sides, Weather Decks, Superstructures and Tank Interiors.

Module 4

Paints and Corrosion Monitoring: Mechanism of Anticorrosive Paint, Paint Types and Selection. Antifouling paints- Effect of Fouling on Ships, Factors Affecting Growth and Settlement, Principles of Antifouling Paints, Pollution from Paints and Methods to Minimize Them, Painting Tools, Methods, Surface Preparation for Painting, Safety Precautions while using Paints.

Module 5

Corrosion Control: Importance of Corrosion Protection, Measures to Minimise Corrosion, Corrosion Control by Design, Corrosion Inhibitors.

Cathodic Protection- Mechanism of Cathodic Protection, Sacrificial Anode, Design of Sacrificial Anode System for Ships, Advantages and Disadvantages of Sacrificial Anode system, Impressed Current Cathodic Protection System in Ships, Advantages and Disadvantages, Principle of Anodic Protection.

Text Books

1. Fontana M. G, Greene N. D, "Corrosion Engineering", McGraw Hill, 2005.
2. Ramesh Singh, "Corrosion Control for Offshore Structures", Gulf Publishing Company, 2014.
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, 1970.
2. Jayanta Kumar Saha, "Corrosion of Constructional Steels in Marine and Industrial Environment", Springer, 2013.
3. Jones D. A, "Principles and Prevention of Corrosion", 2nd Edition, Prentice Hall, K A Chandeler, Marine and Offshore Corrosion, Butterworths Heinemann, 2017.
4. Raj Narayan, "An Introduction to Metallic Corrosion and its Prevention", Oxford and IBH, 1983.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**INTRODUCTION TO CORROSION**	
1.1	Chemistry of Corrosion, Corrosion Losses, Economic, Impact of Corrosion. Corrosion Triangle, Theories of Corrosion, Erosion Corrosion. Galvanic series of metals.	3
1.2	Formation of Corrosion Cell, Stress Concentrations and Difference	

	in Surface Condition leading to Formation of Corrosion Cells.	3
1.3	Types of Corrosion in Marine Environment, Corrosion Identification, Factors affecting Corrosion.	2
2	**Materials and Corrosion**	
2.1	Types of Steel and Tendency of Corrosion, Use of HTS, Stainless Steel, Corrosion of Titanium and Nickel alloys, Copper and Copper Based Alloys, Zinc, Aluminium and its Alloys	3
2.2	Corrosion on Propeller, Marine machinery and Deck fittings.	1
2.3	**Surface Preparation of Steel:** Material Storage and Preservation in Shipyard, Treatment of Steel in Shipyards. Degreasing, Weathering, Mechanical Surface Cleaning, Pickling, Blast Cleaning, Flame Cleaning.	3
3	**Marine Paints and Paint Schemes in Ships**	
3.1	Classification of Paints- Common Paint Vehicles: Drying Oils, Oleoresins, Alkyd Resins, Polymerizing Chemicals and Bitumen. Role of Constituents of Paints.	3
3.2	Suitability of Each for Various Applications. Typical Paint Schemes for Underwater Areas, Boot Topping, Top sides, Weather Decks, Superstructures and Tank Interiors.	3
4	**Paints and Corrosion Monitoring**	
4.1	Mechanism of Anticorrosive Paint, Paint Types and Selection. Antifouling paints- Effect of Fouling on Ships, Factors Affecting Growth and Settlement Principles of Antifouling Paints.	4
4.2	Pollution from Paints and Methods to Minimize Them, Painting Tools, Methods. Surface Preparation for Painting, Safety Precautions while using Paints	2
5	**Corrosion Control**	
5.1	Importance of Corrosion Protection, Measures to Minimise Corrosion, Corrosion Control by Design, Corrosion Inhibitors.	2
5.2	Cathodic Protection- Mechanism of Cathodic Protection, Sacrificial Anode, Design of Sacrificial Anode System for Ships, Advantages and Disadvantages of Sacrificial Anode system.	4
5.3	Impressed Current Cathodic Protection System in Ships, Advantages and Disadvantages. Principle of Anodic Protection	3

SEMESTER VII

MINOR

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
SBD481	MINIPROJECT	PWS	0	0	3	4

Preamble: This course is designed for enabling the students to apply the knowledge to address the real-world situations/problems and find solutions. The course is also intended to estimate the ability of the students in transforming theoretical knowledge studied as part of the curriculum so far in to a working model of a software system. The students are expected to design and develop a software/hardware project to innovatively solve a real-world problem.

Prerequisites: Subjects studied up to sixth semester.

Course Outcomes: After the completion of the course the student will be able to

CO No.	Course Outcome (CO)	Bloom's Category Level
CO 1	Make use of acquired knowledge within the selected area of technology for project development.	Level 3: Apply
CO 2	Identify, discuss and justify the technical aspects and design aspects of the project with a systematic approach.	Level 3: Apply
CO 3	Interpret, improve and refine technical aspects for engineering projects.	Level 3: Apply
CO 4	Associate with a team as an effective team player for the development of technical projects.	Level 3: Apply
CO 5	Report effectively the project related activities and findings.	Level 2: Understand

Mapping of course outcomes with program outcomes

POs / COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	3	3	3	3	3	3	-	-	-	3
CO 2	3	3	3	3	3	-	2	3	-	3	2	3
CO 3	3	3	3	3	3	2	3	3	-	2	3	3
CO 4	3	3	2	2	-	-	-	3	3	3	3	3
CO 5	3	-	-	-	2	-	-	3	2	3	2	3

3/2/1: high/medium/low

Assessment Pattern

The End Semester Evaluation (ESE) will be conducted as an internal evaluation based on the product, the report and a viva- voce examination, conducted by a 3-member committee appointed by Head of the Department comprising HoD or a senior faculty member, academic coordinator for that program and project guide/coordinator. The Committee will be evaluating the level of completion and demonstration of functionality/specifications, presentation, oral examination, working knowledge and involvement.

The Continuous Internal Evaluation (CIE) is conducted by evaluating the progress of the mini project through minimum of TWO reviews. At the time of the 1st review, students are supposed to propose a new system/design/idea, after completing a thorough literature study of the existing systms under their chosen area. In the 2nd review students are expected to highlight the implementation details of the proposed solution. The review committee should assess the extent to which the implementation reflects the proposed design. A well coded, assembled and completely functional product is the expected output at this stage. The final CIE mark is the average of 1st and 2nd review marks.

A zeroth review may be conducted before the beginning of the project to give a chance for the students to present their area of interest or problem domain or conduct open brain storming sessions for innovative ideas. Zeroth review will not be a part of the CIE evaluation process.

Marks Distribution

Total Marks	CIE	ESE
150	75	75

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Marks awarded by Guide : 15 marks
Project Report : 10 marks
Evaluation by the Committee : 40 Marks

End Semester Examination Pattern: The following guidelines should be followed regarding award of marks.

(a) Demonstration : 50 Marks
(b) Project report : 10 Marks
(d) Viva voce : 15marks

Course Plan

In this course, each group consisting of three/four members is expected to design and develop a moderately complex software/hardware system with practical applications. This should be a working model. The basic concept of product design may be taken into consideration.

Students should identify a topic of interest in consultation with Faculty-in-charge of miniproject/Advisor. Review the literature and gather information pertaining to the chosen topic. State the objectives and develop a methodology to achieve the objectives. Carryout the design/fabrication or develop codes/programs to achieve the objectives. Demonstrate the novelty of the project through the results and outputs. The progress of the mini project is evaluated based on a minimum of two reviews.

The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The product has to be demonstrated for its full design specifications. Innovative design concepts, reliability considerations, aesthetics/ergonomic aspects taken care of in the project shall be given due weight.

SEMESTER VII

HONOURS

SBT495	ECONOMICS IN SHIP DESIGN	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: Cost elements (capital, operational and maintenance) are the most important parameters considered by the ship owner in decision making for a new project. The ship designer needs to gain specific knowledge in economic aspects of ship design for practical application by understanding different aspects of ship's first cost and the operating cost to maximize profitability. He is required to evaluate the technical and economic performance of alternative designs of ships and their equipment, and to assist the owner to take decisions whether to build, when to build, or where to build. This course is aimed at enabling a designer to do the initial cost estimation in design phases.

Prerequisites: HUT 300, HUT 310, SBT302

Course Outcomes: After the completion of the course the student will be able to:

CO 1	Understand the basic economic aspects in shipping industry.
CO 2	Apply knowledge of engineering economy for various calculations using different engineering tools.
CO 3	Apply knowledge of economics in various aspects of ship design.
CO 4	Apply knowledge in optimizing ship design, different aspects of ship's first cost and the operating cost to maximize profitability
CO 5	Evaluate the technical and economic performance of alternative designs of ships.
CO 6	Estimate operating and maintenance costs of ships.
CO 7	Perform the initial cost estimation of a ship using the knowledge in economics.

Mapping of Course Outcomes against Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2										
CO 2	3	2		2	2							1
CO 3	3	3		2	2							1
CO 4	3	3	3	2	2							1
CO 5	3	3	3	2	2							1
CO 6	3	2										1
CO 7	2	2	1	2	2							1

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	15
Understand	10	10	25

Apply	10	10	25
Analyse	10	10	20
Evaluate	10	10	15
Create			

Mark Distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/ Drawings/Quiz : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contains 10 questions, with 2 questions from each module, having 3 marks each. Students should answer all questions. Part B contains 3 questions from each module, of which student should answer any 2. Each question can have maximum 4 sub-divisions and carry 7 marks.

Course Level Assessment Questions

Course Outcome 1 (CO 1):

1. Explain flow in an economy, Law of supply and demand.
2. Describe the following - Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis
3. What is elementary economic Analysis?

Course Outcome 2 (CO 2):

1. Describe the concept of engineering economics, engineering efficiency, scope of engineering economics
2. Explain the engineering economy calculations with reference to basic interest relationships, economic criteria and practical cash flows
3. What are the economic complexities in shipping's economic environment?

Course Outcome 3 (CO 3):

1. Describe the derived demand for ships with reference to cargo types.

2. How are economic criteria used for evaluating ship design?
3. Explain the concepts of operating costs, daily running costs, voyage costs and cargo handling costs.

Course Outcome 4 (CO 4):

1. What are the criteria for Optimizing Ship Design?
2. Illustrate the concepts of operating economics, time–value of money and cash flow profile in ship construction.
3. What is the significance of interest Relationships**?**

Course Outcome 5 (CO 5):

1. How does comparison of alternative ship designs help in cost minimisation of shipbuilding?
2. Explain the concept of optimal ship
3. What are the financial drivers in ship design optimisation?

Course Outcome 6 (CO 6):

1. Explain the practical application of economics to merchant ship design
2. Define the following economic criteria - Capital Recovery Factor, Returned Interest, Average Annual Cost, Required Freight Rate
3. How can SWBS be used in cost estimation of ships?

Course Outcome 7 (CO 7):

1. Explain Profit, Duplicate ship savings and Cost summary in shipbuilding
2. How is the initial cost of a commercial ship estimated?
3. What are the factors to be considered in ship design for cost minimisation?

Model Question paper

Question Paper Code **Total Pages: 2**

Reg No.: _____ Name: _____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B. TECH DEGREE EXAMINATION

Course Code: SBT495

Course Name: ECONOMICS IN SHIP DESIGN

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries 3 marks. Marks

1	Define the law of supply and demand.	(3)
2	Differentiate between marginal cost and marginal revenue.	(3)
3	How long will it take for an investment to triple at an interest rate of 7%, compounded monthly?	(3)
4	What are freight markets?	(3)
5	Define ARR, IRR, NPV and RFR	(3)
6	Define capital cost in shipping	(3)
7	List out the operational cost elements in shipping	(3)
8	Name the measures of merit in ship design	(3)
9	What is SWBS?	(3)
10	Define average annual cost in shipping	(3)

PART B

Module I

Answer any two full questions, each carries 7 marks.

11	Differentiate between cost and price with reference to shipbuilding.	(7)
12	Explain the concept of flow in an economy	(7)
13	A company has to replace a present facility after 15 years at an outlay of Rs. 5, 00,000. It plans to deposit an equal amount at the end of every year for the next 15 years at an interest rate of 18% compounded annually. Find the equivalent amount that must be deposited at the end of every year for the next 15 years.	(7)

Module II

Answer any two full questions, each carries 7 marks.

14	A shipyard is considering purchasing a CNC machine which costs Rs 150,0000. This machine will have an estimated service life of 10 years with a net after-tax salvage value of Rs 15,0000/-. Its annual after-tax O & M costs (considering depreciation tax shields) are estimated to be Rs 500,000. To expect an 18% rate of return on investment (after-tax), what	(7)

would be the required minimum after-tax revenues?

15 How do demand and supply scenarios influence ship acquisition programmes? (7)

16 Find the average annual cost for a ship which requires an initial investment of Rs 76 Crores with 15% annual operating cost. The ship's life span is 25 years. The interest rate is 16%. (7)

Module III

Answer any two full questions, each carries 7 marks.

17 Explain the economic criteria for evaluating a ship design. (7)

18 Describe the practical applications of techno-economic calculations in shipbuilding. (7)

19 Which is the better freight contract for the owner of an existing ship: one with an NPV of Rs 50 Crores, with a duration of 8 years, or one with Rs 55 Crores over 10 years? Owner's opportunity cost of capital 10 per cent. (7)

Module IV

Answer any two full questions, each carries 7 marks.

20 Describe the cost estimating relationships in shipbuilding. (7)

21 What are the various measures of merit in ship design optimisation? Explain with examples. (7)

22 Explain the major factors affecting the design of an optimal ship. (7)

Module V

Answer any two full questions, each carries 7 marks.

23 How does SWBS enable costing estimation? (7)

24 How is the total cost of a ship estimated? (7)

25 Explain the terms Capital Recovery Factor, Returned Interest, Average Annual Cost, Required Freight Rate (7)

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SYLLABUS

Module 1

Introduction to Economics- Flow in an economy, Law of supply and demand, Economic efficiency, Scope of economics- Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis - V ratio, Elementary economic Analysis, Interest relationships, Depreciation.

Module 2

Concept of Engineering Economics, Engineering efficiency, Engineering Economy Calculations in shipping: Basic Interest Relationships, Economic Criteria, Practical Cash Flows, Some Economic Complexities, Shipping's Economic Environment: Demand for Marine Transport, Supply of Marine Transport, Freight Markets, Operating Economics

Module 3

Economics in Ship Design; The derived demand for ships, Cargo type and ship design, Fitting the ship to the shipping operation, Economic criteria for evaluating ship design (Average rate of return (ARR), Internal Rate of Return (IRR), Net Present Value (NPV), Required Freight Rate (RFR), AAC Average Annual Cost), Practical application of techno-economic calculation, Operational Economics, Ship owners and operations, Types of cost estimates - Concept Design (ship type oriented), Preliminary Design (ship systems oriented), Contract Design (interim product and manufacturing process oriented). Capital costs, Operating Costs, Daily running costs, Voyage costs, Cargo handling costs, Typical cost figures.

Module 4

Cost estimating relationships (CER) - Manual CERs, Calculated CERs, Predictive CERs, Empirical CERs. Criteria for Optimizing Ship Design, Measures of merit, Operating Economics, Time–Value of Money, Cash Flow Profile, Comparison of Alternative Ship Designs, Cost trade off methodologies, Choice of optimal ship for given cargo and speed.

Module 5

Practical application of economics to merchant ship design, Economic criteria – Capital Recovery Factor, Returned Interest, Average Annual Cost, Required Freight Rate, Weight Breakdown. Building Cost – Hull structure cost, Outfitting cost, Machinery cost, Miscellaneous cost, Overhead cost, Profit, Duplicate ship savings, Cost summary. Practical cost estimation of a ship

Text Books

1. I. L. Buxton; Engineering economics and ship design, ISBN 0950276820, British Ship Research Association, 1976.
2. Harry Benford; A Naval Architect's Guide to Practical Economics, 1991, University of Michigan
3. Chan S. Park; Fundamentals of Engineering Economics, ISBN 10: 0-273-77291-0, Pearson International Edition 2013

Reference Books

1. SC Mishra, O P Sha; Engineering Economics in Ship Design, IIT Kharagpur, 1994
2. Charles E. Dart; Cost Estimating - Ship Design and Construction, The University of Michigan's Engineering Summer Conference on Economics in Ship Design, June 8-12, 1970
3. DGM Watson; Practical Ship Design, Elsevier Ocean Engineering Book Series, 1998, ISBN: 0-08-042999-8
4. T Lamb (Ed.); Ship Design and Construction, SNAME 2003, ISBN 0-939773-40-6,
5. H Benford; Practical Application of Economics to Merchant Ship Design, SNAME 1967

Course Contents and Lecture Schedule

SL.No	Topic	Hours
1.	**Introduction to Economics**	
1.1	Introduction to Economics- Flow in an economy, Law of supply and demand	3
1.2	Concept of Engineering Economics, Engineering efficiency, Economic efficiency	3
1.3	Scope of economics- Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis- V ratio, Elementary economic Analysis	3
2	**Engineering Economics**	
2.1	Engineering Economy Calculations: Basic Interest Relationships, Economic Criteria, Practical Cash Flows	4
2.2	Some Economic Complexities, Shipping's Economic Environment: Demand for Marine Transport, Supply of Marine Transport, Freight Markets, Operating Economics	4
3	**Economics in Ship Design**	
3.1	The derived demand for ships, Cargo type and ship design, Fitting the ship to the shipping operation	3

3.2	Economic criteria for evaluating ship design (ARR, IRR, NPV, RFR), Practical application of techno-economic calculation, Operational Economic, Ship owners and operations, Operating Costs, Daily running costs, Voyage costs, Cargo handling costs.	5
4	**Ship Design Optimisation**	
4.1	Criteria for Optimizing Ship Design, Operating Economics, Time - Value of Money, Cash Flow Profile, Interest Relationships,	4
4.2	Comparison of Alternative Ship Designs, Cost trade off methodologies, The Optimal Ship	4
5	**Practical application of economics to merchant ship design**	
5.1	Economic criteria – Capital Recovery Factor, Returned Interest, Average Annual Cost, Required Freight Rate,	3
5.2	Weight Breakdown. Building Cost – Hull structure cost, Outfitting cost, Machinery cost, Miscellaneous cost, Overhead cost	3
5.3	Profit, Duplicate ship savings, Cost summary, Cost estimate examples	5

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SEMESTER VIII

SBT402	OFFSHORE STRUCTURES	CATEGORY	L	T	P	CREDIT
		PCC	2	1	0	3

Preamble: The goal of this course is to introduce the domain of offshore engineering, its history and significance and impart basic knowledge on the loads acting on floating and fixed structures, the methods of calculation of these loads and response of structure.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the basic concepts of offshore engineering by being familiar with different types of structures their functions and applications
CO 2	Explain ocean wave properties, wave theories and their applicability regime.
CO 3	Acquire a basic understanding of the sea loads (wind, wave & current) acting on offshore structures and their applicability regime.
CO 4	Demonstrate the various offshore design process.
CO 5	Identify and list the function of the different components of conventional offshore structures.
CO 6	Illustrate different methods of offshore installations.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	1										1
CO 2	2	1										1
CO 3	2	3										1
CO 4	2	3										1
CO 5	3	2										1
CO 6	3	2										1

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	40
Apply	20	20	50
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 3 questions from each module of which student should answer any two. Each question can have maximum 3 sub-divisions and carry 7 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What are the different types of offshore structures?

2. Explain a jack up platform with the help of a neat figure

3. Explain the various parameters that influence the selection of Deepwater production systems.

Course Outcome 2 (CO2)

1. Write a note on fully developed sea. What are the conditions for the breaking of a wave?

2. Derive the expression for horizontal velocity and acceleration from Laplace Equation in Linear Wave Theory.

3. Explain the chemical composition of sea water.

Course Outcome 3 (CO3)

1. Explain a) Wave Slam Load, b) Wave Slap Load, c) Wave Breaking Load.

2. What are the assumptions used in Morison Equation? Derive the expression for the total load acting on a cylindrical member.

3. How will you estimate the wave Loads acting on a member?

Course Outcome 4(CO4):

1. What are the various sources of damping in a floating system? Explain beat phenomena.

2. What is the need of damping in an offshore structure? Derive the expression for a free damped condition. Also mention the different damping conditions.

3. Derive the expression for the displacement of the system, and the phase angle, for a forced linearly damped system. Explain the term dynamic amplification factor.

Course Outcome 5 (CO5):

1. Write a note on:

   a. Transverse Stability of floating offshore platforms.

   b. Longitudinal Stability of floating offshore platforms.

   c. Dynamic Stability of floating offshore platforms.

2. Explain, with diagram, the various platform bracing patterns of jacket structures.

3. Write a note on concept selection of floating offshore platforms.

Course Outcome 6 (CO6):

1. Explain the different stages in the construction and installation of offshore gravity towers

2. With the support of neat sketches describe the various stages in the installation of an offshore jacket structure.

3. Differentiate between wet towing and dry towing with the aid of suitable examples. How you decide upon which mode of towing to choose.

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B. TECH DEGREE EXAMINATION, XXXX 20XX

Course Code: SBT402

Course Name: OFFSHORE STRUCTURES

Max. Marks: 100 **Duration: 3 Hours**

PART A

(Answer all questions, each carries 3 Marks)

Question Number		Marks
1	Classify novel and small field offshore structures.	(3)
2	What are the assumptions in deriving linear wave theory?	(3)
3	What are the assumptions used in Morison Equation? Write the Morison equation in its general form.	(3)
4	What is the expression of variation of wind speed across different elevations?	(3)
5	Write the equation for the general theory of oscillation.	(3)
6	Write a note on the interaction of two floating structures.	(3)
7	What are the major components of a jacket structure?	(3)
8	Write notes on environmental loads and constructional loads.	(3)
9	What are the different platform installation methods?	(3)
10	What is sea fastening?	(3)

PART B

(Answer any two full questions from each modules, each full question carries 7 Marks)

MODULE I

11	What are the different types of offshore structures?	(7)
12	Write a note on jacket of structures. State the advantages and disadvantages.	(7)
13	Derive the dispersion relationship for infinite water depth.	(7)

MODULE II

14	How will you estimate the wave Loads acting on a member?	(7)
15	Using Dimensional Analysis, show that the force on a structural member subjected to waves is a function of (KC, Re, (πD/L), e, VR). KC: Keulegan Carpenter Number, Re: Reynolds Number, (πD/L): Diffraction Parameter, e: Relative Surface Roughness.	(7)
16	What are the assumptions used in Morison Equation? Derive the expression for the total load acting on a cylindrical member.	(7)

MODULE III

17	What is Damping Factor? How will the damping in a system vary with the value of damping factor?	(7)

18	Explain the importance of high frequency responses in the design of a TLP.	(7)
19	What is the difference between free vibration and forced vibration?	(7)

MODULE IV

20	Draw the design spiral for an offshore floating system and explain each stage of the spiral in detail.	(7)
21	Explain, with diagram, the various platform bracing patterns of jacket structures.	(7)
22	What is the functional requirement of a floating offshore platform?	(7)

MODULE V

23	Describe the various stages in the installation of a TLP.	(7)
24	Explain the different platform installation methods:	
	a) Heavy Lift.	(3)
	b) Launch.	(2)
	c) Mating.	(2)
25	Differentiate between wet towing and dry towing with the aid of suitable examples. How you decide upon which mode of towing to choose.	(7)

SYLLABUS

Module 1

Historical Development of Offshore Structures: Definition of Offshore structures, Brief Historical Development, Selection of Deepwater Production Concepts; Deepwater Challenges; Functions of Offshore Structures; Offshore Structure Configurations; Bottom Supported Fixed Structures, Compliant Structures, Floating Structures; Classification Societies & Industry Standards.

Novel & Small Field Offshore Structures: Bottom Supported Systems, Neutrally-Buoyant Floating Systems, Positively Buoyant Floating Systems.

Oceanic Environment (Basic Theory Only): Introduction; Ocean Water Properties-Density, Viscosity, Salinity & Temperature; Wave Theory- Linear, Second Order Stokes, Fifth Order Stokes, Stream Function, Stretching Formulae for Waves at SWL, Applicability of Wave Theories, Wave Group, Series Representation of Long Crested Waves; Wave Breaking; Internal Waves; Sea Spectrum (Definition Only), Directional Spectrum (Definition Only); Sea States; Wave Driven Current-Steady Uniform Current, Steady Shear Current, Combined Current & Waves; Wind & Wind Spectrum, Wind Speed; Offshore Environment by Location.

Module 2

Loads on Offshore Structures (Basic Theory Only): Introduction- Dimensionless Parameters; Gravity Loads; Hydrostatic Loads; Resistance Loads; Current Loads- Current Drag & Lift Force, Blockage Factor in Current; Steady & Dynamic Wind Loads on Structures; Wave Loads on Structures- Morison Equation, Forces on Oscillating Structures, Combined Wave and Current Loads, Froude-Krylov Force on Structure, Wave Diffraction Force on Structure, Added Mass and Damping Coefficients; Applicability of Morison Force Vs Diffraction Force; Steady Wave-Drift Force – Steady Drift Potential Force, Viscous Drift Force; Slow Drift Wave Forces; Varying Wind Load; Impulse Loads- Wave Slamming, Wave Breaking, Wave Run-Up.

Module 3

Response of Structures (Basic Theory Only): Structure Motion in One Degree; Transient Response of Structures; Forced Linearly Damped System; Non- Linearly Damped Structure Response; Motions of Floating Structure; Interaction of Two Floating Structures; Slowly Varying Response; Simplified Computation of Slow Drift Oscillation; High Frequency Response; Types of Hydrodynamic Damping of Floating Systems; Applicability of Response Formulae.

Module 4

Introduction to Fixed Offshore Platform Design: Introduction to field development, Design Spiral and Field Development Timeline, Factors That Drive Concept Selection, Field

Development Design Phases; Major Structural Components of a Jacket Platform; Types of Loads on a Fixed Platform; Detailed Structural Design Schedule; Selection of Design Parameters (Basics Only); Selection of Member Sizes; Deck Leg & Deck Structure; Jacket Bracing Configurations.

Introduction to Floating Offshore Platform Design: Types of Floating Platforms- Functions of Floating Platforms, Motions of Floating Platforms, Concept Selection; Design of Floaters- Functional Requirements, Configuration Proportions, Weight Control, Stability, Co-ordinate Systems & Transformations.

Module 5

Offshore Installation: Introduction; Fixed Platform Substructures- Types, Jackets, Compliant Towers, Gravity Base Structures; Floating Structures- Types, Installation of FPSOs, Installation of Semi Submersibles, Installation of TLPs, Spar Installation; Load Out Methods; Transportation- Configuration, Barges & Heavy Lift Ships (introduction only), Sea Fastenings/Tie Downs; Platform Installation Methods- Heavy Lift, Launch, Mating.

Text Books

1. Subrata. K. Chakrabarti; Handbook of Offshore Engineering Vol I & II; Elsevier, 2005.

2. Angus Mather; Offshore Engineering- An Introduction; Witherby & Co, 2000.

Reference Books

1. D.V Reddy, A. S. J Swamidas; Essentials of Offshore Structures- Framed & Gravity Platforms; CRC Press.

2. Mohammed A El Reedy; Offshore Structures- Design, Construction and Maintenance; Gulf Professional Publishing.

3. S.K Chakrabarti; Hydrodynamics of Offshore Structures; WIT Press.

4. William L. Leffler, Richard Pattarozi, Gordon Sterling; Deepwater Petroleum Exploration & Production – A Non Technical Guide; PennWell Books.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Module 1**	
1.1	**Historical Development of Offshore Structures:** Definition of Offshore structures, Brief Historical Development.	1
1.2	Selection of Deepwater Production Concepts, Deepwater Challenges;	3

	Functions of Offshore Structures; Offshore Structure Configurations; Bottom Supported Fixed Structures, Compliant Structures, Floating Structures; Classification Societies & Industry Standards.	
1.3	**Novel & Small Field Offshore Structures:** Bottom Supported Systems, Neutrally-Buoyant Floating Systems, Positively Buoyant Floating Systems.	2
1.4	**Oceanic Environment (Basic Theory Only):** Introduction; Ocean Water Properties-Density, Viscosity, Salinity & Temperature; Wave Theory-Linear, Second Order Stokes, Fifth Order Stokes, Stream Function, Stretching Formulae for Waves at SWL, Applicability of Wave Theories, Wave Group, Series Representation of Long Crested Waves; Wave Breaking; Internal Waves; Sea Spectrum (Definition Only), Directional Spectrum (Definition Only); Sea States; Wave Driven Current-Steady Uniform Current, Steady Shear Current, Combined Current & Waves; Wind & Wind Spectrum, Wind Speed; Offshore Environment by Location.	4
2	**Module 2**: **Loads on Offshore Structures (Basic Theory Only**	
2.1	Introduction- Dimensionless Parameters; Gravity Loads; Hydrostatic Loads; Resistance Loads; Current Loads - Current Drag & Lift Force, Blockage Factor in Current	2
2.2	Steady & Dynamic Wind Loads on Structures; Wave Loads on Structures-Morison Equation, Forces on Oscillating Structures, Combined Wave and Current Loads, Froude-Krylov Force on Structure, Wave Diffraction Force on Structure, Added Mass and Damping Coefficients	3
2.3	Applicability of Morison Force Vs Diffraction Force; Steady Wave-Drift Force – Steady Drift Potential Force, Viscous Drift Force; Slow Drift Wave Forces; Varying Wind Load; Impulse Loads- Wave Slamming, Wave Breaking, Wave Run-Up.	3
3	**Module 3**	
3.1	**Response of Structures (Basic Theory Only):** Structure Motion in One Degree; Transient Response of Structures; Forced Linearly Damped System; Non- Linearly Damped Structure Response	2
3.2	Motions of Floating Structure; Interaction of Two Floating Structures; Slowly Varying Response; Simplified Computation of Slow Drift Oscillation	2
3.3	High Frequency Response; Types of Hydrodynamic Damping of Floating Systems; Applicability of Response Formulae.	2
4	**Module 4**	
4.1	**Introduction to Fixed Offshore Platform Design**: Introduction to field development, Design Spiral and Field Development Timeline, Factors That Drive Concept Selection, Field Development Design Phases; Major Structural Components of a Jacket Platform; Types of Loads on a Fixed Platform; Detailed Structural Design Schedule; Selection of Design Parameters (Basics Only); Selection of Member Sizes; Deck Leg & Deck Structure; Jacket Bracing Configurations.	4

4.2	**Introduction to Floating Offshore Platform Design:** Types of Floating Platforms- Functions of Floating Platforms, Motions of Floating Platforms, Concept Selection; Design of Floaters- Functional Requirements, Configuration Proportions, Weight Control, Stability, Co-ordinate Systems & Transformations.	2
5	**Module 5**	
5.1	**Offshore Installation: Introduction;** Fixed Platform Substructures - Types, Jackets, Compliant Towers, Gravity Base Structures	2
	Floating Structures - Types, Installation of FPSOs, Installation of Semi Submersibles, Installation of TLPs, Spar Installation; Load Out Methods	2
	Transportation- Configuration, Barges & Heavy Lift Ships (introduction only), Sea Fastenings/Tie Downs; Platform Installation Methods- Heavy Lift, Launch, Mating.	3

SBT404	COMPREHENSIVE COURSE VIVA	CATEGORY	L	T	P	CREDIT
		PCC	1	0	0	1

Preamble: The objective of this Course viva is to ensure the basic knowledge of each student in the most fundamental core courses in the curriculum. The viva voce shall be conducted based on the core subjects studied from third to eighth semester. This course helps the learner to become competent in placement tests and other competitive examinations.

Guidelines

1. The course should be mapped with a faculty and classes shall be arranged for practicing questions based on the core courses listed in the curriculum.
2. The viva voce will be conducted by the same three member committee assigned for final project phase II evaluation. It comprises of Project coordinator, expert from Industry/research Institute and a senior faculty from a sister department.
3. The pass minimum for this course is 25.
4. The mark will be treated as internal and should be uploaded along with internal marks of other courses.
5. Comprehensive Viva should be conducted along with final project evaluation by the three member committee.

Mark Distribution

Total marks: 50, only CIE, minimum required to pass : 25 Marks

SBD416	PROJECT PHASE II	CATEGORY	L	T	P	CREDIT
		PWS	0	0	12	4

Preamble: The course 'Project Work' is mainly intended to evoke the innovation and invention skills in a student. The course will provide an opportunity to synthesize and apply the knowledge and analytical skills learned, to be developed as a prototype or simulation. The project extends to 2 semesters and will be evaluated in the 7th and 8th semester separately, based on the achieved objectives. One third of the project credits shall be completed in 7th semester and two third in 8th semester. It is recommended that the projects may be finalized in the thrust areas of the respective engineering stream or as interdisciplinary projects. Importance should be given to address societal problems and developing indigenous technologies.

Course Objectives

- To apply engineering knowledge in practical problem solving.
- To foster innovation in design of products, processes or systems.
- To develop creative thinking in finding viable solutions to engineering problems.

Course Outcomes [COs]: After successful completion of the course, the students will be able to:

CO1	Model and solve real world problems by applying knowledge across domains (Cognitive knowledge level: **Apply**).
CO2	Develop products, processes or technologies for sustainable and socially relevant applications (Cognitive knowledge level: **Apply**).
CO3	Function effectively as an individual and as a leader in diverse teams and to comprehend and execute designated tasks (Cognitive knowledge level: **Apply**).
CO4	Plan and execute tasks utilizing available resources within timelines, following ethical and professional norms (Cognitive knowledge level: **Apply**).
CO5	Identify technology/research gaps and propose innovative/creative solutions (Cognitive knowledge level: **Analyze**).
CO6	Organize and communicate technical and scientific findings effectively in written and oral forms (Cognitive knowledge level: **Apply**).

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	1	2	2	2	1	1	1	1	2
CO2	2	2	2		1	3	3	1	1		1	1
CO3									3	2	2	1
CO4					2			3	2	2	3	2
CO5	2	3	3	1	2							1
CO6					2			2	2	3	1	1

Abstract POs defined by National Board of Accreditation			
PO #	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work
PO4	Conduct investigations of complex problems	PO0	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Lifelong learning

PROJECT PHASE II

Phase 2 Targets

- In depth study of the topic assigned in the light of the report prepared under Phase - I;
- Review and finalization of the approach to the problem relating to the assigned topic.
- Preparing a detailed action plan for conducting the investigation, including teamwork.
- Detailed Analysis/ Modeling / Simulation/ Design/ Problem Solving/Experiment as needed.
- Final development of product/ process, testing, results, conclusions and future directions.
- Preparing a paper for Conference Presentation/ Publication in Journals, if possible.
- Presenting projects in Project Expos conducted by the University at the cluster level and/ or state level as well as others conducted in India and abroad.
- Filing Intellectual Property Rights (IPR) if applicable.
- Preparing a report in the standard format for being evaluated by the Department Assessment Board.
- Final project presentation and viva voce by the assessment board including the external expert.

Evaluation Guidelines & Rubrics

Total: 150 marks (Minimum required to pass: 75 marks).

- Project progress evaluation by guide: 30 Marks.
- Two interim evaluations by the Evaluation Committee: 50 Marks (25 marks for each evaluation).
- Final evaluation by the Final Evaluation committee: 40 Marks
- Quality of the report evaluated by the evaluation committee: 30 Marks

(The evaluation committee comprises HoD or a senior faculty member, Project coordinator and project supervisor. The final evaluation committee comprises of Project coordinator, expert from Industry/research/academic Institute and a senior faculty from a sister department).

Evaluation by the Guide

The guide/supervisor must monitor the progress being carried out by the project groups on regular basis. In case it is found that progress is unsatisfactory it should be reported to the Department Evaluation Committee for necessary action. The presence of each student in the group and their involvement in all stages of execution of the project shall be ensured by the guide. Project evaluation by the guide: 30 Marks. This mark shall be awarded to the students in his/her group by considering the following aspects:

Project Scheduling & Distribution of Work among Team members: Detailed and extensive Scheduling with timelines provided for each phase of project. Work breakdown structure well defined. (5)

Literature survey: Outstanding investigation in all aspects. (4)

Student's Diary/ Daily Log: The main purpose of writing daily diary is to cultivate the habit of documenting and to encourage the students to search for details. It develops the students' thought process and reasoning abilities. The students should record in the daily/weekly activity diary the day to day account of the observations, impressions, information gathered and suggestions given, if any. It should contain the sketches & drawings related to the observations made by the students. The daily/weekly activity diary shall be signed after every day/week by the guide. (7)

Individual Contribution: The contribution of each student at various stages. (9)

Completion of the project: The students should demonstrate the project to their respective guide. The guide shall verify the results and see that the objectives are met. (5)

EVALUATION RUBRICS for PROJECT Phase II: Interim Evaluation - 1

No.	Parameters	Marks	Poor	Fair	Very Good	Outstanding
2-a	Novelty of idea, and Implementation scope [CO5] [Group Evaluation]	5	The project is not addressing any useful requirement. The idea is evolved into a non-implementable one. The work presented so far is lacking any amount of original work by the team.	Some of the aspects of the proposed idea can be implemented. There is still lack of originality in the work done so far by the team. The project is a regularly done theme/topic without any freshness in terms of specifications, features, and/or improvements.	Good evidence of an implementable project. There is some evidence for the originality of the work done by the team . There is fresh specifications/ features/improvements suggested by the team. The team is doing a design from fundamental principles, and there is some independent learning and engineering ingenuity.	The project has evolved into incorporating an outstandingly novel idea. Original work which is not yet reported anywhere else. Evidence for ingenious way of innovation which is also Implementable. Could be a patentable / publishable work.
			(0 – 1 Marks)	(2 – 3 Marks)	(4 Marks)	(5 Marks)
2-b	Effectiveness of task distribution among team members. [CO3] [Group Evaluation]	5	No task distribution of any kind. Members are still having no clue on what to do.	Task allocation done, but not effectively, some members do not have any idea of the tasks assigned. Some of the tasks were identified but not followed individually well.	Good evidence of task allocation being done, supported by project journal entries, identification of tasks through discussion etc. However, the task distribution seems to be skewed, and depends a few members heavily than others. Mostly the tasks are being followed by the individual members.	Excellent display of task identification and distribution backed by documentary evidence of team brainstorming, and project journal entries. All members are allocated tasks according to their capabilities, and as much as possible in an equal manner. The individual members are following the tasks in an excellent manner.
			(0 – 1 Marks)	(2 – 3 Marks)	(4 Marks)	(5 Marks)
2-c	Adherence to project schedule. [CO4] [Group Evaluation]	5	Little or no evidence of continued planning or scheduling of the project. The students did not stick to the plan what they were going to build nor plan on what materials / resources to use in the project. The students do not have any idea on the budget required even after the end of phase - I. No project journal kept or the journal.	There is some improvement in the primary plan prepared during phase I. There were some ideas on the materials /resources required, but not really thought out. The students have some idea on the finances required, but they have not formalized a budget plan. Schedules were not prepared. The project journal has no useful details on the project.	Good evidence of planning done and being followed up to a good extent after phase I. Materials were listed and thought out, but the plan wasn't followed completely. Schedules were prepared, but not detailed, and needs improvement. Project journal is presented but it is neither complete nor updated regularly.	Excellent evidence of enterprising and extensive project planning and follow-up since phase I. Continued use of project management/version control tool to track the project. Material procurement if applicable is progressing well. Tasks are updated and incorporated in the schedule. A well-kept project journal showed evidence for all the above, in addition to the interaction with the project guide.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)

2-d	Interim Results. [CO6] [Group assessment]	**5**	There are no interim results to show.	The team showed some interim results, but they are not complete / consistent to the current stage, Some corrections are needed.	The interim results showed were good and mostly consistent/correct with respect to the current stage. There is room for improvement.	There were significant interim results presented which clearly shows the progress.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-e	Presentation [Individual assessment]	**5**	Very poor presentation and there is no interim results. The student has no idea about the project proposal.	Presentation is average, and the student has only a feeble idea about the team work.	Good presentation. Student has good idea about the team's project. The overall presentation quality is good.	Exceptionally good presentation. Student has excellent grasp of the project. The quality of presentation is outstanding.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
Phase-II Interim Evaluation - 1 Total Marks: 25						

EVALUATION RUBRICS for PROJECT Phase II: Interim Evaluation – 2

No	Parameters	Marks	Poor	Fair	Very Good	Outstanding
2-f	Application of engineering knowledge [CO1] [Individual Assessment]	**10**	The student does not show any evidence of applying engineering knowledge on the design and the methodology adopted. The student's contribution in application of engineering knowledge in the project is poor.	The student appears to apply some basic knowledge, but not able to show the design procedure and the methodologies adopted in a comprehensive manner.	The student is able to show some evidence of application of engineering knowledge in the design and development of the project to good extent.	Excellent knowledge in design procedure and its adaptation. The student is able to apply knowledge from engineering domains to the problem and develop solutions.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)
2-g	Involvement of individual members [CO3] [Individual Assessment]	**5**	No evidence of any Individual participation in the project work.	There is evidence for some amount of individual contribution, but is limited to some of the superficial tasks.	The individual contribution is evident. The student has good amount of involvement in core activities of the project.	Evidence available for the student acting as the core technical lead and has excellent contribution to the project.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-h	Results and inferences upon execution [CO5] [Group Assessment]	**5**	None of the expected outcomes are achieved yet. The team is unable to derive any inferences on the failures/ issues observed. Any kind o f observations or studies are not made.	Only a few of the expected outcomes are achieved. A few inferences are made on the observed failures/issues. No further work suggested.	Many of the expected outcomes are achieved. Many observations and inferences are made, and attempts to identify the issues are done. Some suggestions are made for further work.	Most of the stated outcomes are met. Extensive studies are done and inferences drawn. Most of the failures are addressed and solutions suggested. Clear and valid suggestions made for further work.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-i	Documentation and presentation. ·[CO6] [Individual assessment]	**5**	The individual student has no idea on the presentation of his/her part. The presentation is of poor quality.	Presentation's overall quality needs to be improved.	The individual's presentation performance is satisfactory.	The individual's presentation is done professionally and with great clarity. The individual's performance is excellent.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
Phase-II Interim Evaluation - 2 Total Marks: 25						

EVALUATION RUBRICS for PROJECT Phase II: Final Evaluation						
No	**Parameters**	**Marks**	**Poor**	**Fair**	**Very Good**	**Outstanding**
2-j	Engineering knowledge. [CO1] [Group Assessment]	10	The team does not show any evidence of applying engineering knowledge on the design and the methodology adopted.	The team is able to show some of the design procedure and the methodologies adopted, but not in a comprehensive manner.	The team is able to show evidence of application of engineering knowledge in the design and development of the project to good extent. There is scope for improvement.	Excellent knowledge in design procedure and its adaptation. The team is able to apply knowledge from engineering domains to the problem and develop an excellent solution.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)
2-k	Relevance of the project with respect to societal and/or industrial needs. [Group Assessment] [CO2]	5	The project as a whole do not have any societal / industrial relevance at all.	The project has some relevance with respect to social and/or industrial application. The team has however made not much effort to explore further and make it better.	The project is relevant to the society and/or industry. The team is mostly successful in translating the problem into an engineering specification and managed to solve much of it.	The project is exceptionally relevant to society and/or industry. The team has made outstanding contribution while solving the problem in a professional and/ or ethical manner.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-i	Innovation / novelty / Creativity [CO5] [Group Assessment]	5	The project is not addressing any useful requirement. The idea is evolved into a non-implementable one. The work presented so far is lacking any amount of original work by the team.	Some of the aspects of the proposed idea appears to be practical. There is still lack of originality in the work done. The project is a regularly done theme/topic without any freshness in terms of specifications, features, and/ or improvements.	Good evidence of an implementable project. There is some evidence for the originality of the work done by the team. There is fresh specifications/ features/improvements suggested by the team. The team is doing a design from fundamental principles, and there is some independent learning and engineering ingenuity. Could be translated into a product / process if more work is done.	The project has evolved into incorporating an outstandingly novel idea. Original work which is not yet reported anywhere else. Evidence for ingenious way of innovation which is also Implementable. Could be a patentable publishable work.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-m	Quality of results / conclusions / solutions. [CO1] [Group Assessment]	10	None of the expected outcomes are achieved. The team is unable to derive any inferences on the failures/issues observed. Any kind of observations or studies is not made.	Only a few of the expected outcomes are achieved. A few inferences are made on the observed failures/issues. No further work suggested.	Many of the expected outcomes are achieved. Many observations and inferences are made, and attempts to identify the issues are done. Some suggestions are made for further work.	Most of the stated outcomes are met. Extensive studies are done and inferences drawn. Most of the failures are addressed and solutions suggested. Clear and valid suggestions made for further work.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)

2-n	Presentation - Part I Preparation of slides. [CO6] [Group Assessment].	5	The presentation slides are shallow and in a clumsy format. It does not follow proper organization.	Presentation slides follow professional style formats to some extent. However, its organization is not very good. Language needs to be improved. All references are not cited properly, or acknowledged. Presentation slides needs to be more professional.	Presentation slides follow a good style format and there are only a few issues. Organization of the slides is good. Most of references are cited properly. The flow is good and team presentation is neatly organized. Some of the results are not clearly shown. There is room for improvement.	The presentation slides are exceptionally good. Neatly organized. All references cited properly. Diagrams/Figures, Tables and equations are properly numbered, and l i s ted. Results/ inferences clearly highlighted and readable.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
	Presentation - Part II: Individual Communication [CO6] [Individual Assessment].	5	The student is not communicating properly. Poor response to questions.	The student is able to explain some of the content. The student requires a lot of prompts to get to the idea. There are language issues.	Good presentation/ communication by the student. The student is able to explain most of the content very well. There are however, a few areas where the student shows lack of preparation. Language is better.	Clear and concise communication exhibited by the student. The presentation is outstanding. Very confident and tackles all the questions without hesitation. Exceptional traits of communicator.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
Phase-II Final Evaluation, Marks: 40						

EVALUATION RUBRICS for PROJECT Phase II: Report Evaluation						
Sl. No.	**Parameters**	**Marks**	**Poor**	**Fair**	**Very Good**	**Outstanding**
2-o	Report [CO6]	30	The prepared report is shallow and not as per standard format. It does not follow proper organization. Contains mostly unacknowledged content. Lack of effort in preparation is evident. References are not cited. Unprofessional and inconsistent formatting.	Project report follows the standard format to some extent. However, its organization is not very good. Language needs to be improved. All references are not cited properly in the report. There is lack of formatting consistency.	Project report shows evidence of systematic documentation. Report is mostly following the standard style format and there are only a few issues. Organization of the report is good. Mostly consistently formatted. Most of references/sources are cited/ acknowledged properly.	The report is exceptionally good. Neatly organized. All references cited properly. Diagrams/Figures, Tables and equations are properly numbered, and listed and clearly shown. Language is excellent and follows professional styles. Consistent formatting and exceptional readability.
			(0 - 11 Marks)	(12 - 18 Marks)	(19 - 28 Marks)	(29 - 30 Marks)
Phase - II Project Report Marks: 30						

SEMESTER VIII

PROGRAM ELECTIVE III

SBT414	JOINING TECHNIQUES IN SHIPBUILDING TECHNOLOGY	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course has been developed to impart knowledge on various joining techniques used in ship building technology. The theory and application different manual/ automatic joining techniques are covered in detail.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to:

CO 1	Explain types of welding, welding process and welding parameters used in shipbuilding.
CO 2	Identify the GMAW, its process and different types of metal transfers.
CO 3	Elucidate various welding process that are used in production shop and in building berths.
CO 4	Classify the welding defects, destructive tests and its classifications and explain WPS, WPQ and WPQR related to quality control of welding.
CO 5	Explain application of Robotic welding in shipbuilding.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2										1
CO 2	3	2										1
CO 3	3	2										1
CO 4	3	2										1
CO 5	3	2										1

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	40
Apply	20	20	50
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 3 questions from each module of which student should answer any two. Each question can have maximum 4 sub-divisions and carry 7 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain welding and classification of welding process.

2. What all parameters that affecting welding and explain their effects?

3. Draw the sketch of Laser beam welding and explain the welding process.

Course Outcome 2 (CO2)

1. Explain the advantages and disadvantages of Gas metal arc welding.

2. Define electrodes and explain the classification of electrodes.

3. Describe adhesive bonding with the essential steps required to make an adhesive joint.

Course Outcome 3 (CO3):

1. Explain Carbon dioxide welding.

2. Explain the types of Resistance welding with figures.

3. Differentiate between Electro slag and Electro gas welding.

Course Outcome 4 (CO4):

1.Explain WPS, WPQ, WPQR.

2. Explain Magnetic particle testing.

3. Explain the types of welding defects with neat sketches.

Course Outcome 5 (CO5):

1. What are types of industrial robots?

2. What are some of the key factors to be analysed before implementing a robotic system?

3. Differentiate between Rectilinear and Articulated robots, with the use of sketches.

Model Question paper

Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, XXXXX 20XX

Course Code: SBT414

Course Name: JOINING TECHNIQUES IN SHIPBUILDING TECHNOLOGY

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions. Each question carries 3 marks Marks

1.	Define welding and List different types of welding processes.	(3)
2	Explain any three characteristics of MIG welding?	(3)
3	What are advantages of SAW?	(3)
4	Differentiate between GTAW and GMAW.	(3)
5	What are the main causes of distortion in welding?	(3)
6	Which NDT methods can be used to detect internal defects?	(3)
7	Explain application of robotic welding in ship production.	(3)
8	Define the term robot and list its application in shipyards.	(3)
9	Write down different joint methods in adhesive bonding?	(3)
10	Explain the need for edge preparation in welding.	(3)

PART B

Answer any two full questions from each module. Each question carries 7 marks

Module 1

11		What are the parameters that effect welding?	(7)
12	A	Explain the structure of metals with help of solidification rate vs temperature gradient graph.	(3)
	B	What do you mean by HAZ? Also state its classification.	(2)

	C	Draw the sketch of Laser beam welding and explain the welding process.	(2)
13	A	List some of the methods of reducing spatter in welding?	(4)
	B	List the principle used in Resistance welding.	(3)

Module 2

14	A	What are the gases used in GMAW? Why are they preferred?	(4)
	B	Write down components in GMAW also explain each one?	(3)
15		Explain the different bonding methods used in adhesive bonding.	(7)
16		Describe analysis of butt and fillet joint with sketches.	(7)

Module 3

17	A	Explain Auto-Contact welding with figure.	(3)
	B	Differentiate between external and internal welding on berth.	(2)
	C	Explain the salient features of CO_2 welding.	(2)
18	A	Explain Submerged arc welding with a neat sketch.	(4)
	B	Differentiate between Electro slag and Electro gas welding.	(3)
19	A	Explain the term Gravity welding.	(2)
	B	What are the advantages and disadvantages of Flash butt welding?	(3)
	C	Explain the Sub-block assembly in panel line.	(2)

Module 4

20		What is meant by distortion? Explain types of distortion with sketches.	(7)
21		What are the methods to control accuracy of welds? Explain them.	(7)
22		Explain magnetic particle testing and its application in shipbuilding.	(7)

Module 5

23		Describe a rectilinear robot with suitable diagrams.	(7)
24		Explain a typical robotic welding system with sketches.	(7)
25		What are the important points to be considered for welding robots? Explain in detail.	(7)

****

SYLLABUS

Module 1 - Introduction to Welding

Understand the welding and classification of welding process, development and science in welding, effect of weldability. Study on welding parameters and its effects and welding metallurgy.Structure of Metals, Crystallization of a Pure Metal, Phase Transformation in Iron-Carbon Diagram

Module 2 - Mechanized System in Shipbuilding

GMAW process, different metal transfers, power source, electrodes, shielding gas, uses of gas in metal arc welding. Understand the philosophy of automation in welding, different welding systems in shipyards. Study of adhesives and bonding methods.

Module 3 - Welding in Production Shop and Welding Berth

Study on different types of welding process like SAW, Gravity Welding, Auto Contact Welding, CO2 Welding. Panel Line Production, One-Sided Welding - SAW, MIG Welding TIG Welding, Welding of Stiffeners. 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.

Module 4 - Weld Defects and Quality Control

Study on Weld Defects, Distortion, Accuracy Control; Non-Destructive Tests. Define the 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.

Module 5 - Robotic Welding

Define the Introduction of Robotic welding, Application of Robotic Welding in Ship Production, Robotic Welding System, and Types of Welding Robots. Study on the Analysis of Joints for Strength, Edge Preparation for Steel, Aluminium and Other Materials used.

Text Books

1. D. J. Eyres; Ship Construction, Butterworth Heinemann, 2001

2. O.P. Khanna; A Textbook of Welding Technology; Dhanpat Rai & Sons, 2011.

3. Robert Taggart; Ship Design & Construction, SNAME, 1980.

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, 2017.
5. Rossi, Welding Technology, McGraw Hill, 1954.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction to Welding**	
1.1	Welding and classification of welding process, development and science in welding, effect of weldability.	3
1.2	Study on welding parameters and its effects and welding metallurgy	1
1.3	Structure of Metals, Crystallization of a Pure Metal, Phase Transformation in Iron-Carbon Diagram.	3
2	**Mechanized System in Shipbuilding**	
2.1	GMAW process, different metal transfers, power source, electrodes, shielding gas, uses of gas in metal arc welding.	3
2.2	Understand the philosophy of automation in welding, different welding systems in shipyards.	3
2.3	Study of adhesives and bonding methods.	1
3	**Welding in Production Shop and Welding Berth**	
3.1	Study on different types of welding process like SAW, Gravity Welding, Auto Contact Welding, and CO2 Welding.	3
3.2	Study on Panel Line Production, One-Sided Welding - SAW, MIG Welding TIG Welding, Welding of Stiffeners.	2
3.3	External Welding on the Berth, Electro-Slag Welding, Electro-Gas Welding, One-Sided Welding, Internal Welding on The Berth.	3
4	**Weld Defects and Quality Control**	
4.1	Study on Weld Defects, Distortion, Accuracy Control; Non-Destructive Tests.	2
4.2	Define the Welding Standards, Welding Procedure Qualification, Effect of Variables on Qualification of Tests, Performance Qualification of Welders & Operators.	3
4.3	Study on Test Reports, Acceptance Standards, Quality Assurance and Audit, Consumable Classification & Coding.	2
5	**Robotic Welding**	
5.1	Define the Introduction of Robotic welding, Application of Robotic Welding in Ship Production.	2
5.2	Study on Robotic Welding System, and Types of Welding Robots.	2
5.3	Study on the Analysis of Joints for Strength, Edge Preparation for Steel, Aluminium and Other Materials used.	3

SBT424	SHIP PRODUCTION MANAGEMENT	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course is introduced in the curriculum for providing an overview on layout of shipyard, knowledge on shipbuilding practices and sequence of ship production.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand a typical shipyard organization and components of integrated approach in planning ship production.
CO 2	Apply knowledge and understanding of various machining process in fabrication of prepared plates from storage area to units.
CO 3	Understand the practice of prefabrication prior to erection and sequence of erection of hull.
CO 4	Demonstrate knowledge and understand various technologies involved during erection of hull.
CO 5	Apply CPM and PERT on production management.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO 1	2	2										
CO 2	3	2										1
CO 3	2	2										
CO 4	2	2										2
CO 5	3	3										2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	20	20	40
Apply	20	20	40
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 3 questions from each module of which student should answer any two. Each question can have maximum 2 sub-divisions and carry 7 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain any six material handling equipment used in shipyards.

2. (a) What is product-oriented work breakdown structure in shipbuilding? What are the components of this integrated approach? Explain each one of them in detail.

(b) What are computer based supports needed for application of PWBS?

3. With help of suitable diagrams, explain the following:

(i) Process Layout (ii) Product Layout

Discuss the above as applied to shipbuilding. Highlight the merits and demerits

Course Outcome 2 (CO2)

1. Explain objectives of a ship production planning and control department.

2. What are the techniques used for planning, scheduling and control of activities in ship production?

3. A contractor identifies 12 tasks (A, B.....L) in a project with the following relationships and durations:

Task	A	B	C	D	E	F	G	H	I	J	K	L
Predecessors	-	-	A	B, C	D	E	B, C	F, G	F, G	H, I	B	F, G, K
Duration (days)	30	7	10	14	10	7	21	7	12	15	30	15

(i) Construct the network diagram.

(ii) Identify the critical path and duration of project.

(iii) Determine the early and late start and finish times for all tasks.

(iv) What is the total and free slack of task K?

Course Outcome 3(CO3):

1. Explain different types of NDT test used in shipbuilding process for welded joints.

2. What is IHOP (Integrated Hull Outfitting and Painting)? Explain its advantages

3. What are different stages of ship hull construction? Explain the quality surveys and quality control measures taken at each stage for dimensional tolerances.

Course Outcome 4 (CO4):

1. Give two examples of assembly charts and explain how they are used for process planning.

2. List and explain major international standards for process standards and product standards

3. What is difference between training need assessment and training evaluation?

Course Outcome 5 (CO5):

1. Write a brief on the recent/upcoming technological developments in marine industry.

2. What are the difference between PERT and CPM? Which method is the most suitable for a shipyard making only bulk carriers? Why?

3. With help of neat figures explain various inventory systems.

Model Question paper

			Total Pages: 3
Reg No.:_____		**Name:_____**	

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, XXXX 20XX

Course Code: SB424

Course Name: SHIP PRODUCTION MANAGEMENT

Max. Marks: 100		**Duration: 3 Hours**

PART A

		Answer all questions, each carries 3 marks.(3x10=30)	Marks
1		Explain the elements of product mix with a suitable example.	(3)
2		Draw a typical Process layout and Product layout	(3)
3		List down advantages of process study.	(3)
4		Draw Gantt charts and list the application in shipbuilding.	(3)
5		Explain various factors which affect the productivity.	(3)
6		Compare time limited and resource limited scheduling.	(3)
7		Explain receipt inspection.	(3)
8		Compare quality assurance and quality control.	(3)
9		List any six drawings drawn by production office and brief their functions.	(3)
10		What is DBMS? Explain how it helps the shipyard	(3)

PART B

Answer any two full question from each module, each question carries 7 marks (7x10=70)

Module I

11		What is meant by prefabrication in shipbuilding? Explain any two examples which connect structural design with prefabrication.	(7)
12		Explain with suitable examples, production design and its application in shipbuilding.	(7)

13		Explain how material handling equipment can improve ship production.	(7)
		Module II	
14		The management of a company is interested in crashing of the following project by spending an additional amount not exceeding Rs.2,000/-. Suggest how this can be accomplished.	(7)

Activity	Predecessor Activity	Normal Time (weeks)	Crash Time (weeks)	Normal Cost(Rs.)	Crash cost(Rs.)
A	-	7	6	15,000	18,000
B	A	12	9	11,000	14,000
C	A	22	21	18,500	19,000
D	B	11	10	8,000	9,000
E	C, D	6	5	4,000	4,500

15 (7)

Find out the time required to complete the following project and the critical activities:

Activity	Predecessor Activity	Optimistic Time Estimate (to days)	Most likely Time Estimate (tm days)	Pessimistic Time Estimate(tp days)
A	-	2	4	6
B	A	3	6	9
C	A	8	10	12
D	B	9	12	15
E	C	8	9	10
F	D, E	16	21	26
G	D, E	19	22	25
H	F	2	5	8
I	G	1	3	5

16.

<table>
<tr><td></td><td></td><td>Draw a specimen of “Gantt Chart” which is normally used in the production planning and control department. Describe its utility for checking the actual progress of a job against the schedule.</td><td>(7)</td></tr>
<tr><td colspan="4">Module III</td></tr>
<tr><td>17

18.</td><td></td><td>What are the different work measurement systems? Describe the methods for man-hour determination.

The table below shows the demand for a product in a shop for each of the last nine months.

<table>
<tr><td>Month</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td>Demand</td><td>10</td><td>12</td><td>18</td><td>15</td><td>14</td><td>19</td><td>22</td><td>22</td><td>24</td></tr>
</table>

(a) Calculate a four month moving average for months four to nine. What would be your forecast for the demand in month ten?

(b) Apply exponential smoothing with a smoothing constant of 0.25 to derive a forecast for the demand in month ten. (assume initial forecast =9)</td><td>(7)

(7)</td></tr>
<tr><td>19</td><td></td><td>Explain group technology and describe its use in shipbuilding activities</td><td>(7)</td></tr>
<tr><td colspan="4">Module IV</td></tr>
<tr><td>20</td><td></td><td>Draw a typical CPM flow chart for the construction of an Inland Tug</td><td>(7)</td></tr>
<tr><td>21

22</td><td></td><td>Explain the following with neat sketches:

(i) Shipyard Functional Layout.

(ii) Shipyard Group Layout.

Explain the quality surveys and quality control measures taken at each stage for dimensional tolerances.</td><td>(7)

(7)</td></tr>
<tr><td colspan="4">Module V</td></tr>
<tr><td>23</td><td></td><td>What does mean by EOQ? Explain the purpose of stock holding in a shipyard.</td><td>(7)</td></tr>
<tr><td>24</td><td></td><td>Given that

i) Annual usage, U=60 units

ii) Procurement cost, P= Rs. 125 per order

iii) Cost per piece, C= Rs. 500</td><td>(7)</td></tr>
</table>

		iv) Cost of carrying inventory I, a percentage including expenditure on obsolescence, taxes, insurance, deterioration etc.=17%. Calculate EOQ.	
25		Explain ABC analysis.	(7)
		****	

SYLLABUS

Module 1

Ship Production Systems - The Systems Approach-Subsystems, Comprehensive System Model – The Ship as a System. Product Standardization and Work Simplification, Product Mix.

Module 2

Production Planning and Production Control - Planning for Operations – Interconnection between Production Design and Process Planning. Production and Process Analysis - Assembly Charts, Operation Process Charts, Flow Process Charts; Process Selection. Application of Models for Process Planning, Scheduling and Control – Gantt charts, CPM & PERT, Transportation Models.

Module 3

Introduction to operation research. Operation planning and control production planning scheduling network models (PERT, CPM) quality control maintenance analysis. Production Standards–production standards in several parts of the ship production process, work measurement systems,
methods of man- hour determination.

Module 4

Quality Assurance and quality control activities in shipyards; Problems of accuracy – tolerances, standards, measuring techniques (Theodolite & laser), Ship Production Management Software.

Module 5

Information Exchange during Ship Production - Communication between Departments and other Stakeholders - Classification Society, Regulatory Body, Ship Owner, Design Office. Database Management Systems (DBMS) in Ship Production. Production Inventory System - The Inventory Problem, Functions of Inventory, Inventory Costs Inventory Concepts.

Text Books

1) Taggart, "Ship Design and Construction", SNAME, 1980.
2) Storch R. Lee, Hammon C.P. & Bunch H.M.," Ship Production", Cornell Maritime Press, Maryland, USA, 1988.
3) Dormidontov V.K. &et.al., "Shipbuilding Technology", Mir Publishers, Moscow, 1966.
4) Arthur C.Laufer, " Operations Management", South Western Publishing Co, 1979.
5) George Bruce, " Shipbuilding Management", Springer Nature Singapore Pte. Ltd.,2021

Reference Books

1. EyresD.J., "Ship Construction ", William Heinemann Ltd, London,1982
2. Elwood S.Buffa, "Modern Production/Operations Management", Wiley Eastern Ltd., 2004.
3. Richard J. Hopeman, "Production -Concepts, Analysis, Control", 3rd Edition, Charles E. Merril Publishing Co., 1976.
4. Khanna,O.P., " Industrial Engineering and Management", Dhanpat Rai Publication., 1999.
5. Richard I. Levin, et.al., "Production/Operations Management: Contemporary Policy for Managing Operating Systems", Tata McGraw Hill Publishing Co. Ltd., 1974.
6. Rajesh Kumar Arora, "Optimisation. Algorithm and Applications", CRC Press, 2015
7. R. Paneerselvam, "Operations Research", PHI Learning Private Ltd., 2017
8. Chary, Production & Operations Management, TMH, New Delhi.
9. Joseph W. Curmxmnskey, "Report on United States Commercial shipbuilding productivity: An International view", Naval Post Graduate School, California, 1990.
10. 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.
11. Report on Producibility in Ship Design, 1989 Ship Production Symposium, and NSRP, U.S. Department of the Navy.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Ship Production system:**	
1.1	The systems approach, subsystems, comprehensive system model – the ship as a system.	3
1.2	Product Standardization and Work Simplification, Product Mix.	3
2	**Production Planning, Control and Process Analysis**	
2.1	Production Planning and Production Control - Planning for Operations – Interconnection between Production Design and Process Planning	2
2.2	Production and Process Analysis - Assembly Charts, Operation Process Charts, Flow Process Charts; Process Selection.	3
2.3	Application of Models for Process Planning, Scheduling and Control – Gantt charts, CPM & PERT, Transportation Models.	2
3	**Introduction to operation research**	
3.1	Operation planning and control production planning scheduling network models (PERT, CPM) quality control maintenance analysis	3
3.2	Production Standards -production standards in several parts of the ship production process, work measurement systems, Methods of man- hour determination.	4
4	**Quality Assurance and quality control activities in shipyards**	
4.1	Problems of accuracy – tolerances, standards, measuring techniques (Theodolite & laser).	3
4.2	Ship Production Management Software.	4
5	**General Shipbuilding and Shipyard Activities**	
5.1	Information Exchange During Ship Production - Communication between Departments and other Stakeholders - Classification Society, Regulatory Body, Ship Owner, Design Office.	3
5.2	Database Management Systems (DBMS) in Ship Production.	3
5.3	Production Inventory System - The Inventory Problem, Functions of Inventory, Inventory Costs Inventory Concepts.	3

SBT434	SUBMARINE AND SUBMERSIBLES	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This subject gives an overview of submersibles; students will get to learn about design concepts, structural aspects, powering and propulsion of submarines. They will get familiarized with different systems of submarines and hydrostatics

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Develop basic design concepts of submersibles like ROV, AUV and submarine
CO 2	Understand and demonstrate knowledge on design methods, design phases and generation of concept design
CO 3	Acquire knowledge on weight and space relationship, geometric form and submarine hydrostatics
CO 4	Elucidate on powering, propulsion, dynamics and control of submarine
CO 5	Explain the structural design considerations of submarines and various failure modes
CO 6	Identify different systems in submarines

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3											3
CO 2	3	2	2			1	1		1			3
CO 3	3	2	2			1	1		1			3
CO 4	3	2	2			1	1		1			3
CO 5	3	2	2			1	1		1			3
CO 6	3											3

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	40
Apply	20	20	50
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 3 questions from each module of which student should answer any two. Each question can have maximum 3 sub-divisions and carry 7 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Write down the classification of submarine based on USN, power transmission and route.
2. Differentiate between passive bearing sonar and passive ranging sonar.
3. Show the surface stability condition of submarine with a neat diagram.

Course Outcome 2 (CO2):

1. Explain the concept design of submarine using building method.
2. What is flounder diagram? Draw a flounder diagram and show how it is used for submarine design.
3. Explain about the concept sizing of a submarine

Course Outcome 3 (CO3):

1. With the help of neat diagram show the shift of buoyancy when the submarine heels at surface condition
2. Explain about different sources of buoyancy in submarine
3. Draw a diagram to show the hydrostatic force acting on submarine at submerged condition.

Course Outcome 4 (CO4):

1. With the help of diagrams, show the pressure distribution of submarine hull at ideal fluid, actual viscous fluid and actual viscous fluid with propeller working.
2. Explain different components of standard diesel electric power plant.
3. Explain why nuclear power plants are not feasible for submarines?

Course Outcome 5 (CO5):

1. Draw a neat diagram and show the different modes of failure of pressure hull.
2. What is fatigue and where it is acting on submarine hull? Which type of hull materials undergoes fatigue easily?
3. Draw a neat diagram and show the different modes of failure of pressure hull.

Course Outcome 6 (CO6):

1. Explain about water distribution system in submarines.
2. What are characteristics of hydraulic system in submarines
3. Write down the functions of high pressure air system in submarines

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
EIGHTH SEMESTER B.TECH DEGREE EXAMINATION
SBT434 SUBMARINE AND SUBMERSIBLES

PART A

Answer ALL questions. Each question carries 3 marks.

(3x10 = 30Marks)

1. Differentiate between AUV and ROV
2. Show the surface and submerged stability condition of a submarine with neat diagrams
3. Draw a flow chart which shows the concept design of a submarine.
4. What are the primary design objectives of a submarine?
5. What is the purpose of weight compensation tank in submarine?
6. Write down the characteristics of a submarine.
7. What are the desirable features which a submarine should have, to meet the forgoing requirement?
8. What are the factors which govern the power and energy storage requirement of submarine?
9. How buckle deformation happens to an unstiffened pressure hull cylinder and what is the solution for it

10. How elastic deformation happens to a shell of sphere, cylinder and hemispherical dome?

PART B

Answer any two complete questions from each module.

MODULE I

(7x2=14 Marks)

11. Explain about the important roles submarine posses
12. Write down the classification of submarine based on USN, power transmission and route.
13. List down the weapons, sensors and navigational equipments used in submarines

MODULE II

(7x2 = 14 Marks)

14. What is flounder diagram? Draw a flounder diagram and show how it is used for submarine design.
15. With a neat diagram explain the concept design of submarine using type ship method
16. Explain the concept design of submarine using graphics method

MODULE III

(7x2=14 Marks)

17. Define reserve buoyancy of a submarine and list down the external factors that affect the buoyancy of submarine.
18. Explain different sources of buoyancy in submarine and show the shift of buoyancy of submarine with a diagram when it heels at surface condition
19. What are the different tank system used in submarine and write down the functions of each one?

MODULE IV

(7x2=14 Marks)

20. With the help of diagrams, show the pressure distribution of submarine hull at ideal fluid, actual viscous fluid and actual viscous fluid with propeller working.
21. Explain how a hydroplane works with a neat diagram?
22. Explain the term quiet speed, listening speed, ultra quite speed

MODULE V

(7x2=14 Marks)

23. Explain about different shapes of pressure hull used in submarines. Why non circular sections are not preferred?
24. What is dome bulk head? Which construction is used for it? What are the advantages of dome bulk head construction?
25. Draw a neat diagram and show the different modes of failure of pressure hull

SYLLABUS

Module – I

Introduction to Submarines and Submersibles: Definition of Submarines and Submersibles, Features of Submersibles, Operating Environment and Requirements.

Autonomous Underwater Vehicles & Remotely Operated Vehicles: Definition, Difference between AUV & ROV, Types, Basic Design Concepts, Materials Used for Construction, Applications, Communication System, Power Source, Navigational System.

Module – II

Submarine Design Management and Methods: Design Phases, Development of Technical Proposal and Submarine Design Specifications, Sequence of Building a Submarine, Costing, Design Influence on Cost and Building.

Design Methods: Convergence Methods, Drawing or Graphic Method, Analytical Method, Computer Application in Submarine Design.

Generation of concept design: Concept sizing, Concept sizing with AlP systems, Other sizing's, iterations in design

Module – III

Weight/ Space Relationship: Purpose, Significance of Density, Weight Assessment and Control, Space, Margin Policy and Budgeting, Space Margin Policy, Other Size Deciding Factors.

Geometric Form and Arrangements: Introduction, Factors Influencing Form and Arrangement, Factors Governing Diameter of Hull, Internal Arrangements.

Submarine Hydrostatics: First Principles of Flotation, Submarines on Surface, Arrangements of Main Ballast Tanks, Buoyancy Elements, Weight Elements, Trim and Compensating Tanks, Special Tanks, Stability.

Module – IV

Powering of Submarines: Introduction, Powering Requirements, Resistance to motion, Speed-power relationship, Surface resistance

Propulsion: Design Aspects of Propulsion Plants, Design Aspects of Powering

Dynamics and Control: Concepts, Equations of Motion of a Submarine, Stability and Control in the Horizontal Plane, Stability and Control in the Vertical Plane, Steering and Depth Control Systems, Contributions of Hull Form and Appendages to Control Dynamics, Emergency Recovery

Module –V

Submarine Structures- Introduction, Operational Requirements for Depth, Pressure Vessel Shape, Shell-Elastic Deformations, Buckling Deformations; Other Failure Modes.

Internal supporting structure, Pressure hull penetrations, Fabrication considerations, Fatigue, Choice of materials, structural design philosophy.

Submarine Systems: Requirements, Hydraulic Systems, High Pressure Air Systems, Water Systems, Systems for Hydrostatic Control, Environmental Control Systems, Provision for Escape, Various Electrical Systems

Text Books

1. Y.N. Kormilitsin, O.A. Khalizev; Theory of Submarine Design, Riviera Maritime Media (August 1, 2001)
2. Drew Nelson; Submarines and Submersibles, Gareth Stevens Publishing (January 1, 2013)
3. Kate Hayden; Submarines and Submersibles, DK Readers, 2016

Reference Books

1. Roy Burcher, Louis J. Rydill; Concepts in Submarine Design, , Cambridge University Press , 1995
2. Anthony J. Watts; A Source Book of Submarines and Submersibles, Ward Lock, 1976
3. James B. Sweeney; A Pictorial History of Oceanographic Submersibles, Crown Pub, 1970
4. James P. Delgado, Clive Cussler; Silent Killers: Submarines and Underwater Warfare, Osprey Publishing; 2011
5. Harry Bohm and Vickie Jensen; Build Your Own Programmable Lego Submersible: Project: Sea Angel AUV (Autonomous Underwater Vehicle), WESTCOAST WORDS (2002)
6. Lance J. Watkins; Self-Propelled Semi- Submersibles: The Next Great Threat to Regional Security and Stability, Master's Thesis, Naval Post Graduate school, Monterey, California, 2011
7. Robert F. Burgess; Those Magnificent Men in their Diving Machines, A History of Subs and Submersibles (Illustrated), Spyglass Publications, 2012
8. William A. Nash; Hydrostatically Loaded Structures: The Structural Mechanics, Analysis and Design of Powered Submersibles, Elsevier, 1995
9. E. Eugene Allmendinger; Submersible Vehicle Systems Design, SNAME, 1990

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Module – I**	
1.1	**Introduction to Submarines and Submersibles**: Definition of Submarines and Submersibles, Features of Submersibles, Operating Environment and Requirements.	2
1.2	**Autonomous Underwater Vehicles & Remotely Operated Vehicles**: Definition, Difference between AUV & ROV, Types, Basic Design Concepts, Materials Used for Construction, Applications, Communication System, Power Source, Navigational System.	4
2	**Module – II**	
2.1	**Submarine Design Management and Methods**: Design Phases, Development of Technical Proposal and Submarine Design Specifications, Sequence of Building a Submarine, Costing, Design Influence on Cost and Building.	3
2.2	**Design Methods**: Convergence Methods, Drawing or Graphic Method, Analytical Method, Computer Application in Submarine Design.	2
2.3	**Generation of concept design:** Concept sizing, Concept sizing with AIP systems, Other sizing's, iterations in design	2
3	**Module – III**	
3.1	**Weight/ Space Relationship**: Purpose, Significance of Density, Weight Assessment and Control, Space, Margin Policy and Budgeting, Space Margin Policy, Other Size Deciding Factors.	3
3.2	**Geometric Form and Arrangements:** Introduction, Factors Influencing Form and Arrangement, Factors Governing Diameter of Hull, Internal Arrangements.	2
3.3	**Submarine Hydrostatics**: First Principles of Flotation, Submarines on Surface, Arrangements of Main Ballast Tanks, Buoyancy Elements, Weight Elements, Trim and Compensating Tanks, Special Tanks, Stability.	3
4	**Module – IV**	
4.1	**Powering of Submarines:** Introduction, Powering Requirements, Resistance to motion, Speed-power relationship, Surface resistance	2
4.2	**Propulsion**: Design Aspects of Propulsion Plants, Design Aspects of Powering	2
4.3	**Dynamics and Control:** Concepts, Equations of Motion of a Submarine, Stability and Control in the Horizontal Plane, Stability and Control in the Vertical Plane, Steering and Depth Control Systems, Contributions of Hull Form and Appendages to Control Dynamics, Emergency Recovery	3

5	**Module – V**	
5.1	**Submarine Structures**- Introduction, Operational Requirements for Depth, Pressure Vessel Shape, Shell-Elastic Deformations, Buckling Deformations; Other Failure Modes.	3
5.2	Internal supporting structure, Pressure hull penetrations, Fabrication considerations, Fatigue, Choice of materials, structural design philosophy.	2
5.3	**Submarine Systems:** Requirements, Hydraulic Systems, High Pressure Air Systems, Water Systems, Systems for Hydrostatic Control, Environmental Control Systems, Provision for Escape, Various Electrical Systems	3

SBT444	ELECTRICAL SYSTEMS IN SHIPS AND SHIPYARDS	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course is designed to impart basic knowledge on electrical systems in ships & shipyards, various power supply systems used in ships and the importance of electrical systems used in Ships and Shipyards.

Prerequisite: EE214 - Electrical technology & Instrumentation

Course Outcomes: After the completion of the course the student will be able to:

CO 1	Understand various types of Systems and Major Components, Load Analysis, Power Management Systems.
CO 2	Identify the general alternators, specific systems for distribution of AC power in Ships, emergency power and shore supply
CO 3	Explain the various types of DC generators and types of starters.
CO 4	Explain the performance requirements of alternators, thyristor-based static automatic voltage regulator and effect of kW loading.
CO 5	Elucidate the layout and principle of electrical propulsion, advantages & disadvantages of electrical propulsion and turbo-electric propulsion.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	2										1
CO 2	2	2										1
CO 3	3	2										1
CO 4	3	2										1
CO 5	3	2										1

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	40
Apply	20	20	50
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern:
There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 3 questions from each module of which student should answer any two. Each question can have maximum 3 sub-divisions and carry 7 marks.

Course Level Assessment Questions
Course Outcome 1 (CO1):

1. Name all the components of a ship's electrical supply system

2. Explain how Marine environment affects the electrical system in ships

3. Define Dead Ship Condition and Emergency Condition in relation to conditions on-board a ship.

Course Outcome 2 (CO2)

1. Why AC distribution is preferred over DC distribution on-board a ship?

2. Sketch a ship's typical electrical distribution system showing the loads to which power is supplied

3. Explain starting and stopping procedure of an emergency generator

Course Outcome 3 (CO3):

1. What is a shunt wound generator? Explain the same with suitable sketches

2. Briefly explain compound wound motor with neat sketches

3. What is the purpose of starter? Mention various types. Draw the circuit diagram for any one type of starter

Course Outcome 4 (CO4):

1.What is synchronising? Explain Auto Synchronising with neat sketch

2. What is Thyristor-based Static Automatic Voltage Regulator? Explain the main components of the same

3. Explain how the power tariff calculated in shipyards

Course Outcome 5 (CO5):

1. Name different types of propulsion system

2. What is cable testing? Explain why cable testing is important? What all to be tested in the cable testing process?

3. Explain Turbo-Electrical propulsion system with neat sketch

Model Question paper

Question Paper Code **Total Pages: 2**

Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, XXXXX 20XX

Course Code: SBT444

Course Name: ELECTRICAL SYSTEMS IN SHIPS AND SHIPYARDS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions. Each question carries 3 marks Marks

1	What are the various electrical loads involved in ships?	(3)
2	List the critical equipment supplied with power from emergency generator.	(3)
3	Differentiate between Cumulative Compound and Differential Compound Motors	(3)
4	What are the effects of kW loading?	(3)
5	List any three navigational equipment used on-board vessel	(3)
6	What does AWG stands for in cable specification?	(3)
7	What is the significance of back emf in motor?	(3)
8	What do you mean by power factor?	(3)
9	What does manoeuvring system in a ship mean?	(3)
10	Why can't DC current voltage be stepped up and down using a transformer?	(3)

PART B

Answer any two full questions, Each question carries 7 marks

Module 1

11		With a suitable diagram explain general distribution system on board a ship	(7)
12		What is the desired angle of inclination permissible for electrical systems on board a ship?	(7)
13	(a)	Explain Main Generating Station in relation to electrical equipment on-board a ship	(2)
	(b)	What is the Main source of Electrical Power and Emergency Source of Electrical Power in relation to electrical equipment on-board a ship.	(3)
	(c)	Why 60Hz is preferred over 50Hz on board a ship?	(2)

Module 2

Answer any two full questions, Each question carries 7 marks

14	(a)	Why AC distribution system preferred over DC distribution system on board ship?	(4)
	(b)	What are the differences between feeders and distributors?	(3)
15		When does a ship require shore supply? Explain shore supply with diagram	(7)
16		Sketch a ship's typical electrical distribution system showing the loads to which power is supplied.	(7)

Module 3

Answer any two full questions, Each question carries 7 marks

17	(a)	What are the methods adopted to reduce armature reaction?	(2)
	(b)	List the different types of D.C generators	(2)
	(c)	Compare Series and Shunt wound motor with a help of diagram	(3)
18	(a)	What is the role of the armature in D.C generator?	(4)
	(b)	List the types of D.C motors	(3)
19	(a)	With a help of neat sketch explain D.O.L starter	(2)
	(b)	What is the purpose of starter? Mention various types.	(2)
	(c)	What are the additional features that star-delta starter has?	(3)

Module 4

Answer any two full questions, Each question carries 7 marks

20		How does a thyristor-controlled static AVR work? Explain the same with a suitable diagram.	(7)
21		List down the various electrical loads in shipyards.	(7)
22		What are the methods employed in improving the power factor?	(7)

Module 5

Answer any two full questions, Each question carries 7 marks

23	With a neat diagram, explain the method of using a DC propulsion motor powered by an alternator.	(7)
24	Explain Turbo-Electric propulsion system with neat sketch.	(7)
25	How do modern electrical propulsion systems help to optimize cargo space? Explain with simple sketches.	(7)

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SYLLABUS

Module 1 - Overview of a Ship's Electrical System

Understand the Marine Environment, General Provisions, Different systems and Major Components, Load Analysis, Power Management Systems, Electrical Diagrams, Relevant SOLAS Regulations.

Module 2 - AC Distribution Systems & Emergency Power and Shore Supply

Identify the general concept of alternators, Specific Systems for distribution of AC power in Ships, General Distribution Scheme On-board a Ship, Relevant Regulations.The Method of Supplying Emergency Power, Actions by Engineers during a Blackout Situation, Shore Supply, Relevant Rules.

Module 3 - Direct Current Machines & Starters for Alternating Current Motors

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. The Basics of Starters, the Direct-on-line or D.O.L. Starter, Star-delta Starter, Autotransformer Starter.

Module 4 - Automatic Voltage Regulators & Electrical system in shipyards

Understand the Performance Requirements of Alternators, Operating Principle of an AVR, Thyristor-based Static Automatic Voltage Regulator, Effect of kW Loading, Effect of kVA Loading.The Basics, Manual Synchronising, Auto-Synchronising, Parallel Operation, Load Sharing, Speed Droop and Power Generation. Power factor improvement, power tariff calculation, essential regulations, and main loads. Potential Hazards, Maritime Labour/Industry Recommendations.

Module 5 - Electrical Propulsion Systems & Bridge Equipment's

Detailed study on the 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. Communication Equipment's & their function, Define navigation and navigational Equipment's & their function, Lighting Arrangements, Cable Specifications, Testing of Cables.

Text Books

1. Elstan A. Fernandez; Marine Electrical Technology, Shroff Publishers, 2014.

2. Harrington L Roy; Marine Engineering, SNAME Publications, 1992.

Reference Books

1. Watson G.O.; Marine Electrical Practice, ELSEVIER, 6th Ed, 1990.
2. Starr A.T.; Generation, Transmission and Utilisation of Electrical Power, Pitman Publishing; 4th edition edition, 1957.
3. Sonnenberg G.J. & Newnen Butterworth; Radar Electronic Navigation, Butterworth-Heinemann; 6th edition, 1988.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Overview of a Ship's Electrical System**	
1.1	Marine Environment, General Provisions, Systems and Major Components.	3
1.2	Load Analysis, Power Management Systems, Electrical Diagrams, Relevant SOLAS Regulations.	2
2	**AC Distribution Systems & Emergency Power and Shore Supply**	
2.1	General Concept of Alternators, Specific Systems for distribution of AC power in Ships.	3
2.2	General Distribution Scheme On-board a Ship, Relevant Regulations.	2
2.3	Method of Supplying Emergency Power, Actions by Engineers during a Blackout Situation, Shore Supply, Relevant Rules.	3
3	**Direct Current Machines & Starters for Alternating Current Motors**	
3.1	Introduction to DC Generators, Types of Direct Current Generators, Series Wound Generator, Shunt Wound Generator, Compound Wound Generators.	3
3.2	Introduction to DC Motors, Principle of DC Motor Operation, Shunt Wound Motor, Series Wound Motor, Compound Motors.	2
3.3	Basics of Starters, the Direct-on-line or D.O.L. Starter, Star-delta Starter,	3

	Autotransformer Starter.	
4	**Automatic Voltage Regulators & Electrical system in shipyards**	
4.1	Performance Requirements of Alternators, Operating Principle of an AVR, thyristor-based Static Automatic Voltage Regulator, Effect of kW Loading, Effect of kVA Loading.	3
4.2	Manual Synchronising, Auto-Synchronising, Parallel Operation, Load Sharing, Speed Droop and Power Generation.	3
4.3	Power factor improvement, power tariff calculation, essential regulations, and main loads. Potential Hazards, Maritime Labour/Industry Recommendations.	3
5	**Electrical Propulsion Systems & Bridge Equipment's**	
5.1	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.	3
5.2	Communication Equipment's & their function, Navigational Equipment's & their function, Lighting Arrangements, Cable Specifications, Testing of Cables.	3

SEMESTER VIII

PROGRAM ELECTIVE IV

SBT416	SHIP SURVEY ESTIMATION AND REPAIR	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course content has been developed to impart knowledge on various ship surveys and ship repair techniques. This course begins with various surveys, surveying agencies and then moves on to various repairs performed on ships and standards adopted to those processes. The last part of this course deals with the cost estimation of various ship repair works.

Prerequisite:NIL

Course Outcomes: After the completion of the course the student will be able to:

CO 1	understand various types of surveys and certifications concerning ship design, Construction and Operation.
CO 2	identify various types of repair works carried out onboard ships and their monitoring and certification by survey agencies.
CO 3	Compare the difference in class rules of various classification societies.
CO 4	Explain types of dry docks, drydocking procedure for various vessels, different inspections and repairs performed during dry docking.
CO 5	use the different techniques for the preliminary cost estimation and work estimation in design, dry docking and repair of ships.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	2				1						1
CO 2	2	2										1
CO 3	3	3										1
CO 4	3	3				2						2
CO 5	3	3										1

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	40
Apply	20	20	50
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 3 questions from each module of which student should answer any two. Each question can have maximum 4 sub-divisions and carry 7 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What are the differences between intermediate survey and special survey?

2. What are the different checks that has to be performed while doing renewal survey?

3. Compare the transfer survey and annual survey of an ocean-going vessel.

Course Outcome 2 (CO2)

1. What are the different checks that has to be performed on the propeller sealing to ensure its functionality?

2. What are the methodologies adopted for the maintenance of Overboard valves?

3. Explain the repair process of shaft bracket in ocean-going vessels.

Course Outcome 3(CO3):

1. Compare the class rules of IRS and ABS.

2. Compare the class rules of LR and DNV.

3. Compare the class rules of IRS and LR.

Course Outcome 4 (CO4):

1.Compare the functionality of graving dry dock and a floating Dry Dock.

2. Explain that procedure of dry docking in a floating Dry Dock.

3. Explain the dry-docking procedure of a bulk carrier for an annual inspection.

Course Outcome 5 (CO5):

1. Explain a methodology to estimate the drydocking cost of a bulk carrier for an intermediate survey in a floating dry dock.

2. What are the different factors influence in the cost of coating repair of an Ocean-going vessel?

3. What are the major difference between cost and price?

Model Question paper

Question Paper Code **Total Pages: 2**

Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, XXXXX 20XX

Course Code: SBT416

Course Name: SHIP SURVEY ESTIMATION AND REPAIR

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions. Each question carries 3 marks Marks

1	Explain the different functions performed by IMO council.	(3)
2	Define flag state control and explain the role of flag state control.	(3)
3	Name any six classification societies and their headquarters.	(3)
4	Explain the role of classification Societies in Environmental Protection by giving some examples.	(3)
5	What are the major causes of deterioration of ship's hull during service?	(3)
6	Name the different tests that are used to ensure the water tightness and Hulk continuity in ocean-going vessels.	(3)
7	Draw a floating Dry Dock and Mark its major components.	(3)
8	Name the different components that has to be inspected during the repair process of stem part of an ocean-going vessel.	(3)
9	What are the different types of dry docks?	(3)
10	What are the different types of paints used in ships?	(3)

PART B

Answer any two full questions from each module. Each question carries 7 marks

Module 1

11		Explain the different types of marine surveys and surveyors in maritime sector.	(7)
12	A	Differentiate between exclusive and non-exclusive surveyors.	(3)
	B	Name the different maritime surveying agencies.	(2)
	C	What are the objectives of Directorate General of Shipping	(2)
13	A	How the marine surveys are helping the different stakeholders? Explain.	(4)
	B	Explain any six key IMO conventions	(3)

Module 2

14	A	What are the different tests and trials conducted before an ocean-going vessel is commissioned?	(4)
	B	Explain the different conditions prescribed by IACS on conduct of inclining experiment of ocean-going vessels.	(3)
15		Explain the process of design approval and construction survey of ships by ship classification societies.	(7)
16		Explain the significance of Joint projects undertaken by IACS by listing the classification Societies participating in these projects.	(7)

Module 3

17	A	Explain the main characteristics of underwater welding.	(3)
	B	What are the major problems encountered in underwater welding?	(2)
	C	Why underwater welding is done in Hyperbaric environment?	(2)
18	A	What are the different types of underwater welding? Explain with schematic diagrams.	(4)
	B	What are the advantages and disadvantages of underwater welding?	(3)
19	A	Define habitat welding.	(2)
	B	Differentiate between dry and wet welding.	(3)
	C	Electroslag welding cannot be used in ship building. Justify this statement.	(2)

Module 4

20		Briefly describe the replacement of corroded hull plate in underwater side shell of a ship with necessary sketches.	(7)
21		What are the safety standards and precautions that has to be followed while Working with the different types of scaffolds? Explain.	(7)
22		Explain the maintenance and repair procedure of seawater suction valves.	(7)

Module 5

23		Explain the different surface cleaning methods employed prior to the coating repair process with necessary sketches.	(7)
24		Differentiate between specialized subcontract and economic subcontract in Ship Repair.	(7)
25		Compare the top-down and bottom-up approaches in costing.	(7)

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SYLLABUS

Module 1 – Introduction to Marine Survey

Introduction to Marine Survey: Definition of Elementary Terminologies like Survey Authority, Recognized Organisation, Port State control, Flag State control

Various Types of Marine Surveys - Initial Survey, Annual Survey, Periodic Survey, Intermediate Survey, Renewal Survey, Additional Survey. Survey During Transfer of Ships.

Marine Surveying Agencies- Roles and Responsibilities, Statutory Surveys – Role of MMD, IWAI.

Marine Cargo Survey- Dry, Liquid and Container Cargoes.

Module 2-Ship Classification Societies and their activities

Ship Classification Societies- Historical Development, Major Activities of Classification Societies; Rules and Class Notations.

IACS and Joint Projects, Comparison of Ship Class Rules by IRS and ABS, Activities of Classification Societies and Surveying Agencies

Activities of Classification Society – Design Approval; Construction Survey; Survey on Operation, Repair Conversion.

Industrial Surveys, Third Party Accreditation.

Module 3 – Repairing vessels while afloat

Introduction, Causes of Wear and Damage in Ship's Hull.

Comparison Between Different Types of Repair Activities (Afloat, Berthed etc.)

Testing for Water Tightness and Hull Continuity.

Repair of hull and other Parts While Afloat.

Underwater Welding – Welding Equipment, Quality Control and Standards; Degree of Automation.

Module 4 – Dry docking and repairing

Dry-docking- Steps to be Taken Before, During and After Dry-docking

Replacement of Hull Plates and Stiffeners, Decks and Bulkheads, Repair of Stem and Stern Frames and Shaft Bracket, Propeller Shaft Sealing Equipment.

Rudder– pintle Clearances, Maintenance of Sea Water Suction and Overboard Valves.

Safety During Repair – Various Operations Involving Risk, Safety Devices and Plans.

Module 5–Work and Cost Estimation

Work Estimation: Dry-docking Works - Docking and Undocking, Hull Preparation, Hull Painting, Propeller Works, Chain Lockers,Steel Works, Planning Charts.

Shipbuilding Contracts.

Costing and Estimation- 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.

Text Books

1. Don Butler,"Guide to Ship Repair Estimates", Butterworth-Heinemann, 2nd edition, 2012.

2.Jan O Fischer; "Cost Management in Shipbuilding", GKP Publishing, 1st edition, 2011.

Reference Books

1.Mohammed Khamis, "Ship repair project manager's guide", IIEC, 1st edition, 2018.
2.Mohammed Khamis, "Ship repair technical superintendent's guide", Gulf publishing co., 1st edition, 2019.
3.Lloyds Register; 'Rules and Regulations for the Classification of Ships', Part 1, Regulations, Chapters 2 and 3.
4.Rules and Regulations for the Construction and Classification of Inland Waterways ships - January 1997; IR Class, Mumbai.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**INTRODUCTION TO MARINE SURVEY**	
1.1	Introduction to Marine Survey: Definition of Elementary Terminologies like Survey Authority, Recognized Organisation, Port State control, Flag State control	2
1.2	Various Types of Marine Surveys - Initial Survey, Annual Survey, Periodic Survey, Intermediate Survey, Renewal Survey, Additional Survey. Survey During Transfer of Ships.	2
1.3	Marine Surveying Agencies- Roles and Responsibilities, Statutory Surveys – Role of MMD, IWAI.	2
1.4	Marine Cargo Survey- Dry, Liquid and Container Cargoes.	1
2	**SHIP CLASSIFICATION SOCIETIES AND THEIR ACTIVITIES**	
2.1	Ship Classification Societies- Historical Development, Major Activities of Classification Societies; Rules and Class Notations.	2
2.2	IACS and Joint Projects, Comparison of Ship Class Rules by IRS and ABS, Activities of Classification Societies and Surveying Agencies	2
2.3	Activities of Classification Society – Design Approval; Construction Survey; Survey on Operation, Repair Conversion.	2
2.4	Industrial Surveys, Third Party Accreditation.	1
3	**REPAIRING VESSELS WHILE AFLOAT**	
3.1	Introduction, Causes of Wear and Damage in Ship's Hull.	2
3.2	Comparison Between Different Types of Repair Activities (Afloat, Berthed etc.)	1
3.3	Testing for Water Tightness and Hull Continuity.	1
3.4	Repair of hull and other Parts While Afloat.	1
3.5	Underwater Welding – Welding Equipment, Quality Control and Standards; Degree of Automation.	2
4	**DRY DOCKING AND REPAIRING**	

4.1	Dry-docking- Steps to be Taken Before, During and After Dry-docking	2
4.2	Replacement of Hull Plates and Stiffeners, Decks and Bulkheads, Repair of Stem and Stern Frames and Shaft Bracket, Propeller Shaft Sealing Equipment.	2
4.3	Rudder– pintle Clearances, Maintenance of Sea Water Suction and Overboard Valves.	2
4.4	Safety During Repair – Various Operations Involving Risk, Safety Devices and Plans.	1
5	**WORK AND COST ESTIMATION**	
5.1	Work Estimation: Dry-docking Works - Docking and Undocking, Hull Preparation, Hull Painting, Propeller Works, Chain Lockers. Steel Works, Planning Charts.	3
5.2	Shipbuilding Contracts.	2
5.3	Costing and Estimation- 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

SBT426	REFRIGERATION AND AIR CONDITIONING OF SHIPS	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: The goal of this course are to impart basic knowledge on Refrigeration Cycle & Systems, various Refrigerants used in ship's refrigeration system, operation of HVAC and importance of Refrigeration & Air conditioning systems in ships.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Have knowledge of Refrigeration & Air conditioning system used in ships and types of Compression cycle.
CO 2	Understand the operation and different types of compressors, condensers, evaporators and expansion devices used.
CO 3	Ability to perform psychrometric calculations, humidity control and analysis of air-conditioning processes
CO 4	Calculate cooling load for air conditioning systems used for various
CO 5	Understand the operation of various components in the Refrigeration system & HVAC system in ships

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	2										1
CO 2	2	2										1
CO 3	3	2										1
CO 4	3	2										1
CO 5	3	2										1

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	40
Apply	20	20	50
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 3 questions from each module of which student should answer any two. Each question can have maximum 3 sub-divisions and carry 7 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Discuss the factors affecting coefficient of performance of refrigeration system.

2. With help of p-h diagram of a vapour compression refrigeration system explain the effect of refrigerant returning to the compressor suction with saturated vapour, with liquid and with superheat, while the liquid is under cooled in the condenser. What will happen if lot of liquid is returned to the compressor suction?

3. Compare the properties of new refrigerants with old generation refrigerants.

Course Outcome 2 (CO2)

1. Explain working principle of rotary and centrifugal compressors.

2. With help of diagrams explain low-pressure float valve and high-pressure float valve.

3. Explain air cooling and liquid cooling evaporators.

Course Outcome 3 (CO3)

1. A sample of moist air has a dry bulb temperature of 48°C and a wet bulb temperature of 31°C. Calculate the following without making use of the psychrometric chart:

(a) Partial pressure of water vapour. (b) Specific humidity.

(c) Relative humidity. (d) Dew point temperature.

(e) Humid specific heat. (f) Enthalpy.

(g) Degree of saturation. (h) Sigma heat function.

2. Air at a condition of 30°C dry bulb, 15°C wet bulb and a barometric pressure of 1050 m bar enters an equipment where it undergoes a process of adiabatic saturation, the air leaving with a moisture content of 6 g/kg higher than what it was while entering. Calculate:

i. Moisture content of air entering the equipment.

ii. Dry bulb temperature and enthalpy of the air leaving the equipment.

3. a. Write short notes on:

i. Psychrometric Chart for Moist Air

ii. Dry-Bulb temperatures and Wet Bulb temperatures.

b. Air at a dry-bulb temperature of20°C and wet-bulb temperature of 15°C is heated by a coil heater to raise its dbt to 35°C. Show the heating process on the chart and tabulate the change in the psychrometric data.

Course Outcome 4 (CO4):

1. How do you calculate the total load on the refrigeration plant of a ship? Briefly explain the sizing of the refrigeration plant.
2. Discuss the special design requirements of a marine air conditioning plant. What are its functions in different weather conditions?
3. For a hall to be air-conditioned, the following conditions are given:

Outdoor condition: 40°C dbt, 20°C wbt
Required comfort condition: 20°C dbt, 60% Rt
Seating capacity of the hall: 1500
Amount of outdoor air supplied: 0.3m^3/min per person

If the required conditions are achieved first by adiabatic dehumidification and then by cooling, estimate:

i. the capacity of the cooling coil in tones
ii. the capacity of the humidifier in kg/hour.

Course Outcome 5 (CO5):

1. What is an HVAC zone, and how might a zone differ from a room?

2. With help of schematic figure explain Water Systems and Unitary system. Also list out any two advantages and dis advantages of dual duct system.

3. Why dehumidification system is required for a vessel? Explain how dehumidification processes are carried out in a cargo hold.

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B. TECH DEGREE EXAMINATION, XXXX 20XX

Course Code: SBT426

Course Name: REFRIGERATION AND AIR CONDITIONING OF SHIPS

Max. Marks: 100 **Duration: 3 Hours**

PART A

(Answer all questions, each carries 3 Marks)

Question Number		Marks
1	Define C.O.P., Find the C.O.P of a refrigeration system if the work input is 90kJ/kg and refrigeration effect produced is 150kJ/kg of refrigerant flowing.	(3)
2	What is Montreal and Kyoto Protocol	(3)
3	Draw performance characteristics of a reciprocating compressor.	(3)
4	Explain liquid cooling evaporators.	(3)
5	Define terms Specific humidity and Dew point temperature.	(3)
6	Explain adiabatic dehumidifier.	(3)
7	What are Sensible heat loads? Give examples	(3)
8	Differentiate between Ventilation load and Infiltration heat loads.	(3)
9	What is absorption system?	(3)
10	What is HVAC testing and balancing?	(3)

PART B

(Answer any two full questions from each modules, each full question carries 7 Marks)

MODULE I

11	Explain with help of p-v and T-s diagram explain air refrigeration working on reversed Carnot cycle.	(7)
12	What are the desirable properties of a refrigerant?	(7)
13	Draw a schematic diagram of a refrigeration system and explain functions of its components.	(7)

MODULE II

14	For a particular condenser pressure, how does the power requirement of a reciprocating compressor vary with change in evaporator pressure? Explain giving reasons.	(7)
15	Determine the length of tubes in a 3-pass, shell-and-tube R 22 condenser with 108 tubes for 40 TR chiller. The condensing temperature is 45°C. The heat rejection ratio is 1.20. Water is cooled	(7)

to 32°C in the cooling tower. The temperature rise of water may be taken as 4.8°C. Use integral fin copper tubes with an O.D. of 1.59 cm, an I.D. of 1.37 cm with 748 fins/m length of tube. Fins are 1 mm thick and 1 mm high over tubes.

16 A An R22 expansion valve is factory set for a superheat of 7°C when supplying refrigerant to an evaporator at 5°C. If the evaporator is operating at – 15°C, what will be the effective superheat of the suction vapour? (4)

B If the valve is cross-charged with R 134a as the power fluid, what will be the effective superheat? (3)

MODULE III

17 Mixture of dry air and water vapour is at a temperature of 21°C under a total pressure of 746 mm Hg. The dew-point temperature is 15°C. Find: (7)

i. Partial pressure of water vapour.
ii. Relative humidity.
iii. Specific humidity.
iv. Specific enthalpy of water vapour
v. Enthalpy of air per kg of dry air.

Specific volume of air per kg of dry air.

18 Calculate, (i) relative humidity, (ii) humidity ratio, (iii) dew point temperature, (iv) density and (v) enthalpy of atmospheric air when the DBT is 36°C, WBT is 22°C and the barometer reads 730 mm Hg. (7)

19 Using tables and applying first law of thermodynamics, estimate the heat transfer rates in the following two cases: (7)

i. Heating of 1.2 m3/s of air at 15°C and 90% RH to 50°C without the addition of moisture.
ii. Cooling of 1.5 m3/s of moist air at 30°C and 60% RH to 15°C and 80% RH. The condensate leaves at 20°C.

MODULE IV

20 Explain different loads involved in a cooling load estimation. (7)

21 How do you calculate the total load on the refrigeration plant of a ship? Briefly explain the sizing of the refrigeration plant. Assume a suitable bypass factor of the cooling coil. (7)

22 A room has the following heat gains: (7)

Sensible heat: 35 kW
Latent heat: 20 kW

The design conditions are as follows:

Outside: 40°C DB, 27°C WB
Inside: 22°C DB, 50% RH

The ventilation air requirement is 80 cmm. A cooling coil with a bypass factor of 0.05 must be used. An apparatus dew point of 10°C must be

maintained. Determine:

i. Amount of reheat required.
ii. Supply air quantity.
iii. Dry bulb and wet bulb temperatures of air entering apparatus.
iv. Dry bulb and wet bulb temperatures of air leaving apparatus.
v. Supply air temperature.

MODULE V

23	Why dehumidification system is required for a vessel? Explain how dehumidification process is carried out in a cargo hold.	(7)
24	With help of schematic figure explain dual duct system. Also list out any two advantages and dis advantages of dual duct system.	(7)
25	Compare single zone and multi zone HVAC system.	(7)

SYLLABUS

Module 1

Introduction; Marine Applications of Mechanical Refrigeration; Refrigerated Ship's Stores; Air-Conditioning of Ships; Refrigerated Cargo Spaces; Reversed Carnot Cycle; Vapour-Compression Cycle; Ideal Saturated Vapour-Compression Cycle; Multiple Evaporators with One Compressor.

Refrigerant Properties; Safety; Lubricants; Refrigerant Numbering System; Refrigerant Blends; Ozone Depletion and the Montreal Protocols; Alternative Refrigerants; Secondary Refrigerants.

Module 2

Reciprocating Compressors; Rotary Compressors; Centrifugal Compressors (Only Theory).

Evaporators; Condensers; Liquid Chillers and Secondary Refrigerants; Sizing of Evaporators and Condensers; Expansion Devices (Only Theory).

Module 3

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 Vapour Mixtures; The Psychrometric Chart; HVAC Processes.

Module 4

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.

Module 5

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).

Text Books

1. Earl S. Shulters; Marine Air Conditioning and Refrigeration; Cornell Maritime Press, 1952.
2. James A. Harbach; Marine Refrigeration and Air-Conditioning; Cornell Maritime Press, 2005.
3. Handbook of Air Conditioning and Refrigeration, Shan K Wang, McGraw Hill, 2000.

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, 2005.

Data Book (Approved for use in the examination):

1. Refrigeration tables with charts.
2. Steam Tables with Mollier diagram.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Module 1**	
1.1	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	4

	Vapor-Compression Cycle; Multiple Evaporators with One Compressor.	
1.2	Refrigerant Properties; Safety; Lubricants; Refrigerant Numbering System; Refrigerant Blends; Ozone Depletion and the Montreal Protocols; Alternative Refrigerants; Secondary Refrigerants.	4
2	**Module 2**:	
2.1	Reciprocating Compressors; Rotary Compressors; Centrifugal Compressors (Only Theory).	2
2.2	Evaporators; Condensers; Liquid Chillers and Secondary Refrigerants; Sizing of Evaporators and Condensers; Expansion Devices (Only Theory).	4
3	**Module 3**	
3.1	Psychrometry and HVAC Processes - Dry-Bulb Temperature; Wet-Bulb Temperature; Dew Point Temperature.	3
3.2	Relative Humidity; Humidity Ratio; Specific Volume; Enthalpy; Calculation of Properties of Air-Water Vapor Mixtures	2
3.3	The Psychrometric Chart; HVAC Processes.	1
4	**Module 4**	
4.1	Cooling and Heating Load Calculations: Design Conditions; Components of the Cooling and Heating Load.	3
4.2	Thermal Transmission Load; Ventilation and Infiltration Load; Solar Load.	3
4.3	Equipment and Lighting Load; Occupant Load; Product Load; Heating and Cooling Load Sizing.	2
5	**Module 5**	
5.1	HVAC Systems and Components; Single Zone System; Multiple Zone Systems; Terminal Reheat System;	2
5.2	Dual Duct System; Variable Air Volume Systems; Water Systems; Unitary Systems;	2
5.3	Cargo Hold Dehumidification Systems; HVAC System Components; System Testing and Balancing; Absorption Systems; Multi-Pressure Systems; Low-Temperature Systems (Only Theory).	3

SBT436	MARITIME LAW	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course content is developed to apprise the Naval Architecture students about basic knowledge and understanding on Maritime Law, Maritime contracts, various Regulations on Marine Safety & Pollution. This will be helpful for the students when they start working in the shipping industry.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the nature and importance of Maritime Law.
CO 2	Explain different types of charter and charter party contacts.
CO 3	Explain the various types and clauses in a typical marine insurance law.
CO 4	Understand different Payment and Finance activities applicable for International Trade
CO 5	Apply the concepts to write down typical shipbuilding and ship repair contracts.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2					1					1	1
CO 2	2										1	1
CO 3	2					1	1				1	1
CO 4	2										1	1
CO 5	2										1	1

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	20	20	40
Apply	20	20	40
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
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Continuous Internal Evaluation Pattern:

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End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 3 questions from each module of which student should answer any two. Each question can have maximum 4 sub-divisions and carry 7 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain the concept Bills of Lading with an example. What is its purpose and what are its contents.
2. Explain the application of the Hague Visby Rules in international trade with examples.
3. Explain the purpose and salient features of Hamburg Rules and Rotterdam Rules.

Course Outcome 2 (CO2)

1. What are the factors to be considered while choosing the type of Charter in the international trade?
2. Explain the obligations between Owner and Charterer regarding Voyage and Time Charter Parties. How is the risk and cost allocation between Owner and Charterer carried out?
3. Assume that a delay has been occurred while executing a voyage charter. Explain the various clauses and limitations of liability are to be considered as per the regulations.

Course Outcome 3 (CO3)

1. Explain the salient features of Marine Insurance Act 1906.
2. What are the different types of marine insurance policies? Explain any one with an example.
3. Clauses on Protection and Indemnity are important marine insurance. Explain with reasons.

Course Outcome 4 (CO4)

1. Explain the different forms of mercantile finance with examples.
2. Letters of credit and Bank guarantees are important parts of finance in international trade. Explain.
3. What do you understand by bills of exchange? Explain different types of bills of exchange with example.

Course Outcome 5 (CO5):

1. List down the major clauses in a typical Shipbuilding Contract. How are the warranties and liabilities addressed in this contract?
2. Explain the salient features of a typical Ship Repair Contract for a merchant ship.
3. Explain the important clauses to be agreed by different parties in a Ship Sale & Purchase Contract.

Model Question paper

Question Paper Code			**Total Pages: 4**
Reg No.:_____		Name:_____	
APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, XXXXX 20XX			
Course Code: SBT436			
Course Name: MARITIME LAW			
Max. Marks: 100			Duration: 3 Hours
PART A			
		Answer all questions. Each question carries 3 marks	Marks
1		What is the difference between Hague and Hague-Visby Rules?	(3)
2		What is the necessity for formulating maritime law?	(3)

3		What do you understand by Hybrid Charter Parties	(3)
4		Differentiate between voyage charter parties, time charter parties and demise charter parties	(3)
5		What is meant by good faith duties of the parties and insurable interests?	(3)
6		Is salvage a part of marine insurance policy? If yes give reasons.	(3)
7		What do you understand by mercantile fiancé?	(3)
8		Explain the terms counter Trade. Where is it used in the maritime field?	(3)
9		What are the different types of payments mentioned in a shipbuilding contract?	(3)
10		Explain the purpose of insurance in a ship repair contact.	(3)
PART B			
Answer any two full questions from each module. Each question carries 7 marks			
		Module 1	
11		Explain the concept Bills of Lading with an example. What is its purpose and what are its contents.	(7)
12		Explain the application of the Hague□Visby Rules in international trade with examples.	(7)
13		Explain the purpose and salient features of Hamburg Rules and Rotterdam Rules.	(7)
		Module 2	
14		What are the factors to be considered while choosing the type of Charter in the international trade?	(7)
15		Explain the obligations between Owner and Charterer regarding Voyage and Time Charter Parties. How is the risk and cost allocation between Owner and Charterer carried out?	(7)
16		Assume that a delay has been occurred while executing a voyage charter. Explain the various clauses and limitations of liability are to be considered as per the regulations.	(7)
		Module 3	
17		Explain the salient features of Marine Insurance Act 1906.	(7)
18		What are the different types of marine insurance policies? Explain any one with an example.	(7)

19		Clauses on Protection and Indemnity are important marine insurance. Explain with reasons.	(7)
		Module 4	
20		Explain the different forms of mercantile finance with examples.	(7)
21		Letters of credit and Bank guarantees are important parts of finance in international trade. Explain.	(7)
22		What do you understand by bills of exchange? Explain different types of bills of exchange with example.	(7)
		Module 5	
23		List down the major clauses in a typical Shipbuilding Contract. How are the warranties and liabilities addressed in this contract?	(7)
24		Explain the salient features of a typical Ship Repair Contract for a merchant ship.	(7)
25		Explain the important clauses to be agreed by different parties in a Ship Sale & Purchase Contract.	(7)

SYLLABUS

Module 1 – Introduction to Maritime Law

Bills of Lading; Electronic Bills of Lading; Bills of Lading Issued under Charter Parties; The Hague and Hague-Visby Rules; Application of the Hague Visby Rules; The Hamburg Rules; The Rotterdam Rules.

Module 2 - Charter Party Contracts

Choosing the type of Charter and Factors to be Considered; Obligations between Owner and Charterer regarding Voyage and Time Charter Parties; Risk and Cost Allocation between Owner and Charterer; Commercial Control of the Vessel; Exception Clauses / Limitations of Liability / International Conventions; The Problem of Delay Under Time and Voyage Charters; Hybrid Charter Parties

Module 3 - Marine Insurance Law

The Nature of the Marine Insurance Contract; Capacity to Contract, Good Faith Duties of the Parties and Insurable Interests; The Marine Insurance Act 1906; Types of Policies and Insured Perils; Coverage for General Average and Salvage; Protection & Indemnity Insurance.

Module 4 - Payment and Finance for International Trade

Bills of Exchange; Collection Arrangements and the Uniform Rules 1995; Letters of Credit; Counter Trade; Bank Guarantees and Performance Bonds; Other Forms of Mercantile Finance.

The Four Pillars of Maritime Regulations
International Maritime Organisation and its Mandate
Origins and Content of the Four Pillars - SOLAS, MARPOL, STCW, MLC.

Module 5

Shipbuilding Contract: Method of Payment; Title and Security; Plans and Specifications; Warranties and Limitation of Liability; Completion Dates, Insurance, Taxes.

Ship Repair Contract: Processes Involved in Ship Repair; 20% Contract and Financing Repairs; Cancellations, Variations, Delays, Warranties; Losses and Damage; Insurance and Regulatory Issues; Protecting Rights; Managing Risk, Liability and Di

Ship Sale & Purchase Contracts: Introduction to Sale and Purchase, Parties, Roles and Contract Forms; Ship Broker and Formation of the Contract in Sale and Purchase; The Memorandum of Agreement; Performance Guarantees; Default, Remedies and Arbitration.

Text Books

1. Christopher Hill, “Maritime Law”, Lloyd's Practical Shipping Guides, Publisher : Informa Law, 6th edition, 2017
2. “Guidance for the Ship Operators on Port State Control”, The ILO Maritime Labour Convention, 2006.
3. SOLAS consolidated edition, 2014 by IMO.
4. Yvonne Baatz, “Maritime Law”, Publisher : Informa Law, 6th edition, 2021

Reference Books

1. Capt. M. V.Naik & Capt. C. L.Dubey, “Maritime Legislation & Ship Board Management for Deck Officers”
2. IMO STCW Convention and STCW Codes.
3. MARPOL consolidated edition, IMO, 2011.
4. Thomas J. Schoenbaum, “Admiralty and Maritime Law”, Hornbook Series Student Edition, 2018.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction to Maritime Law**	
1.1	Bills of Lading; Electronic Bills of Lading; Bills of Lading Issued under Charter Parties	2
1.2	The Hague and Hague-Visby Rules; Application of the Hague□Visby Rules	2
1.3	The Hamburg Rules; The Rotterdam Rules	2
2	**Charter Party Contracts**	
2.1	Choosing the type of Charter and Factors to be Considered Risk and Cost	2
2.2	Obligations between Owner and Charterer regarding Voyage and Time Charter Parties;	2
2.3	Allocation between Owner and Charterer; Commercial Control of the Vessel; Exception Clauses / Limitations of Liability / International Conventions	2
2.4	The Problem of Delay Under Time and Voyage Charters; Hybrid Charter Parties	1
3	**Marine Insurance Law**	
3.1	The Nature of the Marine Insurance Contract; Capacity to Contract, Good Faith Duties of the Parties and Insurable Interests	2
3.2	The Marine Insurance Act 1906	1

3.3	Types of Policies and Insured Perils; Coverage for General Average and Salvage; Protection & Indemnity Insurance.	2
4		
4.1	**Payment and Finance for International Trade** Bills of Exchange; Collection Arrangements and the Uniform Rules 1995; Letters of Credit; Counter Trade; Bank Guarantees and Performance Bonds; Other Forms of Mercantile Finance.	4
4.2	**The Four Pillars of Maritime Regulations** International Maritime Organisation and its Mandate Origins and Content of the Four Pillars - SOLAS, MARPOL, STCW, MLC.	3
5		
5.1	**Shipbuilding Contract**: Method of Payment; Title and Security; Plans and Specifications; Warranties and Limitation of Liability; Completion Dates, Insurance, Taxes.	3
5.2	**Ship Repair Contract**: Processes Involved in Ship Repair; 20% Contract and Financing Repairs; Cancellations, Variations, Delays, Warranties; Losses and Damage; Insurance and Regulatory Issues; Protecting Rights; Managing Risk, Liability and Disputes.	3
5.3	**Ship Sale & Purchase Contracts**: Introduction to Sale and Purchase, Parties, Roles and Contract Forms; The Ship Broker and Formation of the Contract in Sale and Purchase; The Memorandum of Agreement; Performance Guarantees; Default, Remedies and Arbitration.	3

SBT446	DESIGN OF MACHINE ELEMENTS	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course is an introductory course in designing of machine components which mainly deals with design of welded joints, couplings, shafts, springs gears, etc. This course starts with the Fundamentals of Machine Design and the various factors to be considered while designing a component. Then it deals with design procedure for 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. Finally, it deals with the concepts of gears and its design procedures. This course meets the requirements for naval architecture and ship building engineering branch students.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the fundamentals of machine design and various theories of failures.
CO 2	Apply the design procedure for designing the welded Joints, Couplings and Shafts.
CO 3	Apply the design procedure steps for designing of a helical Spring.
CO 4	Analyse the need of bearing, uses of lubrication and its design.
CO 5	Carry out material selection of gear based on the application requirements.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2	2									1
CO 2	3	2	3									1
CO 3	3	2	3	2								1
CO 4	3	2	3	2								1
CO 5	3	2	3	2								1

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	20	20	40
Apply	20	20	40
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contain five questions from each module of 4 marks each. Students should answer all questions. Part B contains 3 questions from each module of which student should answer any two. Each question can have maximum 3 sub-divisions and carry 8 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What are the factors to be considered in the selection of materials for a machine element?
2. A bolt is subjected to a direct tensile load of 25kN and shear load of 15kN. Considering various theories of failure, determine the suitable size of bolt if the yield stress in tension is 250N/mm2. Take FOS as 2 and Poisson's ratio as 0.3.
3. Define the various theories of failure.

Course Outcome 2 (CO2)

1. Design of welded joints and its material used
2. A cylindrical shaft made of steel of yield strength 700 MPa is subjected to static loads consisting of bending moment 10 KN-m and a torsional moment 30 KN-m. Determine the diameter of the shaft using two different theories of failure and assuming a factor of safety of 2. Take E = 210 GPa and Poisson's ratio = 0.25.
3. It is required to design a rigid type of flange coupling to connect two shafts. The input shaft transmits 37.5 kW power at 180 rpm to the output shaft through the coupling. The service factor for the application is 1.5, i.e. the design torque is 1.5 times of rated torque. Select suitable materials for various parts of the coupling, design the coupling and specify the dimensions of its components.

Course Outcome 3(CO3):

1. List out the various types of spring and its uses
2. Explain the various factors considered while designing a spring.
3. A helical compression spring of cam mechanism is subjected to an initial preload of 50 N. The maximum operating force during the load cycle is 150 N. The wire diameter is 3mm while the mean coil diameter is 18 mm. The spring is made of oil-hardened and tempered valve spring wire of grade VW (Sut=1430N/mm2). Determine the factor of safety used in design on the basis of fluctuating stresses.

Course Outcome 4 (CO4):

1. Illustrate the various types of bearings
2. Explain the functions of lubrication?
3. A hydrodynamic journal bearing operates at 1200 rpm and carries a load of 5.5 k N. The journal diameter is 55 mm and length is 55 mm. The bearing is lubricated with SAE 20 oil and the operating temperature of oil is 790C. Assume radial clearance as 0.025 mm and the attitude angle as 600. Determine: (i) bearing pressure, (ii) Attitude, (iii) minimum film thickness, (iv) heat generated, (v) heat dissipated, if the ambient temperature is 250C, and (vi) amount of artificial cooling if necessary.

Course Outcome 5 (CO5):

1. Describe the various types of gears and its function
2. Design a pair of spur gear with 20° full-depth involute teeth based on Lewis Equation. The velocity factor is to be used to account for dynamic load. The pinion shaft is to be connected to 10kW, 1440 RPM motor. The starting torque of the motor is 150% of the rated torque. The speed reduction is 4:1. The pinion as well as gear is made of plain carbon steel 40C8 (S_{ut}=600 N/mm^2), factor of safety as 1.5. Design the gears based on velocity factor and, determine their dimensions.
3. Demonstrate Buckingham's Equation for Dynamic Load.

Model Question paper

Reg No.:_____ **Name: _____**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, XXXX 20XX

Course Code: SBT446

Course Name: DESIGN OF MACHINE ELEMENTS

Max. Marks: 100 **Duration: 3hrs**

PART A

Answer all questions, each carries 4 marks.

1. What is factor of safety? What are the factors to be considered in the selection of factor of safety (FoS)?
2. What are the different types of keys? (Any four); and explain its failure modes.
3. What is stiffness of the spring?
4. State and explain law of gearing with a neat sketch.
5. Define static and dynamic load carrying capacity of ball bearing.

PART B

Answer any two complete questions from each module.

MODULE I

(8x2=16 Marks)

11. A mild steel shaft is subjected to a 3500 N-m of bending moment at its critical point and transmits a torque of 2500 N-m. The shaft is made of steel having a yield stress of 230 MPa. Estimate the size of the shaft (FOS =2) based on following theories of failure 1. Maximum normal stress theory 2. Maximum shear stress theory 3. Distortion energy theory

12. A shaft is loaded by a torque of 5 KN-m. The material has a yield point of 350 MPa. Find the required diameter using (a) Maximum shear stress theory (b) Maximum distortion energy theory Take a factor of safety of 2.5.

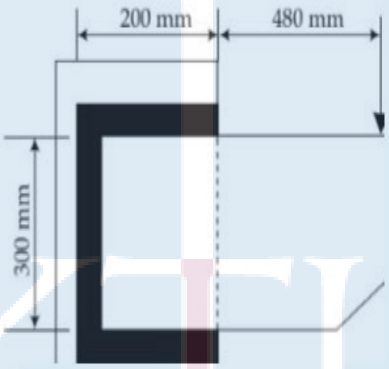
13. A bolt is subjected to an axial pull of 5KN. The yield strength of the bolt is material is 300 MPa. Considering the factor of safety as 2.5. determine the diameter of the bolt, using i) maximum normal stress theory ii) maximum shear stress theory iii) maximum principal strain theory. Take poisson's ratio as 0.25.

MODULE II

(8x2 = 16 Marks)

14. a) Why do we design the weld joints based on throat area?

    b) Determine the size of the weld for a bracket loaded as shown in the figure. The allowable stress in the weld as 60 MPa



15. Design a protected type CI flange coupling for a steel shaft transmitting 28 kW at 200 rpm. The allowable shear stress in the shaft and key material is 40 MPa. The maximum torque transmitted is to be 20% greater than the mean torque. The allowable shear stress in the bolt is 60 MPa and allowable shear stress in CI flange is 40 MPa.
16. Design a flexible coupling for connecting a motor and a pump shaft. The following data are provided power transmitted= 20 kW, speed= 1000 rpm, diameter of the motor and the pump shaft =50mm.

MODULE III

(8x2=16 Marks)

17. It is required to design a helical compression spring subjected to a maximum force of 1250 N. The deflection of the spring corresponding to the maximum force should be approximately 30 mm. The spring index can be taken as 6. The spring is made of patented and cold-drawn steel wire. The ultimate tensile strength and modulus of rigidity of the spring material are 1090 and 81 370 N/mm^2, respectively. The permissible shear stress for the spring wire should be taken as 50% of the ultimate

tensile strength. Design the spring and calculate • Wire diameter • Mean coil diameter • Number of active coils • Total number of coils • Free length of the spring • Pitch of the coil

18. A railway car weighing 20kNand moving with a velocity of 15kmph is to be stop by a buffer consisting of four helical compression spring in which maximum compression allowed is 0.3m. find the no. Of active turns required if the spring is made of 20mm dia wire and 160mm mean coil diameter. Also find the maximum shear stress induced in the coils.

19. Find out the mean diameter (D), the wire diameter (d), the number of active coils (n) and the free length (Lf) of the spring against the following given data:

    i. Preload on the spring (W1) = 250 N
    ii. Final load on the spring (W2) = 400 N
    iii. Initial Deflection due to preload (X1) = 50 mm
    iv. Final deflection of the spring (X2) = 60 mm
    v. Maximum permissible shear stress (Smax) = 400 MPa
    vi. Modulus of rigidity (G) = 80 x 103 MPa
    vii. Inside diameter of the spring = 25mm

MODULE IV

(8 x2=16 Marks)

20. The following data refers to short hydrodynamic full Journal bearing :
    Radial Load = 1000N
    Journal speed = 2100 RPM (1/d) Ratio=0.5
    Eccentricity ratio=0.65
    Radial clearance=0.002×journal radius
    Flow rate of lubricant = 3.45 litres per hour
    Calculate, i) the diameter of journal ii) the radial clearance iii) the dimensions of bearing iv) the minimum oil film thickness v) the absolute viscosity of lubricant.
21. A hydrodynamic journal bearing operates at 1200 rpm and carries a load of 5.5 k N. The journal diameter is 55 mm and length is 55 mm. The bearing is lubricated with SAE 20 oil and the operating temperature of oil is 790C. Assume radial clearance as 0.025 mm and the attitude angle as 600. Determine: (i) bearing pressure, (ii) Attitude, (iii) minimum film thickness, (iv) heat generated, (v) heat dissipated, if the ambient temperature is 250C, and (vi) amount of artificial cooling if necessary.
22. A ball bearing is subjected to a radial load of 10 kN and a thrust load of 5 kN. The inner ring rotates at 1000 rpm. The average life is to be 5000 hours. What basic load rating must be used to select a bearing for this purpose? Take Fa/Co = 0.5 and assume service factor 1.5.

MODULE V

(8x2=16 Marks)

23. A spur gear pair with 20° full depth involute tooth profile consist of 18 teeth pinion meshing with 36 teeth gear. The pinion & gear is made of steel with ultimate tensile strength 600 N/mm^2 & 510 N/mm^2 respectively, the module is 5 mm while the face width is 10 x module. The surface hardness of pinion & gear are 330 BHN & 280 BHN respectively.
    Calculate the beam strength and wear strength.
24. A pair of helical gears is to transmit 15 kW. The teeth are 20° stub in diametric plane and have a helix angle of 45°. The pinion runs at 10 000 r.p.m. and has 80 mm pitch diameter. The gear has 320 mm pitch diameter. If the gears are made of cast steel having allowable static strength of 100 MPa; determine a suitable module and facer.
25. Design a pair of spur gear with 20° full-depth involute teeth based on Lewis Equation. The velocity factor is to be used to account for dynamic load. The pinion shaft is to be connected to 10kW, 1440 RPM motor. The starting torque of the motor is 150% of the rated torque. The speed reduction is 4:1. The pinion as well as gear is made of plain carbon steel 40C8 (S_{ut}=600 N/mm^2), factor of safety as 1.5. Design the gears based on velocity factor and, determine their dimensions.

SYLLABUS

Module 1

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.

Theories of Failure: Guest's Theory, Rankine's Theory, St. Venant's Theory, Haigh's Theory, Von Mises & Hencky Theory. Stress Concentrations: Methods to Reduce Stress Concentration, Theoretical Stress Concentration Factor.

Module 2

Joints: Design of Detachable Joints (Pins, Keys, Splines and Bolted Joints).

Non-Detachable Joints: Welded, Riveted Joints; Strength of Welded and Riveted Joints.

Drive Elements: Shafts, Torsion and Bending of Shafts, Design of Shafts for Strength and Deflection, Effect of Key Way.

Design of Couplings: Rigid and Flexible Couplings

Module 3

Elastic Springs: Classification and uses of springs, Allowable Stresses and Deflections.

Springs: Stresses and Design of Helical Springs with Axial and Fluctuating Loads.

Module 4

Bearings: Slide Bearings, Introduction to Lubrication, Hydrodynamic Bearings, Bearing Materials, Design of Slide Bearings.

Roller Bearing: Types, Static & Dynamic Load, Capacity, Bearing Life and Selection of Bearing.

Module 5

Gears: Classification, Gear Nomenclature, Tooth profiles, Materials of Gears; Design of Spur, Helical and Bevel Gears.

Beam Strength: Lewis Equation, Buckingham's Equation for Dynamic Load, Wear Load, and Endurance Strength of Tooth.

Text Books

1. M. F. Spotts, T. E. Shoup, Design of Machine Elements, Pearson Education, 2004.
2. R.K .Jain, Machine Design, Khanna Publications, New Delhi, 1988.

Reference Books

1. C.S. Sarma, Kamlesh Purohit, Design of Machine Elements; Prentice Hall of India, 2002.
2. J.E.Shigley; Mechanical Engineering Design; McGraw Hill, 2014.
3. V.B. Bhandari, Design of Machine Elements, McGraw Hill, 2007.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Theories of Failure**	
1.1	**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
1.2	**Theories of Failure:** Guest's Theory, Rankine's Theory, St. Venant's Theory, Haigh's Theory, Von Mises & Hencky Theory. Stress Concentrations: Methods to Reduce Stress Concentration, Theoretical Stress Concentration Factor**.**	2
1.3	Problems on theories of failure	3

2	Design Of Joints, Shafts And Coupling	
2.1	**Joints:** Design of Detachable Joints (Pins, Keys, Splines and Bolted Joints). Non-Detachable Joints: Welded, Riveted Joints; Strength of Welded and Riveted Joints.	2
2.2	Problems on Welded and Riveted Joints	3
2.3	**Drive Elements:** Shafts, Torsion and Bending of Shafts, Design of Shafts for Strength and Deflection, Effect of Key Way.	2
2.4	Problems on shafts	2
2.5	**Design of Couplings:** Rigid and Flexible Couplings , problems	3
3	SPRINGS	
3.1	**Elastic Springs:** Classification and uses of springs, Allowable Stresses and Deflections.	1
3.2	**Springs:** Stresses and Design of Helical Springs with Axial and Fluctuating Loads.	1
3.3	Problems on helical springs	3
4	BEARINGS	
4.1	**Bearings:** Slide Bearings, Introduction to Lubrication, Hydrodynamic Bearings, Bearing Materials, Design of Slide Bearings.	1
4.2	Roller Bearing: Types, Static & Dynamic Load, Capacity, Bearing Life and Selection of Bearing.	2
4.3	Problems on bearing	3
5	GEARS	
5.1	**Gears:** Classification, Gear Nomenclature, Tooth profiles, Materials of Gears; Design of Spur, Helical and Bevel Gears.	2
5.2	Beam Strength: Lewis Equation, Buckingham's Equation for Dynamic Load, Wear Load, and Endurance Strength of Tooth.	1
5.3	PROBLEMS	3

SEMESTER VIII

PROGRAM ELECTIVE V

SBT418	EXPERIMENTAL TECHNIQUES ON SHIPS AND MODELS	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course conveys the knowledge of different hydrodynamic experiments conducted on ship models to figure out the power requirement and performance of actual ship. Students get to know about different trials & test conducted on ship as well.

Prerequisite: SBT281- Fundamental concepts in Naval Architecture

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand different phases of ship model making and resistance test setup. Analyse the test result and find out the power requirement of ship.
CO 2	Identify the performance of a ships propeller and resulting hull propeller interaction using model experiments.
CO 3	Ascertain the knowledge of propeller cavitation and to determine its effects on performance of propeller.
CO 4	Analyse the results to predict delivered power and propeller revolution rate at a given speed of the ship and determine Wake Fraction, Thrust Deduction Factor, and Relative Rotative Efficiency.
CO 5	Discern objectives and procedures of various sea trials and manoeuvring tests
CO 6	Explain the procedure and identify the significance of Paint Erosion Tests, Smoke Disposal Tests, Rudder Tests and Tuft Tests.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2	1	1			1					2
CO 2	3	2	2				1					2
CO 3	3	2					1					2
CO 4	3	2	2				1					2
CO 5	3						1					2
CO 6	3						1					2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	40
Apply	20	20	50
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 3 questions from each module of which student should answer any two. Each question can have maximum 3 sub-divisions and carry 7 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain about the resistance test setup and procedure of ship model conducted in towing tank with the help of a neat diagram.
2. Using Buckingham principle, write down the dimensional analysis of ship resistance.
3. When a ship model of length (Lm) 3.0m in a geometric scale of 1:10 is towed at a speed equivalent to the ship speed (Vs) of 12knots.The total resistance measured

from the load cell is 60N. Find the total resistance of the ship using ITTC -78 prediction method. Given Data: Wetted surface area of model (Sm) - 2.0 m2, Kinematic viscosity of sea water - 0.9425x10-6m2/s, Kinematic viscosity of fresh water -0.8929x10-6.

Course Outcome 2 (CO2):

1. Explain about the open water test setup and procedure with the help of neat diagram
2. Using Buckingham principle, write down the dimensional analysis of propeller thrust
3. A ship propeller of diameter 3.0m with a depth of immersion 2.5m rotates at an rpm of 150 while advancing with an axial velocity of 10 knots. Calculate the depth of immersion, rpm and velocity of a 0.15m diameter model propeller.

Course Outcome 3 (CO3):

1. Explain about the different types of propeller cavitation with the help of neat diagram.
2. Explain the cavitation tunnel experiment setup and procedure for model propeller with the help of a neat diagram.
3. What is propeller cavitation? What are effects of cavitation? How the propeller cavitation can be prevented?

Course Outcome 4 (CO4):

1. Explain about the self propulsion test setup and procedure with the help of neat diagram.
2. Explain the concepts and calculation involved in blade element theory with a neat diagram.
3. In a self propulsion test with a twin screw ship model, the model is self-propelled at a speed of 2.3 m/s when the two propellers together have a total thrust of 34 N and a total torque of 1.18 Nm at 720 rpm. In the open water test with either propeller running at 720 rpm a thrust of 17 N is obtained at a speed of 2 m/s, the torque being 0.61 Nm. The resistance of the model at a speed of 2.3 m/s is 29 N. Calculate the propulsive efficiency and its components.

Course Outcome 5 (CO5):

1. What is maneuvering trials? What are the draw backs of manoeuvring trials? What are the IMO standard criteria for conducting manoeuvring trials?

2. Explain about the different types of sea trials
3. Explain three phases in conducting turning circle manoeuvring.

Course Outcome 6 (CO6):

1. Explain about the procedure and observation involved in paint erosion test.
2. What is the main objective of smoke disposal test? Explain how the smoke disposal test is conducted.
3. What is the main objective of rudder test? Explain how the rudder test is conducted

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
EIGHTH SEMESTER B.TECH DEGREE EXAMINATION
SBT418 - EXPERIMENTAL TECHNIQUES ON SHIPS AND MODELS

PART A

Answer ALL questions. Each question carries 3 marks.

(3x10 = 30Marks)

1. Draw a figure to show how wave making resistance of the ship changes with the Froude number.
2. Draw a figure to show the classifications of ship resistance.
3. What are the similarities that should be fulfilled while doing the open water test?
4. What is the main objective of open water test and what all parameters are measured from the open water test of model propellers?
5. What is the minimum depth of immersion of propeller to avoid cavitation? What is the purpose of honey comb in cavitation tunnel?
6. What is the purpose of the contracting section ahead of the working section and the diffuser ahead of the impeller in cavitation tunnel experiment of model propeller?
7. Define the terms wake, thrust deduction fraction and relative rotative efficiency.
8. What is the purpose of dynamometer and electric motor in self propulsion test?
9. Differentiate between straight line stability and course keeping stability of ships.
10. Define the term advance, transfer and tactical diameter

PART B

Answer any two complete questions from each module.

MODULE I

(7x2=14 Marks)

11. Explain about the resistance test setup and procedure of ship model conducted in towing tank with the help of a neat diagram.
12. A ship of length 60.0m is having a design speed of 15knots. What is the corresponding speed of ship model in a geometric scale of 1:10 based on Froude's law of similarity? Also calculate the wetted surface area of the ship, if the wetted surface area of ship model is 2.82m2
13. Explain about the three phases of fibre glass ship model making

MODULE II

(7x2 = 14 Marks)

14. Explain about the propeller geometry with the help of neat diagram
15. A model propeller of 0.15m diameter having a depth of immersion of 0.5m rotates at 600 rpm while advances with an axial velocity of 1.75m/s. The thrust and torque measured from the dynamometer is 20N and 3Nm. Calculate J, KT, KQ and ηo.
16. Using Buckingham principle, write down the dimensional analysis of propeller thrust

MODULE III

(7x2=14 Marks)

17. A propeller of diameter 4 m rotates at an rpm of 100 while advances with a speed of 3 m/s. Calculate the cavitation number when the depth of immersion is 5m. Given data: Atmospheric pressure 101.325 kPa and Vapour pressure – 1.7kPa
18. Explain about the effects of cavitation in propellers and its prevention
19. Draw the cavitation tunnel experiment setup for model propellers and explain the function of each components

MODULE IV

(7x2=14 Marks)

20. Explain thrust identity method and torque identity method with the help of neat diagram
21. Explain about the self propulsion test setup and procedure with the help of neat diagram
22. In a self propulsion test with a twin screw ship model, the model is self-propelled at a speed of 2.3 m/s when the two propellers together have a total thrust of 34 N and a total torque of 1.18 Nm at 720 rpm. In the open water test with either propeller running at 720 rpm a thrust of 17 N is obtained at a speed of 2 m/s, the torque being

0.61 Nm. The resistance of the model at a speed of 2.3 m/s is 29 N. Calculate the propulsive efficiency and its components.

MODULE V

(7x2=14 Marks)

23. Explain turning circle manoeuvre. What are the IMO manoeuvring standards to conduct ship manoeuvring trials?
24. Explain about the different types of sea trials
25. Define the terms a.) Overshoot yaw angle, b.) Overshoot width of path and c.) time to reach second execute in a zig zag manoeuvre with the help of a neat sketch

SYLLABUS

Module – I

Introduction To Experimental Techniques, Prediction of Ship Resistance, Resistance Tests, Total Resistance, Resistance Curves, Resistance Coefficients, Ship Models, Laws of Comparisons and Similarity, Extension of Model Results to Ships, Towing Tank, Instrumentation and Method of Measurements.

Module – II

Open Water Tests: Objectives, Facilities, Test Set Up, Principles, Procedure, Analysis and Conclusions.

Module – III

Cavitation Tests - Cause of Cavitation, Cavitation Number, Classification of Cavitation, Law of Similarities, Cavitation Tests, Prevention of Cavitation.

Module – IV

Self Propulsion Experiments - Objectives, Instruments and Equipment, Test Arrangements, Basic Principles, Experiment, Results.

Wake Measurements, Sea Keeping Tests.

Paint Erosion Tests, Smoke Disposal Tests, Rudder Tests, Tuft Tests.

Module –V

Sea trials, Shop Tests.

Maneuvering Trials, Dock Trials, Speed Trials, Observations, Data Presentation and Uses.

Shallow Water Resistance Tests.

Text Books

1. E.C. Tupper; Introduction to Naval Architecture, Butterworth-Heinemann, 1996
2. S. C. Misra; Design Principles of Ships and Marine Structures, CRC Press, 2015

Reference Books

1. DGM Watson; Practical Ship Design; Elsevier Ocean Engineering Book Series, 2002.
2. Ship Design & Construction; Volume I and II (2003, 2004), The Society of Naval Architects and Marine Engineers.
3. Tony Molland; The Maritime Engineering Reference Book: A Guide to Ship Design, Construction and Operation; Butterworth-Heinemann, 2011.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Module – I**	
1.1	**Introduction To Experimental Techniques**, Prediction of Ship Resistance, Resistance Tests, Total Resistance, Resistance Curves, Resistance Coefficients	3
1.2	Ship Models, Laws of Comparisons and Similarity,	2
1.3	Towing Tank, Instrumentation and Method of Measurements, Extension of Model Results to Ships,	3
2	**Module – II**	
2.1	**Open Water Tests**: Objectives, Facilities, Test Set Up	2
2.2	Principles, Procedure,	2
2.3	Analysis and Conclusions.	2
3	**Module – III**	
3.1	**Cavitation Tests** - Cause of Cavitation, Cavitation Number	2
3.2	Classification of Cavitation, Law of Similarities	2
3.3	Cavitation Tests, Prevention of Cavitation.	3
4	**Module – IV**	
4.1	**Self Propulsion Experiments** - Objectives, Instruments and Equipment, Test Arrangements	2
4.2	Basic Principles, Experiment, Results.	2
4.3	**Wake Measurements, Sea Keeping Tests.**	2
4.4	**Paint Erosion Tests, Smoke Disposal Tests, Rudder Tests, Tuft Tests.**	2
5	**Module – V**	
5.1	**Sea trials, Shop Tests**.	2
5.2	Maneuvering Trials, Dock Trials, Speed Trials, Observations, Data Presentation and Uses.	3
5.3	**Shallow Water Resistance Tests**.	2

SBT428	OCEAN WAVE HYDRODYNAMICS	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course conveys the knowledge about wave generation and wave deformation. Student will get to learn about wave load calculation and concepts of different wave theories. It also helps them to understand different methods of wave data collection and wave data analysis.

Prerequisite: SB301- Ship Dynamics

Course Outcomes: After the completion of the course the student will be able to

CO 1	Recollect the basics of fluid dynamics
CO 2	Convey the science behind the formation of ocean waves. Analyze the properties of water particle under progressive waves. Apply the knowledge to solve numericals on wave power and wave energy.
CO 3	Identify the force regime to be considered for wave load calculation
CO 4	Acquire knowledge about different stages of wave deformation
CO 5	Differentiate the concept of wave theories
CO 6	Understand different methods of wave data collection and wave data analysis

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3											3
CO 2	3	3	2	1			1					3
CO 3	3	3	2	1		2	2					3
CO 4	3	2				1	2					3
CO 5	3	1					1					3
CO 6	3	3	2	1		2	2					3

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	40
Apply	20	20	50
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 3 questions from each module of which student should answer any two. Each question can have maximum 3 sub-divisions and carry 7 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Differentiate between steady flow and uniform flow of fluid with a neat sketch.
2. Derive continuity equation and list down its assumptions.
3. List down different forces acting on fluids.

Course Outcome 2 (CO2):

1. Derive velocity potential and write down its assumptions.
2. With a neat sketch show the water particle displacement under progressive wave in deep water and shallow water.
3. Consider a particle initially at 8m below the SWL and 20m above the sea bed. After the wave motion is established, what is the size and character of the orbit of the particle? Repeat the calculation for a particle at the surface and at the sea bed. The wave period, T=10sec and deep water wave length, Ho=3m. (Use wave table)

Course Outcome 3 (CO3):

1. What are the important factors that make the wave loads on structure complicated?
2. Why linear wave theory is not applicable for offshore structures?
3. Derive the equation of total force acting on a fixed cylinder in waves using Morison equation.

Course Outcome 4 (CO4):

1. What is diffraction? What happens to the region near break water when diffraction happens?
2. What is wave breaking? Explain, what are the types of wave breaking? What are the conditions for breaking a wave?
3. What happens to wave height, wave length and wave period when the wave propagates from deep water to shallow water?

Course Outcome 5 (CO5):

1. Compare the wave surface profiles in different wave theories with the help of suitable diagram?
2. With the help of diagram, show the regions of validity for different wave theories?
3. Draw a diagram to show the classification of wave theories based on Keulegen-Carpenter number?

Course Outcome 6 (CO6):

1. Define the term fetch and fully developed sea with a neat diagram
2. Explain different methods of wave data analysis.
3. Explain the different methods of wave data collection.

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
EIGHTH SEMESTER B.TECH DEGREE EXAMINATION
SBT428 OCEAN WAVE HYDRODYNAMICS
PART A

Answer ALL questions. Each question carries 3 marks.

(3x10 = 30Marks)

1. Differentiate between the stream function and the velocity potential function.
2. Differentiate between laminar flow and turbulent flow.
3. Draw the water particle trajectory in deep water, intermediate depth and shallow water
4. What is shoaling? Write down the expression for shoaling coefficient.
5. What are wave force equations? What are the major steps involved in the calculation of wave forces?
6. What are the classifications of loads acting on the offshore structures?
7. What is diffraction? What is the importance of diffraction effect?
8. What is refraction? What are the assumptions involved in making a refraction diagram?
9. What are the assumptions of linear wave theory?
10. Define the term wave age and write down its importance.

PART B

Answer any two complete questions from each module.

MODULE I

(7x2=14 Marks)

11. Derive the continuity equation and state its assumptions.
12. Explain classification of fluid flow with neat diagrams.
13. Derive the Euler's equation and state its assumptions.

MODULE II

(7x2 = 14 Marks)

14. Derive the velocity potential using linear wave theory.
15. Consider a particle initially at 8m below the SWL and 20m above the sea bed. After the wave motion is established, what is the size and character of the orbit of the particle? Repeat the calculation for a particle at the surface and at the sea bed. The wave period, T=10sec and deep water wave length, Ho=3m. (Use wave table)
16. Explain classification of waves with suitable sketch

MODULE III

(7x2=14 Marks)

17. Derive the equation of total force acting on a fixed cylinder in waves using Morison equation.
18. Derive the equation of total force acting on a fixed cylinder in waves using Morison equation.
19. Explain about the applicability of Morison equation.

MODULE IV

(7x2=14 Marks)

20. What is wave deformation? Explain, what are the different zones and causes of wave deformation?
21. What is refraction? What are the characteristics of refraction? What are the assumptions involved in making a refraction diagram?
22. What is wave breaking? Explain, what are the types of wave breaking? What are the conditions for breaking a wave?

MODULE V

(7x2=14 Marks)

23. Explain the different methods of wave data collection.
24. Explain Stokes wave theory with a neat diagram
25. Explain Cnoidal wave theory with a suitable sketch

SYLLABUS

Module – 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).

Module – 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.

Module – 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.

Module – IV

Wave Deformation: Wave Refraction; Wave Diffraction; Wave Breaking- Types of Wave Breaking; Waves on Currents; Simple Problems on Wave Deformation.

Module –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.

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).

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, 1991.

Reference Books

1. Daugherty R.L, Franzini J.B and Finneemore E.J; Fluid Mechanics with Engineering Applications; McGraw Hill, 1997.

2. Prof. Alexandra Techet; Hydrodynamics (13.012); MIT Open Courseware.

3. Sir Horace Lamb; Hydrodynamics; University Press, 2009.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Module – I**	
1.1	Introduction; *Types of flow*; Continuity Equation and Conservation of Mass.	2
1.2	Forces Acting on Fluids in Motion; Euler's Equation of Motion; Path lines and Streamlines.	2
1.3	Velocity Potential; Stream Function; Bernoulli Equation (Theory Only).	2
2	**Module – II**	
2.1	**Wave Motion :** *Classification of Waves*; Derivation of the Velocity Potential; Dispersion Relationship; Celerity in Different Water Depth Conditions	3
2.2	Local Fluid Particle Velocities and Acceleration Under Progressive Waves; Water Particle Displacement Under Progressive Waves; Pressure Distribution Under Progressive Waves.	2
2.3	Group Celerity; Wave Energy; Wave Power; Simple Problems on Wave Motion.	3
3	**Module – III**	
3.1	Force Regimes; Design Wave Approach; Morison Equation- Fixed Cylinder in Waves,	2
3.2	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	2
3.3	Wave Forces on Piles in Shallow Water, Submarine Pipelines; Froude-Krylov Forces; Diffraction Regime; Simple Problems on Wave Loads.	3
4	**Module – IV**	
4.1	**Wave Deformation:** Wave Refraction; Wave Diffraction; Wave Breaking- Types of Wave Breaking	3
4.2	Waves on Currents; Simple Problems on Wave Deformation.	3
5	**Module – V**	
5.1	**Finite Amplitude Waves:** Stoke's Wave Theory- Comparison Between Wave Theories; Solitary Wave Theory	2
5.2	Cnoidal Wave Theory; Stream Function Theory; Simple Problems on Finite Amplitude Waves	2
5.3	**Random Waves:** *Generation of Ocean Waves*; Importance of Study of Wave Data; *Collection of Wave Data*	2

5.4	Analysis of Ocean Waves- Statistical Method, Spectral Method, Fast Fourier Transform Method; Irregular Sea Way- Wave-Wave Spectrum Relationship (Theory Only).	3

SBT438	COMPUTER AIDED DESIGN AND COMPUTER AIDED MANUFACTURING	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course is an introductory course in designing which mainly deals with**e**volution of Computer Aided Design, Computer Aided Manufacturing & Computer Intergrated Manufacturing.This course also give an opportunity to learn about various Naval Architecture Design Software for analysis of various components in marine industry. The next part it deals with concepts of Computer Aided Part Programming and Flexible Manufacturing Systems, which are used to speed up the production in an industry. Finally, the basic components of a Robot, its control and its applications in various field are also introduced at the end of the course.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the fundamentals of design process, CAD -CAM- CIM and to familiarise various Naval Architecture software packages used in the industry
CO 2	Explain the basic functioning of Numerically Controlled Machine tools, its need and its application.
CO 3	Develop simple part programs using both manual as well as computer aided part programming methods.
CO 4	Identify the need of computer aided process planning, Group Technology and Flexible Manufacturing Systems in manufacturing environment.
CO 5	Explain the basic components of robots, its driving mechanism and its application in different field.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2	3		2				2			1
CO 2	3	2	2		2							1
CO 3	3	2	3	2	2							1
CO 4	3	2	2	2	2							1
CO 5	3	2	2		1							1

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	20	20	40
Apply	20	20	40
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 3 questions from each module of which student should answer any two. Each question can have maximum 3 sub-divisions and carry 7 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Define the various steps in design process.

2. Differentiate the terms wire frame, surface and solid models, along with their benefits.

3. Explain the different types of naval architecture modelling software's.

Course Outcome 2 (CO2)

1. State the advantages and disadvantages of NC system.

2. Explain point to point, straight cut and contour positioning.

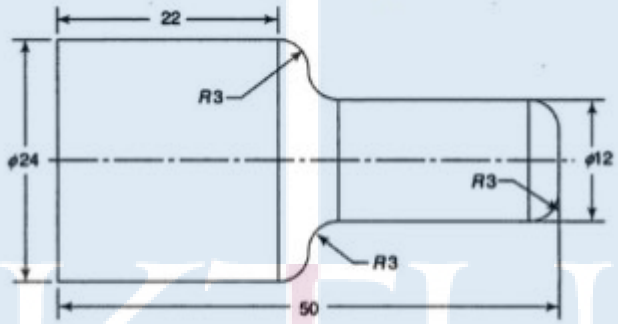
3. Differentiate between CNC and DNC.

Course Outcome 3(CO3):

1. Demonstrate the various codes used in part programming.

2. Explain the concept of CAPP and its advantages.

3. Write NC part program for the part shown in the below figure. All the dimensions are in mm only.



Course Outcome 4 (CO4):

1. Define FMS. Explain its advantages and disadvantages.

2. Describe AI in process planning.

3. What is the need of Group Technology?

Course Outcome 5 (CO5):

1. Illustrate the degree of freedom of a robotic arm.

2. Explain the different types of actuators used in robots.

3. Define the various fields in which robots are used. Discuss in detail.

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, XXXX 20XX

Course Code: SBT438

Course Name: COMPUTER AIDED DESIGN AND COMPUTER AIDED MANUFACTURING

Max. Marks: 100 **Duration: 3hrs**

PART A

Answer all questions each carries 3 marks

1. What are the computer peripherals of CAD?
2. What are the functions of Geometric Modelling in design?
3. What are the properties of B-spline curve?
4. What are the elements of NC system?
5. What are M03, M30 codes stands for in NC Programming?
6. What factors must be considered in selecting a classification and coding systems?
7. What are the various approaches available for CAPP?
8. What are the inputs and outputs of FMS?
9. Explain the working of magnet grippers used for robots.
10. Discuss the current applications of machine vision system.

PART B

Answer any two complete questions from each module.

MODULE I

(7x2=14 Marks)

11. Explain the following terms in detail with respect to surface modelling a) Cylindrical surface b) Ruled Surface and c) Composite surface.
12. Distinguish between surface modelling and wire frame modelling in detail?
13. What is meant by sweep? Discuss in detail the various types of sweep techniques available for 3Dgeometric construction.

MODULE II

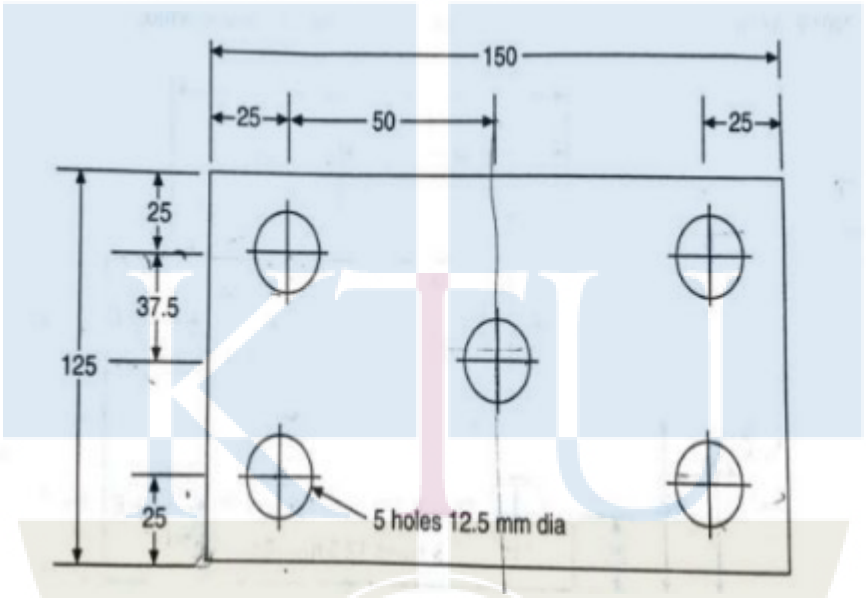
(7x2 = 14 Marks)

14. Distinguish between ACO (Adaptive Control Optimization) and ACC (Adaptive control constraint) types of adaptive control systems?
15. With a neat sketch, explain the functioning of a NC machine. State two important differences between NC and CNC?
16. Explain point to point, straight cut and contour positioning.

MODULE III

(7x2=14 Marks)

17. Write the procedure for writing computer assisted part programming? Write any 10 G-codes and 10 M-codes with a short description.
18. Explain the advantages of computer assisted part programming over manual part programming. Discuss how a company can benefit from a suitable classification and coding systems?
19. The part drawing of a component is shown in fig. Five holes of 12.5 mm diameter are to be drilled at five places. The speed and the feed rate are 592 rpm and 100 mm/min respectively. The machine has floating zero features and absolute zero positioning. The thickness of the plate is 10mm. Write the manual part program.



MODULE IV

(7x2=14 Marks)

20. Explain the various difficulties in traditional process planning in detail.
21. Explain the Scheduling and Dispatching issues related to Flexible Manufacturing System.
22. Discuss how part classification is done in the context of GT. What are the essential attributes such a coding system should take care of?

MODULE V

(7x2=14 Marks)

23. What are the different actuators used in the robots? Describe them briefly.
24. Define degree of freedom. Illustrate the degree of freedom of a robotic arm.
25. What are the various fields in which the robots used? Discuss them in detail.

SYLLABUS

Module 1

Computers in Design & Manufacturing: Evolution of CAD, CAM .CIM; Traditional Design Vs Computer Aided Design; Workstations; Interactive Computer Graphics; Networking of CAD Systems.

Computer Aided Design: Wireframe, Surface & Solid Modelling, Engineering Analysis, Design Review & Evaluation, Automated Drafting, Introduction to Major Naval Architecture Design Software.

Module 2

Introduction to Numerical Control: Need, Advantages & Disadvantages; Classification- Point to Point, Straight Cut & Contouring Positioning; Incremental & Absolute Systems; Open Loop & Closed Loop Systems; CNC & DNC.

Module 3

Part Programming: Part Programming Fundamentals; Manual Programming-NC Coordinate Systems and axes, Tape Format, Sequence Number, Preparatory Functions, Dimension Words, Speed Word, Feed Word, Tool Word, Miscellaneous Functions, Simple Manual Programming Exercises.

Module 4

Computer Aided Part Programming: Concept & Need for Computer aided part programming; CNC Languages; APT Language Structure- Geometry Commands, Motion Commands, Post Processor Commands, Compilation Control Commands, Simple Programming Exercises.

Computer Aided Process Planning: Traditional Process Planning Vs CAPP; General Methodology of Group Technology; Variant and Generative Process Planning Methods; Artificial Intelligence in Process Planning; Process Planning Software. Flexible Manufacturing Systems: Introduction; Types; Concepts; Need & Advantages of FMS; Cellular Manufacturing; JIT and GT Applied to FMS.

Module 5

Introduction to Robotics: Overview of Industrial robotics; Basic Components- End Effectors, Sensors; Control of Actuators in Robotic Mechanisms (basic only); Control of Robot Joint- Stepper Motor, Direct Drive Actuators, Hydraulic & Pneumatic Systems (Basics Only); Robot Applications-Material Transfer, Machine Loading & Unloading, Pre-cutting Operations, Assembly, Welding & Inspection.

Text Books

1. Craig John; “Introduction to Robotics- Mechanics and Control”; Pearson, 2005.
2. Groover M.P, Emory W. Zimmers, Jr; “CAD/CAM”; Prentice Hall of India, 1998.
3. Yoram Koren, “Numerical Control of Machine Tools”; McGraw Hill, 1983.

Reference Books

1. Mikell P. Groover, “Automation, Production Systems & Computer Integrated Manufacturing”; Prentice Hall, 2016.
2. P. Radhakrishnan, S.Subramanian, V. Raju; “CAD/CAM/CIM”; New Age International Publishers, 2018.
3. P.N.Rao; “CAD/CAM Principles and Applications”; Tata McGraw Hill, 2010.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Computer Aided Design**	
1.1	Computers in Design & Manufacturing: Evolution of CAD, CAM, CIM;	1
1.2	Traditional Design Vs Computer Aided Design; Workstations; Interactive Computer Graphics; Networking of CAD Systems	2
1.3	Computer Aided Design: Wireframe, Surface & Solid Modelling, Engineering Analysis, Design Review & Evaluation, Automated Drafting,	3
1.4	Introduction to Major Naval Architecture Design Software.	2
2	**Numerical Control**	
2.1	Introduction to Numerical Control: Need, Advantages & Disadvantages; Classification- Point to Point, Straight Cut & Contouring Positioning;	2
2.2	Incremental & Absolute Systems; Open Loop & Closed Loop Systems; CNC & DNC.	3
3	**Part Programming**	
3.1	Part Programming: Part Programming Fundamentals; Manual Programming-NC Coordinate Systems and axes, Tape Format, Sequence Number	3
3.2	Preparatory Functions, Dimension Words, Speed Word, Feed Word, Tool Word, Miscellaneous Functions	2
3.3	Simple Manual Programming Exercises	3
4	**Computer Aided Part Programming**	

4.1	Computer Aided Part Programming: Concept & Need for CAPP; CNC Languages; APT Language Structure- Geometry Commands, Motion Commands, Post Processor Commands, Compilation Control Commands, Simple Programming Exercises.	5
4.2	Flexible Manufacturing Systems: Introduction; Types; Concepts; Need & Advantages of FMS; Cellular Manufacturing; JIT and GT Applied to FMS	3
5	**ROBOTICS**	
5.1	Introduction to Industrial Robotics: Overview of robotics; Basic Components- End Effectors, Sensors;	2
5.2	Control of Actuators in Robotic Mechanisms (basic only); Control of Robot Joint- Stepper Motor, Direct Drive Actuators, Hydraulic & Pneumatic Systems (Basics Only);	3
5.3	Robot Applications - Material Transfer, Machine Loading & Unloading, Pre-cutting Operations, Assembly, Welding & Inspection.	2

SBT448	FINITE ELEMENT METHOD	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course content is developed to apprise the Naval Architecture students about the basics of the Finite Element Technique, a numerical tool for the solution of different classes of problems in various engineering regimes. Different application areas will be dealt with after introducing the basic aspects of the method. However, major emphasis will be on the solution of problems related to Mechanics of Solids. It is intended to cover the analysis methodologies for 1-D, 2-D and 3-D problems with the advantages and disadvantages clearly spelt out. It is expected that once the students are exposed to the course, they will be in a position to develop computer codes for any physical problem using Finite Element technique.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand basic concepts in FEM and formulation techniques.
CO 2	Elucidate various element properties and apply various numerical integration methods for finding the solutions of 1D, 2D and 3D problems.
CO 3	Carryout the analysis of various frame structures using FEM.
CO 4	Apply FEM for 2D and 3D solids.
CO 5	Apply FEM for finding the solution for the problems in various engineering regimes especially to the bending problems related to plates and shells.
CO 6	Develop computer codes for any physical problem related to their domain using Finite Element techniques.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	2										1
CO 2	3	3	2		2				1			2
CO 3	3	3	2	1	2				1			2
CO 4	3	3	2		2				1			2
CO 5	3	3	2	1	2				1			2
CO 6	3	3	3	1	3				2			3

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	20	20	40
Apply	20	20	40
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 3 questions from each module of which student should answer any two. Each question can have maximum 4 sub-divisions and carry 7 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Define the interpolation function for 8-node brick element in FEM.

2. Differentiate between smoothed and unsmoothed stress conditions in FEM.

3. Explain the degrees of freedom of the various structural members in FEM.

Course Outcome 2 (CO2)

1. Evaluate the integral:

$$I = \int_{-2}^{3} \left(x^2 + 11x - 32\right) dx$$

Using one, two and three-point gauss Quadrature. Also, find the exact solution for comparison of accuracy.

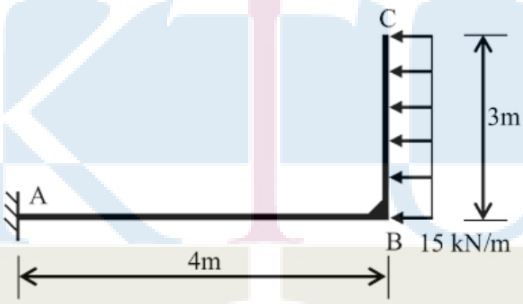
2. Name any three two dimensional serendipity elements and draw their Pascal triangle.

3. Explain Galerkin Method for 2D Fluid Flow Problem with a suitable example.

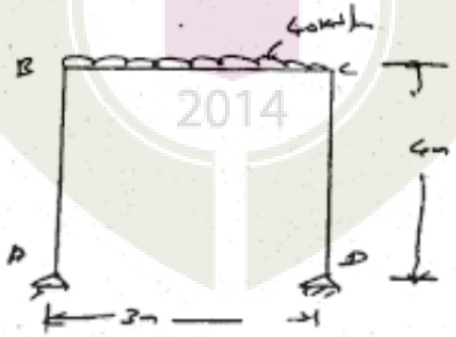
Course Outcome 3 (CO3):

1. Explain the procedure for analysing a simple frame structure using FEM.

2. The L-shaped frame shown below is made from two fixed connected segments. Determine the horizontal displacement of the end C. Use virtual work method and consider EI constant



3. Determine the end moments and draw moment diagram portal frame shown in the figure given below, using moment distribution method. Consider EI constant.



Course Outcome 4 (CO4):

1. Explain the method to determine the mass matrix of a Tetrahedron.

2. Explain the procedure for determining the nodal displacement vector of a hexahedron.

3. Explain the method to determine the material constant matrix of a Tetrahedron.

Course Outcome 5 (CO5):

1. Explain the Reissner-Mindlin plate theory for a Rectangular plate.

2. What are the differences between plate, shell and membrane elements in FEM?

3. What are the differences in calculating deformations of thin and thick shells using FEM?

Course Outcome 6 (CO6):

1. Develop computer code for Generalized Stiffness Matrix of a Plane Truss Member using Finite Element techniques.

2. Develop computer code for Stiffness matrix of a 3 Node Truss Member using Finite Element techniques.

3. Develop computer code for finding the Buckling load of Truss Members using Finite Element techniques.

Model Question Paper

Question Paper Code **Total Pages: 4**

Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, XXXXX 20XX

Course Code: SBT448

Course Name: FINITE ELEMENT METHOD

Max. Marks: 100 Duration: 3 Hours

PART A

	Answer all questions. Each question carries 3 marks	Marks
1	Name any five numerical methods which are commonly used to solve solid and fluid mechanics problems.	(3)
2	Name and sketch any six different types of element library used to discretize the domain in FEM software.	(3)
3	Define the interpolation function for 8-node brick element in FEM.	(3)
4	Name any three Two dimensional serendipity elements and draw their Pascal triangle	(3)
5	Name and draw the different configuration of any four standard truss	(3)

structures.

6		Write down the stiffness matrix of a pin-jointed member of length L with respect to local axis, having cross sectional areas A1 and A2 at the two ends.	(3)
7		Differentiate between smoothed and unsmoothed stress conditions in FEM.	(3)
8		What are the steps that have to be performed for obtaining the nonlinear geometric effect of the structure at a particular instant of time?	(3)
9		What are the three assumptions used to reduce the equations of three dimensional theory of elasticity to two dimensions?	(3)
10		Explain the assumptions of Reissner–Mindlin plate theory.	(3)

PART B

Answer any two full questions from each module. Each question carries 7 marks

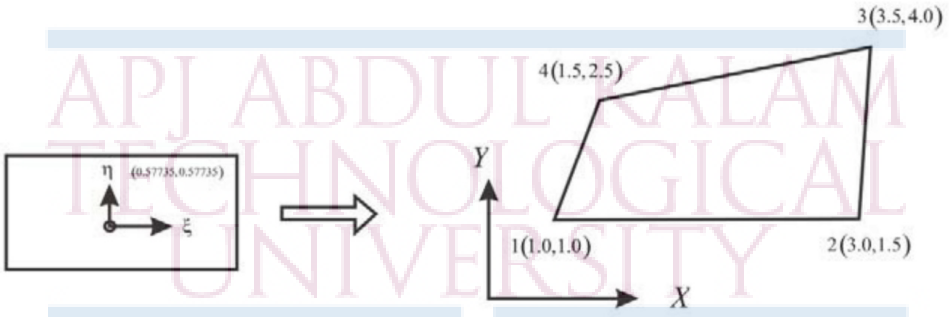
Module 1

Explain the degrees of freedom of the following structural members:

11	A	3D truss	(2)
	B	2D grid	(1)
	C	Membrane	(2)
	D	Shell	(2)
12		With the aid of a flowchart explain the basic steps involved in the FEM to solve basic engineering problems.	(7)
13		Explain Galerkin Method for 2D Fluid Flow Problem with a suitable example.	(7)

Module 2

14 Calculate the Jacobian matrix and the strain displacement matrix for four nodes two dimensional quadrilateral elements corresponding to the gauss point (0.57735, 0.57735) as shown in below given figure. (7)



15 Derive the shape function of four node triangular element. (7)

16 Evaluate the integral: (7)

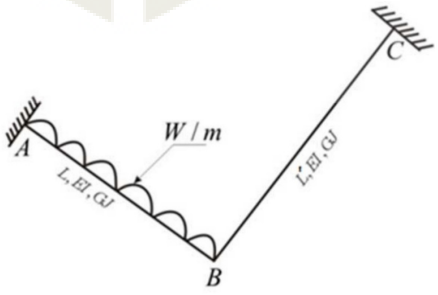
$$I = \int_{-2}^{3} \left(x^2 + 11x - 32\right) dx$$

using one, two and three-point gauss Quadrature. Also, find the exact solution for comparison of accuracy.

Module 3

17 Derive the Generalized Stiffness Matrix of a Plane Truss Member. (7)

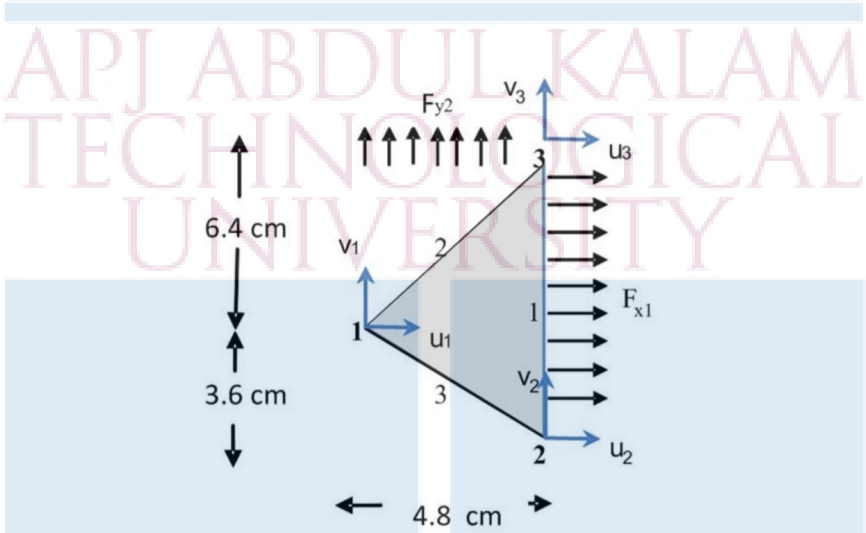
18 Calculate the stiffness matrix of the members AB and BC assuming the cross sectional area and modulus of elasticity of each member as 0.3×0.3 m2 and 2×10^11 N/m2 respectively. Assume EI = 3GJ. The length of member AB and BC is 4 m and 5 m respectively. (7)



19	Derive an expression for the Stiffness matrix of a 3 Node Truss Member.	(7)

Module 4

20	A CST element as shown in the figure given below gets axial loading of (Fx1) 10 kN/m in X direction and (Fy1) 20 kN/m in Y direction. Compute the nodal loads in the element.	(7)



21	Derive an expression for the Stiffness Matrix of a Triangular Element.	(7)
22	Explain the procedure for evaluation of Stiffness using Two Point Gauss Quadrature.	(7)

Module 5

23	By selecting a suitable explain the applicability of FEM in determining Buckling load of Truss Members.	(7)
24	Explain the displacement based finite element formulation in fluid mechanics.	(7)
25	Explain the different boundary conditions applied in Finite strip method.	(7)

SYLLABUS

Module 1 – Introduction to Finite Element Analysis and Formulation Techniques

Introduction, Basic Concepts of Finite Element Analysis, Introduction to Elasticity, Steps in Finite Element Analysis.

Virtual Work and Variational Principle, Galerkin Method, Finite Element Method: Displacement Approach, Stiffness Matrix and Boundary Conditions.

Module 2 - Element Properties

Natural Coordinates, Triangular Elements, Rectangular Elements, Lagrange and Serendipity Elements, Solid Elements, Isoparametric Formulation, Stiffness Matrix of Isoparametric Elements, Numerical Integration: One Dimensional, Two and Three Dimensional.

Module 3 – Analysis of Frame Structures

Stiffness of Truss Members, Analysis of Truss, Stiffness of Beam Members, Finite Element Analysis of Continuous Beam, Plane Frame Analysis, Analysis of Grid and Space Frame.

Module 4 – FEM for Two and Three Dimensional Solids

Constant Strain Triangle, Linear Strain Triangle, Rectangular Elements, Numerical Evaluation of Element Stiffness, Computation of Stresses, Geometric Nonlinearity and Static Condensation, Axisymmetric Element, Finite Element Formulation of Axisymmetric Element, Finite Element Formulation for 3 Dimensional Elements.

Module 5 - FEM for Plates and Shells; Additional Applications

Introduction to Plate Bending Problems, Finite Element Analysis of Thin Plate, Finite Element Analysis of Thick Plate, Finite Element Analysis of Skew Plate, Introduction to Finite Strip Method, Finite Element Analysis of Shell.

Finite Elements for Elastic Stability, Finite Elements in Fluid Mechanics, Dynamic Analysis.

Text Books

1. C.S. Krishnamoorty, “Finite Element Analysis”, Tata McGraw-Hill, 2nd Edition, 2017.

2. Erik G. Thompson, “Introduction to the Finite Element Method: Theory, Programming and Applications”, John Wiley, 2009.

Reference Books

1. R. D. Cook, “Concepts and Applications of Finite Element Analysis”, Wiley, 4th edition, 2001.

2. W. Weaver Jr. and J. M. Gere, "Matrix Analysis of Framed Structure", CBS Publishers & Distributors, 2nd edition, 2018.

3. S.S. Rao, "Finite Element Analysis", Elsevier Butterworth-Heinemann, 6th Edition, 2017.

4. O. C. Zienkiewicz and Y.K. Cheung, "The Finite Element Method in Structural and Soild Mechanics", McGraw Hill, 6th edition, 2005.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**INTRODUCTION TO FINITE ELEMENT ANALYSIS AND FORMULATION TECHNIQUES**	
1.1	Introduction, Basic Concepts of Finite Element Analysis	1
1.2	Introduction to Elasticity	1
1.3	Steps in Finite Element Analysis.	1
1.4	Virtual Work and Variational Principle	1
1.5	Galerkin Method	1
1.6	Finite Element Method: Displacement Approach, Stiffness Matrix and Boundary Conditions.	2
2	**ELEMENT PROPERTIES**	
2.1	Natural Coordinates, Triangular Elements	1
2.2	Rectangular Elements	1
2.3	Lagrange and Serendipity Elements	1
2.4	Solid Elements	1
2.5	Isoparametric Formulation	1
2.6	Stiffness Matrix of Isoparametric Elements	1
2.7	Numerical Integration: One Dimensional, Two and Three Dimensional	1
3	**ANALYSIS OF FRAME STRUCTURES**	
3.1	Stiffness of Truss Members	1
3.2	Analysis of Truss	1
3.3	Stiffness of Beam Members	1
3.4	Finite Element Analysis of Continuous Beam	1
3.5	Plane Frame Analysis	1
3.6	Analysis of Grid and Space Frame	2
4	**FEM FOR TWO AND THREE DIMENSIONAL SOLIDS**	
4.1	Constant Strain Triangle, Linear Strain Triangle	1
4.2	Rectangular Elements, Numerical Evaluation of Element	1
4.3	Stiffness, Computation of Stresses	1
4.4	Geometric Nonlinearity and Static Condensation	1
4.5	Axisymmetric Element	1
4.6	Finite Element Formulation of Axisymmetric Element	1

4.7	Finite Element Formulation for 3 Dimensional Elements.	1
5	**FEM FOR PLATES AND SHELLS; ADDITIONAL APPLICATIONS**	
5.1	Introduction to Plate Bending Problems, Finite Element Analysis of Thin Plate	1
5.2	Finite Element Analysis of Thick Plate	1
5.3	Finite Element Analysis of Skew Plate	1
5.4	Introduction to Finite Strip Method, Finite Element Analysis of Shell	1
5.5	Major features of Construction Support Vessels	1
5.6	Finite Elements for Elastic Stability	1
5.7	Finite Elements in Fluid Mechanics	1
5.8	Dynamic Analysis	1

SEMESTER VIII

MINOR

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
SBD482	MINIPROJECT	PWS	0	0	3	4

Preamble: This course is designed for enabling the students to apply the knowledge to address the real-world situations/problems and find solutions. The course is also intended to estimate the ability of the students in transforming theoretical knowledge studied as part of the curriculum so far in to a working model of a software system. The students are expected to design and develop a software/hardware project to innovatively solve a real-world problem.

Prerequisites: Subjects studied up to sixth semester.

Course Outcomes: After the completion of the course the student will be able to

CO No.	Course Outcome (CO)	Bloom's Category Level
CO 1	Make use of acquired knowledge within the selected area of technology for project development.	Level 3: Apply
CO 2	Identify, discuss and justify the technical aspects and design aspects of the project with a systematic approach.	Level 3: Apply
CO 3	Interpret, improve and refine technical aspects for engineering projects.	Level 3: Apply
CO 4	Associate with a team as an effective team player for the development of technical projects.	Level 3: Apply
CO 5	Report effectively the project related activities and findings.	Level 2: Understand

Mapping of course outcomes with program outcomes

POs / COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	3	3	3	3	3	3	-	-	-	3
CO 2	3	3	3	3	3	-	2	3	-	3	2	3
CO 3	3	3	3	3	3	2	3	3	-	2	3	3
CO 4	3	3	2	2	-	-	-	3	3	3	3	3
CO 5	3	-	-	-	2	-	-	3	2	3	2	3

3/2/1: high/medium/low

Assessment Pattern

The End Semester Evaluation (ESE) will be conducted as an internal evaluation based on the product, the report and a viva- voce examination, conducted by a 3-member committee appointed by Head of the Department comprising HoD or a senior faculty member, academic coordinator for that program and project guide/coordinator. The Committee will be evaluating the level of completion and demonstration of functionality/specifications, presentation, oral examination, working knowledge and involvement.

The Continuous Internal Evaluation (CIE) is conducted by evaluating the progress of the mini project through minimum of TWO reviews. At the time of the 1st review, students are supposed to propose a new system/design/idea, after completing a thorough literature study of the existing systms under their chosen area. In the 2nd review students are expected to highlight the implementation details of the proposed solution. The review committee should assess the extent to which the implementation reflects the proposed design. A well coded, assembled and completely functional product is the expected output at this stage. The final CIE mark is the average of 1st and 2nd review marks.

A zeroth review may be conducted before the beginning of the project to give a chance for the students to present their area of interest or problem domain or conduct open brain storming sessions for innovative ideas. Zeroth review will not be a part of the CIE evaluation process.

Marks Distribution

Total Marks	CIE	ESE
150	75	75

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Marks awarded by Guide : 15 marks
Project Report : 10 marks
Evaluation by the Committee : 40 Marks

End Semester Examination Pattern: The following guidelines should be followed regarding award of marks.

(a) Demonstration : 50 Marks
(b) Project report : 10 Marks
(d) Viva voce : 15marks

Course Plan

In this course, each group consisting of three/four members is expected to design and develop a moderately complex software/hardware system with practical applications. This should be a working model. The basic concept of product design may be taken into consideration.

Students should identify a topic of interest in consultation with Faculty-in-charge of miniproject/Advisor. Review the literature and gather information pertaining to the chosen topic. State the objectives and develop a methodology to achieve the objectives. Carryout the design/fabrication or develop codes/programs to achieve the objectives. Demonstrate the novelty of the project through the results and outputs. The progress of the mini project is evaluated based on a minimum of two reviews.

The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The product has to be demonstrated for its full design specifications. Innovative design concepts, reliability considerations, aesthetics/ergonomic aspects taken care of in the project shall be given due weight.

SEMESTER VIII

HONOURS

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
SBD496	MINIPROJECT	PWS	0	0	3	4

Preamble: This course is designed for enabling the students to apply the knowledge to address the real-world situations/problems and find solutions. The course is also intended to estimate the ability of the students in transforming theoretical knowledge studied as part of the curriculum so far in to a working model of a software system. The students are expected to design and develop a software/hardware project to innovatively solve a real-world problem.

Prerequisites: Subjects studied up to sixth semester.

Course Outcomes: After the completion of the course the student will be able to

CO No.	Course Outcome (CO)	Bloom's Category Level
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Mapping of course outcomes with program outcomes

POs / COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
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CO 2	3	3	3	3	3	-	2	3	-	3	2	3
CO 3	3	3	3	3	3	2	3	3	-	2	3	3
CO 4	3	3	2	2	-	-	-	3	3	3	3	3
CO 5	3	-	-	-	2	-	-	3	2	3	2	3

3/2/1: high/medium/low

Assessment Pattern

The End Semester Evaluation (ESE) will be conducted as an internal evaluation based on the product, the report and a viva- voce examination, conducted by a 3-member committee appointed by Head of the Department comprising HoD or a senior faculty member, academic coordinator for that program and project guide/coordinator. The Committee will be evaluating the level of completion and demonstration of functionality/specifications, presentation, oral examination, working knowledge and involvement.

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Course Plan

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The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The product has to be demonstrated for its full design specifications. Innovative design concepts, reliability considerations, aesthetics/ergonomic aspects taken care of in the project shall be given due weight.