



**ANNA UNIVERSITY, CHENNAI
NON-AUTONOMOUS COLLEGES AFFILIATED TO ANNA UNIVERSITY
REGULATIONS 2021
CHOICE BASED CREDIT SYSTEM**

B.E. MARINE ENGINEERING

PROGRAM EDUCATIONAL OBJECTIVES (PEOs):

Program educational objectives are broad statements that describe what graduates are expected to attain within a few years after graduation. Program educational objectives are based on the needs of the program's constituencies.

1	Graduates will have the knowledge for the application of scientific principles, Mathematical methods, technical and Innovative skills to perform analysis, application engineering, and system or process development in Marine Industry.
2	Graduates will have the knowledge by engaging in continuous education and will have the ability to function effectively as leaders on professional teams with ability to communicate effectively using speaking, writing and presentation skills.
3	Graduates of the program are to have demonstrated the competent to carry out the Engineering watch at sea and to maintain systems or processes and to direct, supervise, and make important decisions regarding the design and engineering of problems based on engineering fundamentals and modern technological tools.
4	Graduates will demonstrate a respect for professional, ethical and social and environmental issues as well as a commitment to safety, quality and productivity.
5	Graduates will demonstrate disciplined way of working as a part of teams in multidisciplinary projects or shipping companies so as to meet the National and International standards.

PROGRAM OUTCOMES (POs):

PO#	Graduate Attribute
1	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2	Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3	Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4	Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6	The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7	Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9	Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10	Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11	Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12	Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs):

In addition to POs, each program should have 3 to 4 PSOs. These statements are the outcomes of a program which should make the students to realize the fact that, the knowledge and techniques learnt in this course has a direct implication for the betterment of society and its sustainability.

1	The ability to have thorough knowledge of Maritime industry in accordance with the STCW-conventions 2010 amendments made time-to-time.
2	Possess an overall and conscious understanding about Marine engineering at the operational and management level
3	Possess knowledge of National and International rules and regulations concerning Marine engineering
4	Possess the necessary skill for the technical operation of ships in both off-shore and on-shore.

PEO's – PO's & PSO's MAPPING

PEO	PO												PSO			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	2	2	2	1	2						1	1	2	2	2	3
2				1	2	1			1	2	1	1	2	2	2	2
3	1	1	2	1	2			1	1	2	1		2	3	2	3
4						1	2	2				1	3	3	3	3
5						1			1		1		3	3	3	3
Av g	3/2=1.5	3/2=1.5	4/2=2	3/3=1	6/3=2	3/3=1	2/1=2	3/2=1.5	3/3=1	4/2=2	4/4=1	3/3=1	12/5=2.4	13/5=2.6	12/5=2.4	13/5=2.6

REGULATIONS 2021
CHOICE BASED CREDIT SYSTEM
B. E. MARINE ENGINEERING
CURRICULUM FOR SEMESTERS I TO VIII AND SYLLABI FOR SEMESTERS III AND IV
SEMESTER I

Sl. No.	Course code	Course Title	Cate - Gory	Periods per week			Total contact periods	Credits
				L	T	P		
1.	IP3151	Induction Programme	-	-	-	-	-	0
THEORY								
2.	HS3101	Technical English for Marine Engineers - I	HSMC	3	0	0	3	3
3.	MA3101	Mathematics for Marine Engineering – I	BSC	4	0	0	4	4
4.	PH3151	Engineering Physics	BSC	3	0	0	3	3
5.	CY3101	Chemistry for Marine Engineering	BSC	3	0	0	3	3
6.	GE3151	Problem Solving and Python Programming	ESC	3	0	0	3	3
7.	GE3152	அறிவியல் தமிழ் /Scientific Thoughts in Tamil	HSMC	1	0	0	1	1
PRACTICAL								
7	GE3171	Problem Solving and Python Programming Laboratory	ESC	0	0	4	4	2
8	BS3171	Physics and Chemistry Laboratory	BSC	0	0	4	4	2
	GE3172	English Laboratory [§]	EEC	0	0	2	2	1
TOTAL				17	0	10	27	22

[§] Skill Based Course

SEMESTER – II								
Sl. No.	Course code	Course Title	Cate - Gory	Periods per week			Total contact periods	Credits
				L	T	P		
THEORY								
1.	HS3201	Technical English for Marine Engineers – II	HSMC	2	0	0	2	2
2.	MA3201	Mathematics for Marine Engineering – II	BSC	4	0	0	4	4
3.	PH3251	Materials Science	BSC	3	0	0	3	3
4.	BE3251	Basic Electrical and Electronics Engineering	ESC	3	0	0	3	3
5.	GE3251	Engineering Graphics	ESC	2	0	4	6	4
6.		NCC Credit Course Level 1#	-	2	0	0	2	2
7.	GE3252	தமிழர் மரபு / Heritage of Tamils	HSMC	1	0	0	1	1
PRACTICAL								
8.	GE3271	Engineering Practices Laboratory	ESC	0	0	4	4	2
9.	BE3271	Basic Electrical and Electronics Engineering Laboratory	ESC	0	0	4	4	2
10.	GE3272	Communication Laboratory / Foreign Language [§]	EEC	0	0	4	4	2
TOTAL				15	0	16	31	23

NCC Credit Course level 1 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.

[§] Skill Based Course

S. No.	Course Code	Course Title	Cate Gory	Periods per week			Total contact periods	Credits
				L	T	P		
THEORY								
1.	MA3351	Transforms and Partial Differential Equations	BSC	3	1	0	4	4
2.	MV3301	Marine Hydraulics and Fluid Machinery	ESC	3	0	0	3	3
3.	MV3302	Strength of Materials for Marine Engineering	ESC	3	0	0	3	3
4.	MV3303	Marine Auxiliary Machinery	PCC	4	0	0	4	4
5.	MV3304	Ship Construction	PCC	3	0	0	3	3
6.	MV3305	Seamanship, Elementary Navigation and Survival at Sea	PCC	3	0	0	3	3
PRACTICALS								
7.	MV3311	Marine Hydraulics and Fluid Machinery Laboratory	ESC	0	0	4	4	2
8.	MV3312	Strength of Materials and Applied Mechanics Laboratory	ESC	0	0	4	4	2
9.	GE3361	Professional Development ^{\$}	EEC	0	0	2	2	1
TOTAL				19	1	10	30	25

^{\$} Skill Based Course

SEMESTER IV

S. No.	Course Code	Course Title	Cate Gory	Periods per week			Total contact periods	Credits
				L	T	P		
THEORY								
1.	MV3401	Marine Electrical Machines	ESC	3	1	0	4	4
2.	MV3402	Marine Refrigeration and Air Conditioning	ESC	3	2	0	5	4
3.	MV3403	Ship's Fire Prevention and Control	PCC	3	0	0	3	3
4.	MV3405	Marine Diesel Engines	PCC	4	0	0	4	4
5.	MV3406	Marine Boilers and Steam Engineering	PCC	3	0	0	3	3
6.	GE3451	Environmental Sciences and Sustainability	BSC	2	0	0	2	2
7.		NCC Credit Course Level 2 [#]		3	0	0	3	3
PRACTICALS								
8.	MV3411	Welding Techniques, Lathe and Special Machine Shop	PCC	0	0	4	4	2
9.	MV3412	Heat Engines, Boiler Chemistry and Refrigeration Laboratory	PCC	0	0	4	4	2
TOTAL				18	3	8	29	24

[#] NCC Credit Course level 2 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.

S. No.	Course Code	Course Title	Category	Periods per week			Total contact periods	Credits
				L	T	P		
THEORY								
1.	MV3501	Marine Propulsion	PCC	3	0	0	3	3
2.		Professional Elective I	PEC	-	-	-	-	3
3.		Professional Elective II	PEC	-	-	-	-	3
4.		Professional Elective III	PEC	-	-	-	-	3
5.		Professional Elective IV	PEC	-	-	-	-	3
6.		Mandatory Course-I ^{&}	MC	3	0	0	3	0
PRACTICALS								
7.	MV3511	Electrical Engineering, Electronics and Microprocessor Laboratory	ESC	0	0	4	4	2
8.	MV3512	Marine Machinery Drawing	ESC	0	0	4	4	2
TOTAL				-	-	-	-	19

[&] Mandatory Course-I is a Non-credit Course (Student shall select one course from the list given under MCI)

SEMESTER VI

S. No.	Course Code	Course Title	Category	Periods per week			Total contact periods	Credits
				L	T	P		
THEORY								
1.	MV3601	Stability of Ships	PCC	4	0	0	4	4
2.		Open Elective – I [*]	OEC	3	0	0	3	3
3.		Professional Elective V	PEC	-	-	-	-	3
4.		Professional Elective VI	PEC	-	-	-	-	3
5.		Professional Elective VII	PEC	-	-	-	-	3
6.		Professional Elective VIII	PEC	-	-	-	-	3
7.		Mandatory Course-II ^{&}	MC					0
8.		NCC Credit Course Level 3 [#]		3	0	0	3	3
PRACTICALS								
9.	MV3611	Fire Fighting, Controls and Simulator Laboratory	PCC	0	0	4	4	2
10.	MV3612	Measurement and Instrumentation Laboratory	PCC	0	0	4	4	2
TOTAL				-	-	-	-	23

^{*}Open Elective – I shall be chosen from the emerging technologies

[&] Mandatory Course-II is a Non-credit Course (Student shall select one course from the list given under MCII)

[#] NCC Credit Course level 3 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA

SEMESTER VII/VIII*

S. No.	Course Code	Course Title	Category	Periods Per week			Total contact periods	Credits
				L	T	P		
THEORY								
1.	MV3701	Ship Operational Management and IMO Requirements	PCC	3	0	0	3	3
2.	MV3702	Marine Vehicles Performance	PCC	3	0	0	3	3
3.	MV3703	Human Values and Ethics	HSMC	2	0	0	2	2
4.		Elective – Management #	HSMC	3	0	0	3	3
5.		Open Elective – II**	OEC	3	0	0	3	3
6.		Open Elective – III***	OEC	3	0	0	3	3
7.		Open Elective – IV***	OEC	3	0	0	3	3
PRACTICALS								
8.	MV3711	Project Work	EEC	0	0	0	6	3
TOTAL				20	0	0	26	23

*If students undergo “Marine Workshop Practical and Afloat Training”, in Semester VII, then the courses offered during semester VII will be offered during semester VIII.

**Open Elective – II shall be chosen from the emerging technologies.

***Open Elective III and IV (Shall be chosen from the list of open electives offered by other Programmes)

Elective - Management shall be chosen from the elective Management courses

SEMESTER VIII/VII*

Sl. No.	Course Code	Course Title	Category	Contact periods	Periods per week			C
					L	T	P	
THEORY								
1.	MV3811	Marine Workshop Practical and Afloat Training	EEC				8hrs per day – 6 days a week, 24 weeks, 500 Marks. Sessional Marks 200 Report + Viva 300	18

If students undergo “Marine Workshop Practical and Afloat Training”, in Semester VII, then the courses offered during semester VII will be offered during semester VIII.

TOTAL CREDITS: 177

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	GE3752	Principles of Management [#]	HSMC	3	0	0	3	3
2.	GE3753	Total Quality Management	HSMC	3	0	0	3	3
3.	GE3754	Engineering Economics and Financial Accounting	HSMC	3	0	0	3	3
4.	GE3755	Human Resource Management [#]	HSMC	3	0	0	3	3
5.	GE3756	Knowledge Management	HSMC	3	0	0	3	3
6.	GE3757	Industrial Management	HSMC	3	0	0	3	3

If the courses enrolled either in Professional Elective courses or Management Elective, the same courses shall not be repeated.

MANDATORY COURSES I

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MX3081	Introduction to Women and Gender Studies	MC	3	0	0	3	0
2.	MX3082	Elements of Literature	MC	3	0	0	3	0
3.	MX3083	Film Appreciation	MC	3	0	0	3	0
4.	MX3084	Disaster Management	MC	3	0	0	3	0

MANDATORY COURSES II

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MX3085	Well Being with traditional practices (Yoga, Ayurveda and Siddha)	MC	3	0	0	3	0
2.	MX3086	History of Science and Technology in India	MC	3	0	0	3	0
3.	MX3087	Political and Economic Thought for a Humane Society	MC	3	0	0	3	0
4.	MX3088	State, Nation Building and Politics in India	MC	3	0	0	3	0
5.	MX3089	Industrial Safety	MC	3	0	0	3	0

PROFESSIONAL ELECTIVE COURSES:VERTICALS			
VERTICAL 1	VERTICAL 2	VERTICAL 3	VERTICAL 4
LOGISTICS AND SUPPLY CHAIN MANAGEMENT	DIVERSIFIED COURSES GROUP 1	DIVERSIFIED COURSES GROUP 2	DIVERSIFIED COURSES GROUP 3
Automation in Manufacturing	Ship logistics and Management	Mechanics of Marine Machines	High Voltage Engineering
Warehousing Automation	English for Competitive Examination	Marine Manufacturing Technology	Marine Control Engineering and Automation
Material Handling Equipment, Repair and Maintenance	Principles of Management	Marine Engineering Materials	Marine Electronics
Robotics	Human Resource Management	Marine Corrosion and Prevention	Marine Robotics
Container Logistics	Safety Precautions and Watch Keeping	Marine Machinery and Systems Design	Cyber Physical Systems
Logistics in Manufacturing, Supply Chain and Distribution	Ship Safety and Environmental Protection	Special Duty Vessels and Type of Operation	Autonomous Ships
Data Science	Advanced Marine Heat Engines	Marine Vehicles	Underwater Vehicles
-	Marine Engineering Thermodynamics	Fuel Cell Technologies	Offshore Technology

Registration of Professional Elective Courses from Verticals:

Professional Elective Courses will be registered in Semesters V and VI. These courses are listed in groups called verticals that represent a particular area of specialisation / diversified group. Students are permitted to choose all the Professional Electives from a particular vertical or from different verticals. Further, only one Professional Elective course shall be chosen in a semester horizontally (row-wise). However, two courses are permitted from the same row, provided one course is enrolled in Semester V and another in semester VI.

The registration of courses for B.E./B.Tech (Honours) or Minor degree shall be done from Semester V to VIII. The procedure for registration of courses explained above shall be followed for the courses of B.E./B.Tech (Honours) or Minor degree also. For more details on B.E./B.Tech (Honours) or Minor degree refer to the Regulations 2021, Clause 4.10.

Total number of courses per vertical may change as 6 or 7 or 8. If there is shortage of courses in a vertical then necessary courses may be chosen from another vertical of the same programme.

VERTICAL 1: LOGISTICS AND SUPPLY CHAIN MANAGEMENT

Sl. No.	Course Code	Course Title	Category	Periods Per week			Total contact periods	Credits
				L	T	P		
1.	CME373	Automation in Manufacturing	PEC	3	0	0	3	3
2.	CME374	Warehousing Automation	PEC	3	0	0	3	3
3.	CME375	Material Handling Equipment, Repair and Maintenance	PEC	3	0	0	3	3
4.	CME376	Logistics in Manufacturing, Supply Chain and Distribution	PEC	3	0	0	3	3
5.	CME377	Container Logistics	PEC	3	0	0	3	3
6.	CME378	Robotics	PEC	2	0	2	4	3
7.	CME379	Data Science	PEC	3	0	0	3	3

VERTICAL 2: DIVERSIFIED COURSES GROUP 1

Sl. No.	Course Code	Course Title	Category	Periods Per week			Total contact periods	Credits
				L	T	P		
1.	MV3001	Ship logistics and Management	PEC	3	0	0	3	3
2.	MV3002	English for Competitive Examination	PEC	3	0	0	3	3
3.	MV3003	Principles of Management #	PEC	3	0	0	3	3
4.	MV3004	Human Resource Management #	PEC	3	0	0	3	3
5.	MV3005	Safety Precautions and Watch Keeping	PEC	3	0	0	3	3
6.	MV3006	Ship Safety and Environmental Protection	PEC	3	0	0	3	3
7.	MV3007	Advanced Marine Heat Engines	PEC	3	0	0	3	3
8.	MV3008	Marine Engineering Thermodynamics	PEC	3	0	0	3	3

If the courses enrolled either in Professional Elective courses or Management Elective, the same courses shall not be repeated.

Sl. No.	Course Code	Course Title	Category	Periods Per week			Total contact periods	Credits
				L	T	P		
1.	MV3009	Mechanics of Marine Machines	PEC	3	0	0	3	3
2.	MV3010	Marine Manufacturing Technology	PEC	3	0	0	3	3
3.	MV3011	Marine Engineering Materials	PEC	3	0	0	3	3
4.	MV3012	Marine Corrosion and Prevention	PEC	3	0	0	3	3
5.	MV3013	Marine Machinery and Systems Design	PEC	3	0	0	3	3
6.	MV3014	Special Duty Vessels and Type of Operation	PEC	3	0	0	3	3
7.	MV3015	Marine Vehicles	PEC	3	0	0	3	3
8.	MV3016	Fuel Cell Technologies	PEC	3	0	0	3	3

VERTICAL 4: DIVERSIFIED COURSES GROUP 3

Sl. No.	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1.	MV3017	High Voltage Engineering	PEC	3	0	0	3	3
2.	MV3018	Marine Control Engineering and Automation	PEC	3	0	0	3	3
3.	MV3019	Marine Electronics	PEC	3	0	0	3	3
4.	MV3020	Marine Robotics	PEC	3	0	0	3	3
5.	MV3021	Cyber Physical Systems	PEC	3	0	0	3	3
6.	MV3022	Autonomous Ships	PEC	3	0	0	3	3
7.	MV3023	Underwater Vehicles	PEC	3	0	0	3	3
8.	MV3024	Offshore Technology	PEC	3	0	0	3	3

OPEN ELECTIVES

(Students shall choose the open elective courses, such that the course contents are not similar to any other course contents/title under other course categories.)

**OPEN ELECTIVE I AND II
(EMERGING TECHNOLOGIES)**

To be offered other than Faculty of Information and Communication Engineering

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OCS351	Artificial Intelligence and Machine Learning Fundamentals	OEC	2	0	2	4	3
2.	OCS352	IoT Concepts and Applications	OEC	2	0	2	4	3
3.	OCS353	Data Science Fundamentals	OEC	2	0	2	4	3
4.	OCS354	Augmented and Virtual Reality	OEC	2	0	2	4	3

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OHS351	English for Competitive Examinations	OEC	3	0	0	3	3
2.	OCE353	Lean Concepts, Tools And Practices	OEC	3	0	0	3	3
3.	OMG352	NGOs and Sustainable Development	OEC	3	0	0	3	3
4.	OMG353	Democracy and Good Governance	OEC	3	0	0	3	3
5.	OME353	Renewable Energy Technologies	OEC	3	0	0	3	3
6.	OME354	Applied Design Thinking	OEC	2	0	2	4	3
7.	OMF351	Reverse Engineering	OEC	3	0	0	3	3
8.	OMF353	Sustainable Manufacturing	OEC	3	0	0	3	3
9.	OAU351	Electric and Hybrid Vehicle	OEC	3	0	0	3	3
10.	OAS352	Space Engineering	OEC	3	0	0	3	3
11.	OIM351	Industrial Management	OEC	3	0	0	3	3
12.	OIE354	Quality Engineering	OEC	3	0	0	3	3
13.	OSF351	Fire Safety Engineering	OEC	3	0	0	3	3
14.	OML351	Introduction to non-destructive testing	OEC	3	0	0	3	3
15.	OMR351	Mechatronics	OEC	3	0	0	3	3
16.	ORA351	Foundation of Robotics	OEC	3	0	0	3	3
17.	OAE352	Fundamentals of Aeronautical engineering	OEC	3	0	0	3	3
18.	OGI351	Remote Sensing Concepts	OEC	3	0	0	3	3
19.	OAI351	Urban Agriculture	OEC	3	0	0	3	3
20.	OEN351	Drinking Water Supply and Treatment	OEC	3	0	0	3	3
21.	OEE352	Electric Vehicle technology	OEC	3	0	0	3	3
22.	OEI353	Introduction to PLC Programming	OEC	3	0	0	3	3
23.	OCH351	Nano Technology	OEC	3	0	0	3	3
24.	OCH352	Functional Materials	OEC	3	0	0	3	3
25.	OBT352	Biomedical Instrumentation	OEC	3	0	0	3	3
26.	OFD352	Traditional Indian Foods	OEC	3	0	0	3	3
27.	OFD353	Introduction to food	OEC	3	0	0	3	3

28.	OPY352	IPR for Pharma Industry	OEC	3	0	0	3	3
29.	OTT351	Basics of Textile Finishing	OEC	3	0	0	3	3
30.	OTT352	Industrial Engineering for Garment Industry	OEC	3	0	0	3	3
31.	OTT353	Basics of Textile Manufacture	OEC	3	0	0	3	3
32.	OPE351	Introduction to Petroleum Refining and Petrochemicals	OEC	3	0	0	3	3
33.	OPE352	Energy Conservation and Management	OEC	3	0	0	3	3
34.	OPT351	Basics of Plastics Processing	OEC	3	0	0	3	3
35.	OEC351	Signals and Systems	OEC	3	0	0	3	3
36.	OEC352	Fundamentals of Electronic Devices and Circuits	OEC	3	0	0	3	3
37.	OBM351	Foundation Skills in integrated product Development	OEC	3	0	0	3	3
38.	OBM352	Assistive Technology	OEC	3	0	0	3	3
39.	OMA352	Operations Research	OEC	3	0	0	3	3
40.	OMA353	Algebra and Number Theory	OEC	3	0	0	3	3
41.	OMA354	Linear Algebra	OEC	3	0	0	3	3

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OPEN ELECTIVES - IV

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OHS352	Project Report Writing	OEC	3	0	0	3	3
2.	OCE354	Basics of Integrated Water Resources Management	OEC	3	0	0	3	3
3.	OMA355	Advanced Numerical Methods	OEC	3	0	0	3	3
4.	OMA356	Random Processes	OEC	3	0	0	3	3
5.	OMA357	Queuing and Reliability Modelling	OEC	3	0	0	3	3
6.	OMG354	Production and Operations Management for Entrepreneurs	OEC	3	0	0	3	3
7.	OMG355	Multivariate Data Analysis	OEC	3	0	0	3	3
8.	OME352	Additive Manufacturing	OEC	3	0	0	3	3
9.	OME353	New Product Development	OEC	3	0	0	3	3
10.	OME355	Industrial Design &	OEC	2	0	2	4	3

		Rapid Prototyping Techniques						
11.	OMF352	Micro and Precision Engineering	OEC	3	0	0	3	3
12.	OMF354	Cost Management of Engineering Projects	OEC	3	0	0	3	3
13.	OAU352	Batteries and Management system	OEC	3	0	0	3	3
14.	OAU353	Sensors and Actuators	OEC	3	0	0	3	3
15.	OAS353	Space Vehicles	OEC	3	0	0	3	3
16.	OIM352	Management Science	OEC	3	0	0	3	3
17.	OIM353	Production Planning and Control	OEC	3	0	0	3	3
18.	OIE353	Operations Management	OEC	3	0	0	3	3
19.	OSF352	Industrial Hygiene	OEC	3	0	0	3	3
20.	OSF353	Chemical Process Safety	OEC	3	0	0	3	3
21.	OML352	Electrical, Electronic and Magnetic materials	OEC	3	0	0	3	3
22.	OML353	Nanomaterials and applications	OEC	3	0	0	3	3
23.	OMR352	Hydraulics and Pneumatics	OEC	3	0	0	3	3
24.	OMR353	Sensors	OEC	3	0	0	3	3
25.	ORA352	Foundation of Automation	OEC	3	0	0	3	3
26.	ORA353	Concepts in Mobile Robotics	OEC	3	0	0	3	3
27.	OAE353	Drone Technologies	OEC	3	0	0	3	3
28.	OGI352	Geographical Information System	OEC	3	0	0	3	3
29.	OAI352	Agriculture Entrepreneurship Development	OEC	3	0	0	3	3
30.	OEN352	Biodiversity Conservation	OEC	3	0	0	3	3
31.	OEE353	Introduction to control systems	OEC	3	0	0	3	3
32.	OEI354	Introduction to Industrial Automation Systems	OEC	3	0	0	3	3
33.	OCH353	Energy Technology	OEC	3	0	0	3	3
34.	OCH354	Surface Science	OEC	3	0	0	3	3
35.	OBT353	Environment and Agriculture	OEC	3	0	0	3	3
36.	OFD354	Fundamentals of Food Engineering	OEC	3	0	0	3	3
37.	OFD355	Food safety and Quality Regulations	OEC	3	0	0	3	3
38.	OPY353	Nutraceuticals	OEC	3	0	0	3	3
39.	OTT354	Basics of Dyeing and Printing	OEC	3	0	0	3	3

40.	OTT355	Fibre Science	OEC	3	0	0	3	3
41.	OTT356	Garment Manufacturing Technology	OEC	3	0	0	3	3
42.	OPE353	Industrial safety	OEC	3	0	0	3	3
43.	OPE354	Unit Operations in Petro Chemical Industries	OEC	3	0	0	3	3
44.	OPT352	Plastic Materials for Engineers	OEC	3	0	0	3	3
45.	OPT353	Properties and Testing of Plastics	OEC	3	0	0	3	3
46.	OEC353	VLSI Design	OEC	3	0	0	3	3
47.	OEC354	Industrial IoT and Industry 4.0	OEC	2	0	2	4	3
48.	OBM353	Wearable devices	OEC	3	0	0	3	3
49.	OBM354	Medical Informatics	OEC	3	0	0	3	3

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B.E. MARINE ENGINEERING										
S.No	Subject Area	Credits per Semester								Total Credits
		I	II	III	IV	V	VI	VII/VIII	VIII/VII	
1	HSMC	4	3					5		10
2	BSC	12	7	4	2					25
3	ESC	5	11	10	8	4				38
4	PCC			10	14	3	8	6		41
5	PEC					12	12			24
6	OEC						3	9		12
7	EEC	1	2	1				3	18	25
8	Non-Credit /(Mandatory)					√	√			
Total		21	22	25	24	19	23	23	18	177



ENROLLMENT FOR B.E. / B. TECH. (HONOURS) / MINOR DEGREE (OPTIONAL)

A student can also optionally register for additional courses (18 credits) and become eligible for the award of B.E. / B. Tech. (Honours) or Minor.

For B.E. / B. Tech. (Honours), a student shall register for the additional courses (18 credits) from semester V onwards. These courses shall be from the same vertical or a combination of different verticals of the same programme of study only.

For minor degree, a student shall register for the additional courses (18 credits) from semester V onwards. All these courses have to be in a particular vertical from any one of the other programmes, Moreover, for minor degree the student can register for courses from any one of the following verticals also.

Complete details are available in clause 4.10 of Regulations 2021.

VERTICALS FOR MINOR DEGREE (In addition to the all the verticals of other programmes)

VERTICAL I FINTECH AND BLOCK CHAIN	VERTICAL II ENTREPRENEURSHIP	VERTICAL III PUBLIC ADMINISTRATION	VERTICAL IV BUSINESS DATA ANALYTICS	VERTICAL V ENVIRONMENTAL AND SUSTAINABILITY
Financial Management	Foundations of Entrepreneurship	Principles of Public Administration	Statistics For Management	Sustainable infrastructure Development
Fundamentals of Investment	Team Building & Leadership Management for Business	Constitution of India	Datamining For Business Intelligence	Sustainable Agriculture and Environmental Management
Banking, Financial Services and Insurance	Creativity & Innovation in Entrepreneurship	Public Personnel Administration	Human Resource Analytics	Sustainable Bio Materials
Introduction to Blockchain and its Applications	Principles of Marketing Management For Business	Administrative Theories	Marketing And Social Media Web Analytics	Materials for Energy Sustainability
Fintech Personal Finance and Payments	Human Resource Management for Entrepreneurs	Indian Administrative System	Operation And Supply Chain Analytics	Green Technology
Introduction to Fintech	Financing New Business Ventures	Public Policy Administration	Financial Analytics	Environmental Quality Monitoring and Analysis
-	-	-	-	Integrated Energy Planning for Sustainable Development
-	-	-	-	Energy Efficiency for Sustainable Development

(Choice of courses for Minor degree is to be made from any one vertical of other programmes or from anyone of the following verticals)

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG331	Financial Management	PEC	3	0	0	3	3
2.	CMG332	Fundamentals of Investment	PEC	3	0	0	3	3
3.	CMG333	Banking, Financial Services and Insurance	PEC	3	0	0	3	3
4.	CMG334	Introduction to Blockchain and its Applications	PEC	3	0	0	3	3
5.	CMG335	Fintech Personal Finance and Payments	PEC	3	0	0	3	3
6.	CMG336	Introduction to Fintech	PEC	3	0	0	3	3

VERTICAL 2: ENTREPRENEURSHIP

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG337	Foundations of Entrepreneurship	PEC	3	0	0	3	3
2.	CMG338	Team Building & Leadership Management for Business	PEC	3	0	0	3	3
3.	CMG339	Creativity & Innovation in Entrepreneurship	PEC	3	0	0	3	3
4.	CMG340	Principles of Marketing Management For Business	PEC	3	0	0	3	3
5.	CMG341	Human Resource Management for Entrepreneurs	PEC	3	0	0	3	3
6.	CMG342	Financing New Business Ventures	PEC	3	0	0	3	3

VERTICAL 3: PUBLIC ADMINISTRATION

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG343	Principles of Public Administration	PEC	3	0	0	3	3
2.	CMG344	Constitution of India	PEC	3	0	0	3	3
3.	CMG345	Public Personnel Administration	PEC	3	0	0	3	3
4.	CMG346	Administrative Theories	PEC	3	0	0	3	3
5.	CMG347	Indian Administrative System	PEC	3	0	0	3	3
6.	CMG348	Public Policy Administration	PEC	3	0	0	3	3

VERTICAL 4: BUSINESS DATA ANALYTICS

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG349	Statistics For Management	PEC	3	0	0	3	3
2.	CMG350	Datamining For Business Intelligence	PEC	3	0	0	3	3
3.	CMG351	Human Resource Analytics	PEC	3	0	0	3	3
4.	CMG352	Marketing And Social Media Web Analytics	PEC	3	0	0	3	3
5.	CMG353	Operation And Supply Chain Analytics	PEC	3	0	0	3	3
6.	CMG354	Financial Analytics	PEC	3	0	0	3	3

VERTICAL 5: ENVIRONMENTAL AND SUSTAINABILITY

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CES331	Sustainable infrastructure Development	PEC	3	0	0	3	3
2.	CES332	Sustainable Agriculture and Environmental Management	PEC	3	0	0	3	3
3.	CES333	Sustainable Bio Materials	PEC	3	0	0	3	3
4.	CES334	Materials for Energy Sustainability	PEC	3	0	0	3	3
5.	CES335	Green Technology	PEC	3	0	0	3	3
6.	CES336	Environmental Quality Monitoring and Analysis	PEC	3	0	0	3	3
7.	CES337	Integrated Energy Planning for Sustainable Development	PEC	3	0	0	3	3
8.	CES338	Energy Efficiency for Sustainable Development	PEC	3	0	0	3	3

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OBJECTIVES:

- To introduce the basic concepts of PDE for solving standard partial differential equations.
- To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems.
- To acquaint the student with Fourier series techniques in solving heat flow problems used in various situations.
- To acquaint the student with Fourier transform techniques used in wide variety of situations.
- To introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Z transform techniques for discrete time systems.

UNIT I PARTIAL DIFFERENTIAL EQUATIONS 9+3

Formation of partial differential equations – Solutions of standard types of first order partial differential equations - First order partial differential equations reducible to standard types- Lagrange's linear equation - Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.

UNIT II FOURIER SERIES 9+3

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series and cosine series – Root mean square value – Parseval's identity – Harmonic analysis.

UNIT III APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 9+3

Classification of PDE – Method of separation of variables - Fourier series solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two dimensional equation of heat conduction (Cartesian coordinates only).

UNIT IV FOURIER TRANSFORMS 9+3

Statement of Fourier integral theorem – Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.

UNIT V Z - TRANSFORMS AND DIFFERENCE EQUATIONS 9+3

Z-transforms - Elementary properties – Convergence of Z-transforms - – Initial and final value theorems - Inverse Z-transform using partial fraction and convolution theorem - Formation of difference equations – Solution of difference equations using Z - transforms.

TOTAL: 60 PERIODS

OUTCOMES:

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

- Understand how to solve the given standard partial differential equations.
- Solve differential equations using Fourier series analysis which plays a vital role in engineering applications.
- Appreciate the physical significance of Fourier series techniques in solving one and two dimensional heat flow problems and one dimensional wave equations.
- Understand the mathematical principles on transforms and partial differential equations would provide them the ability to formulate and solve some of the physical problems of engineering.
- Use the effective mathematical tools for the solutions of partial differential equations by using Z transform techniques for discrete time systems.

TEXT BOOKS:

1. Grewal B.S., "Higher Engineering Mathematics", 44th Edition, Khanna Publishers, New Delhi, 2018.
2. Kreyszig E, "Advanced Engineering Mathematics ", 10th Edition, John Wiley, New Delhi, India, 2016.

REFERENCES:

1. Andrews. L.C and Shivamoggi. B, "Integral Transforms for Engineers" SPIE Press, 1999.
2. Bali. N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 10th Edition, Laxmi Publications Pvt. Ltd, 2015.
3. James. G., "Advanced Modern Engineering Mathematics", 4th Edition, Pearson Education, New Delhi, 2016.
4. Narayanan. S., Manicavachagom Pillay.T.K and Ramanaiah.G "Advanced Mathematics for Engineering Students", Vol. II & III, S.Viswanathan Publishers Pvt. Ltd, Chennai, 1998.
5. Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2018.
6. Wylie. R.C. and Barrett . L.C., "Advanced Engineering Mathematics "Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012.

MV3301**MARINE HYDRAULICS AND FLUID MACHINERY****L T P C
3 0 0 3****COURSE OBJECTIVES:**

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

- To impart knowledge on properties of fluid
- To understand fluid kinematics and dynamics
- Learn laminar and turbulent flow of fluid
- To understand the working principles and characteristics of different types of pumps used onboard ship
- Able to classify and understand working of turbines

UNIT I FLUID STATICS**9**

Properties of fluid – pressure head – Pascal's law – absolute and gauge pressures – measurement of pressure – manometers (single, U-tube, differential), Mechanical gauges – Hydrostatic forces on a submerged plane and curved surfaces – centre of pressure – Buoyancy and Floatation – Meta-centric height – stability of floating and submerged bodies.

UNIT II FLUID KINEMATICS AND DYNAMICS**9**

Kinematics: Types of fluid flow – Types of flow lines – rate of flow – continuity equation – circulation and vorticity – stream function, velocity potential – equipotent line – cauchy riemann equations – flow nets.
Dynamics: Euler's Equation of motion – bernoulli's equation – applications – venturimeter, orifice meter, pilot tube – free liquid jet – impulse momentum equation – coriolis co-efficients – flow through an orifice – torricelli's theorem – hydraulic coefficients.

UNIT III LAMINAR AND TURBULENT FLOWS**9**

Reynold's experiment – critical Reynolds number – Rotating Viscometer – Navier – stokes equations of motion– relation between shear stress and pressure gradient – flow of viscous fluid in circular pipes – turbulent flow – major and minor energy losses – pipes in series and parallel – power transmission through pipes – boundary layer – characteristics – thickness – total drag due to laminar and turbulent layer – boundary layer separation and its control.

UNIT IV PUMPS**9**

Roto dynamic pumps – principles of dimensional analysis – Buckingham's theorem – important dimensionless numbers applicable to fluid mechanics – impact of jets – force exerted by a jet on flat, curved plates and pipe bends. Surge pressure and control – centrifugal pumps – some definitions – pump output and efficiencies – effect of vane angle– cavitation – constructional details, pump characteristics, multistage pumps. Axial flow pumps – characteristics – constructional details, non-dimensional parameters – efficiencies. Vibration & noise in hydraulic pumps.

Classification of hydraulic turbines – pelton turbines, velocity triangle – efficiencies – non dimensional numbers, working principle of the pelton wheel. francis and kaplan turbines – velocity triangles, - efficiencies of the draft tubes, hydraulic turbine characteristics.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- CO1: To understand the Fluid properties and effect of various forces acting on different planes, surfaces and Pipes.
- CO2: The In-viscid flow and Real Viscous flow and their characteristics.
- CO3: To understand the working principles of pumps.
- CO4: To understand and apply the theoretical knowledge hydraulic turbines fitted on board ships.
- CO5: Apply basic equation of laminar flow and turbulent flows of liquid.

TEXT BOOKS:

1. Joy, "Hydraulic Power Transmission In Marine Machinery", Marine Engineering Practice Vol-1, Part-07, IMarEST, London,2002
2. Gupta, S.C., "Fluid Mechanics and Hydraulic Machines" 1st Ed. Pearson, 2011.
3. John F.Douglas, Janusz M. Gasiorek, John A. Swaffield and Lynne B. Jack, "Fluid Mechanics", 1st Ed. Pearson, Sixth Impression, 2011

REFERENCE BOOKS:

1. Roberson, J.A. and Crowe C.T., "Engineering Fluid Mechanics", 6th Edition, John wiley, 1999.
2. Narayana Pillai,N,"Principles of Fluid Mechanics and Fluid Machines",3rd Edition, University Press, 2013
3. James A. Fay, "Introduction to Fluid Mechanics", PHI Learning Pvt. Ltd.,1994
4. Anthony Esposito, "Fluid Power with Applications",6th Ed. Pearson, 2003
5. R K Rajput, "Fluid Mechanics and Hydraulic Machines" 2nd revised Edition, S.Chand & Company Ltd., New Delhi, 2002
6. Bruce,R.M., Donald, F.Y., Theodore, H.O., "Fundamentals Of Fluid Mechanics" 5th Edition, John Wiley & Sons (Asia) Pvt. Ltd. India,2002

MAPPING OF COS AND POS:

CO	PO												PSO			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3	PSO 4
1	1															
2		1														
3					1											
4	1															
5		1														
Av g	2	2			1											

COURSE OBJECTIVES:

- To understand the concepts of stress, strain, principal stresses and principal planes.
- To study the concept of shearing force and bending moment due to external loads in determinate beams and their effect on stresses.
- To determine stresses and deformation in circular shafts and helical spring due to torsion.
- To compute slopes and deflections in determinate beams by various methods.
- To study the stresses and deformations induced in thin and thick shells.

UNIT I STRESS, STRAIN AND DEFORMATION OF SOLIDS 9

Rigid bodies and deformable solids – Tension, Compression and Shear Stresses – Deformation of simple and compound bars – Thermal stresses – Elastic constants – Volumetric strains –Stresses on inclined planes – principal stresses and principal planes – Mohr's circle of stress.

UNIT II TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM 9

Beams – types transverse loading on beams – Shear force and bending moment in beams – Cantilevers – Simply supported beams and over – hanging beams. Theory of simple bending– bending stress distribution – Load carrying capacity – Proportioning of sections – Flitched beams – Shear stress distribution.

UNIT III TORSION 9

Torsion formulation stresses and deformation in circular and hollows shafts – Stepped shafts– Deflection in shafts fixed at the both ends – Stresses in helical springs – Deflection of helical springs, carriage springs.

UNIT IV DEFLECTION OF BEAMS 9

Double Integration method – Macaulay's method – Area moment method for computation of slopes and deflections in beams - Conjugate beam and strain energy – Maxwell's reciprocal theorems.

UNIT V THIN CYLINDERS, SPHERES AND THICK CYLINDERS 9

Stresses in thin cylindrical shell due to internal pressure circumferential and longitudinal stresses and deformation in thin and thick cylinders – spherical shells subjected to internal pressure –Deformation in spherical shells – Lamé's theorem.

TOTAL: 45 PERIODS**COURSE OUTCOMES:**

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

- CO1: Understand the concepts of stress and strain in simple and compound bars, the importance of principal stresses and principal planes.
- CO2: Understand the load transferring mechanism in beams and stress distribution due to shearing force and bending moment.
- CO3: Apply basic equation of simple torsion in designing of shafts and helical spring
- CO4: Calculate the slope and deflection in beams using different methods.
- CO5: Analyze and design thin and thick shells for the applied internal and external pressures.

TEXT BOOKS:

1. Bansal, R.K., "Strength of Materials", Laxmi Publications (P) Ltd., 2016
2. Jindal U.C., "Strength of Materials", Asian Books Pvt. Ltd., New Delhi, 2009

REFERENCES:

1. Egor. P.Popov "Engineering Mechanics of Solids" Prentice Hall of India, New Delhi, 2002
2. Ferdinand P. Beer, Russell Johnson, J.r. and John J. Dewole "Mechanics of Materials", Tata McGraw Hill Publishing 'co. Ltd., New Delhi, 2005.
3. Hibbeler, R.C., "Mechanics of Materials", Pearson Education, Low Price Edition, 2013
4. Subramanian R., "Strength of Materials", Oxford University Press, Oxford Higher Education Series, 2010.

CO	PO										PSO						
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 0	PO 1	PO 1	PO 1	PSO 1	PSO 2	PSO 3	PS O4
1	1																
2	1																
3		1															
4				1													
5		1															
Avg	2	2		1													

MV3303

MARINE AUXILIARY MACHINERY

L T P C
0 0 4

COURSE OBJECTIVES:

- To impart knowledge on pumps, piping systems and its fittings
- Inculcate knowledge on heat exchanger, evaporators and distillers
- To acquire peripheral knowledge on oil purifier, air compressor and deck machinery.
- To impart knowledge on pollution prevention equipment's
- To understand the concepts of steering gear system

UNIT I PUMPS, PIPING SYSTEMS AND FITTINGS

12

Layout of main and auxiliary machinery in Engine Rooms of different ships, different types of pumps – centrifugal, gear, screw and reciprocating- characteristics performance, applications and maintenance. Piping system- bilge and ballast, fuel oil bunkering and service, lubricating oil, engine central cooling system, steam and condensate system, central priming system, control and service air system, hydrophore system and fire main system. Different types of valves- globe, gate, butterfly, relief valve, Quick closing valve, pressure reducing valve, SDNR valve- principle, working and applications. Principle and working of simplex and duplex filters, Autoclean, back flushing and magnetic filters. Different types of packing materials used on board the ships.

UNIT II HEAT EXCHANGERS, EVAPORATORS AND DISTILLERS

12

Principle of surface heat transfer–description, contact heat transfer, construction of shell and tube type–flat plate type, single and double pass–lubricating oil coolers, fuel oil heaters, fresh water coolers, compressed air coolers, Calorifier. Maintenance of heat exchanger and Thermal expansion allowance Distilling equipment on board a ship, methods of distillation- single effect and double effect shell type evaporator, low pressure vacuum evaporator, flash evaporators, multiple effect evaporators. Maintenance of Freshwater generator. Salinometer- Reverse osmosis desalination plant – membranes - drinking water and treatment.

UNIT III THEORY OF OIL PURIFIER, AIR COMPRESSOR AND DECK MACHINERY.

12

Construction, operation, maintenance of fuel oil and lubrication oil purifiers- clarifiers together with self de sludge operation. Construction and Operation, maintenance of main air compress. Theory of air compressor. Emergency air compressor. Uses of compressed air on board the ships. Construction and operation of bow thrusters, cargo winches, windlass and mooring winches.

UNIT IV POLLUTION PREVENTION EQUIPMENTS

12

Prevention of pollution by oil, garbage, sewage- IMO requirement as per MARPOL act. Operation, construction, maintenance of oily water separator both manual and automatic versions- coalescence- ODMS- Control system – Discharge criteria of waste bilge water. Operation, construction, maintenance of incinerator- sludge burning procedure. Construction and operation of sewage treatment plant on board the ships- comminutor- plant - Discharge criteria of treated sewage water

Hydraulic Telemotor system (Transmitter and receiver), Bypass valve–charging system, hydraulic power unit–hunting gear heleshaw pump principle, construction and operation pawl and ratchet mechanism, 2-ram and 4-ram steering gear– Electro-hydraulic steering gear-safematic steering gear Rotary vane steering gear–construction–operation–safety features, relief, isolating and bypass valves, steering system regulations and testing–trouble shooting. Rudder restraining, Automatic system, general arrangement–rudder and pintle, rudder wear down–rudder carrier-swivel bearing

TOTAL: 60 PERIODS**COURSE OUTCOMES:**

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

- CO1: Apply the knowledge on Characteristics and application of pumps, different Pipeline systems.
- CO2: Work on modern Fresh water generator, Shell and Plate type heat exchanger and drinking water treatment plant.
- CO3: Construct and Operate the Purifiers, Two stage air compressor and different types of deck machinery.
- CO4: Adapt and operate Oily water separator, Incinerator and Sewage treatment plant.
- CO5: Modern usage of Steering Gear Operation system.

TEXT BOOKS:

1. H.D. McGeorge, "Marine Auxiliary machinery", 7th edition, Butterworth's, London, 2011.
2. Leslie Jackson and Thomas D. Morton, "Reed's general engineering Knowledge for marine engineers", 4th edition, Thomas reed's, 1999.
3. DW Smith, "Marine auxiliary machinery", 6th edition, Butterworth's, London, 1987.

REFERENCE BOOKS:

1. Heinz P Bloch, Fred K Geitner," Machinery Component Maintenance and repair" 3rd edition, Elsevier,2010.
2. MARPOL 73/78, IMO Publication, 2001.
3. Vikram Gokhale, N. Nanda, "Advanced Marine Engineering Knowledge Vol. II" 2nd Edition, Engineer Enterprises, Mumbai, 2001.
4. "Pumping and Piping Diagram", IME Publication 1999
5. Vikram Gokhale & N. Nanda, "Marine Engineering Knowledge for Junior Engineers, 3rd Edition, Engineer Enterprises, Mumbai, 1999.
6. DK Sanyal, "Principle and Practices of marine diesel engine" 2nd edition, Bhandarkar Publication, Mumbai, 1998.

MAPPING OF COS AND POS:

CO	PO												PSO			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PS O1	PS O2	PS O3	PS O4
1	2															
2	1				1											
3			1													
4				1												
5					1											
Avg	3/2 =1. 5			1	2/2= 1											

COURSE OBJECTIVE:

- Understand the Ships terms and stresses onboard ships structure.
- Determine the Primary and Secondary girders used onboard ships.
- Distinguish between Fore-end and After-end arrangements onboard ships.
- Understand the free board and Tonnage onboard ships.
- Acquire the knowledge of Off shore Technology and Ship's Survey.

UNIT I SHIP TERMS

9

Various terms used in ship construction with reference to ship's parameter e.g. L.B.P. - Moulded Depth - Moulded draught etc. - General classification of ships. Stresses in Ship's structure: Hogging – Sagging – Racking – Pounding – Panting etc., and Strength members to counteract the same.

Sections And Materials Use: Type of sections like angles – Bulb plates flanged beams used in ship construction – Process of welding. Riveting & Welding testing of welds – Fabricated components.

UNIT II BOTTOM & SIDE FRAMING

9

Double bottoms, watertight floors solid and bracket floors – Longitudinal framing keels – side framing like tank side brackets – Beam knee – Web frame etc., Shell & Decks: Plating systems for shells – Deck plating & Deck Girders –discontinuities like hatches and other openings – supporting & closing arrangements – mid-ship section of ships. Bulk Heads & Deep Tanks: water tight bulkheads – Arrangement of plating and stiffeners – water tight sliding doors – Water tight openings through bulkheads for electric cables pipes and shafting – Deep tank for oil fuel or oil cargo corrugated bulk heads.

UNIT III FORE & AFT END ARRANGEMENTS

9

Fore end arrangement, arrangements to resist pounding bulbous bow – Types of sterns stern frame and rudder – Types of rudder – Supporting of rudder – Locking pintle – Bearing pintle – Pallister, bearing shaft tunnel – Tunnel bearings.

UNIT IV FREE BOARD AND TONNAGE

9

Significance and details of markings various international Regulations. Plimsol Line Shipyard Practice - layout of a shipyard – Mould loft –Optical marking – Automatic plate cutting, Fabrication and assembly etc., Ship Types -Tankers, Ventilation arrangements for pump rooms, holds and oil fuel tanks – Bulk Carriers, Arrangement for the carriage of dangerous goods in bulk– Container ships – L.N.G., L.P.G., and Chemical carriers – Lash ships – Passenger ships – Dredgers – Tugs etc., - Constructional details and requirements.

UNIT V OFFSHORE TECHNOLOG

9

Drilling ships and Platforms – Supply vessels – fire fighting arrangement – Pipe laying ships – special auxiliary service ships. Ship Surveys : Survey rules – Functions of ship classification – Societies – Surveys during construction – Periodical surveys for retention of class.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- CO1: Apply the knowledge to identify ships stresses.
- CO2: Design the Primary and Secondary girders used onboard ships.
- CO3: Analyze the Fore-end and After-end arrangements onboard ships.
- CO4: Demonstrate the free board and Tonnage onboard ships
- CO5: Interpretation of data regarding Ship's Survey

TEXT BOOKS:

1. D.J. Eyres, "Ship Construction", 4th Edition, Butter worth – Heinemann, Oxford, 1994.
2. Stokoe,E.A., "Reed's Ship Construction for Marine Engineers", 1st Edition, Thomas Reed Publication, London, 2000.
3. Thomas Lamb, " Ship Design and Construction", 1st Ed., SNAME, 2003

REFERENCES:

1. A.J. Young, "Ship Construction Sketch & Notes", 1st Edition, Butter worth – Heinemann, London,1980.
2. H.J. Pursey, "Merchant Ship Construction", 7th Edition, Brown Son & Ferguson Ltd. GlasGow Great Britain, 1994.
3. Larrie D. Ferreiro, " Ships and Science", 1st Ed. SNAME, 2006
4. Richard Lee Storch, Colin P. Hammon, Howard McRaven Bunch, and Richard C. Moore, "Ship Production, 1st Ed., SNAME,1995

MAPPING OF COS AND POS:

CO	PO												PSO			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PS O1	PS O2	PSO3	PSO4
1	1															
2			1													
3				1												
4											1					
5				1												
Av g	1		1	2/2 =1							1					

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MV3305

**SEAMANSHIP, ELEMENTARY NAVIGATION
AND SURVIVAL AT SEA**

**L T P C
3 0 0 3**

COURSE OBJECTIVES:

- To impart working knowledge on Deck equipment and ship department
- Understand working of navigational system and equipment used.
- Practice on various knots
- To impart on LSA knowledge on life saving appliances.
- To practice survival techniques at sea

UNIT I SEAMAN & THEIR DUTIES

9

Ship's Department, General ship knowledge ad nautical terms like poop-deck forecastle, bridge etc. deck equipment: winces, windlass, derricks cranes, gypsy, capstan, hatches and function. navigation lights and signals: port and starboard, forward and aft mast lights, colors and location. look out, precautions and bad weather, flags used on ships, flag etiquette, sound signals.

UNIT II ROPE KNOTS AND MOORINGS

9

Types of knots. practice of knot formation, materials of ropes, strength, care and maintenance, use of mooring line, heaving line, rat guards, canvas and it's use. anchors: their use, drooping and weighing anchor, cable stopper.

UNIT III NAVIGATION 9

General knowledge of principal stars. Sextant, Navigation compasses, echo sounder, Gps, Glonass, log and uses, barometer and weather classification, G.M.T and Zonal time, wireless Navigational Instruments, radar satellite navigation etc.

UNIT IV LIFE BOATS & LIFE RAFTS 9

Life buoy, EPRIB, SART, TPA, Construction, equipment carried, carrying capacity. Davits and their operation, Launching of life rafts (Inflatable type) Embarkation into lifeboat and life raft. Survival pack, Stowage and securing arrangement, Abandon ship: Manning of lifeboat and life raft. Muster list. Radio an alarm signals, Distress signals (S.O.S) Distress Calls time and Radio frequency. Pyro – techniques.

UNIT V SURVIVAL AT SEA 9

Survival difficulties and factors, equipment available, duties of crew members, Initial action on boarding, Maintaining the craft, Practical: Knots, bends and hitches, Ropes splice, donning of life jackets, life boat drills. Lowering & hoisting of life boats (model).

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- CO1: Operate deck equipment's and carry out department duties
- CO2: Apply knowledge choose the ropes for different types of requirement
- CO3: Distinguish and select different Navigational equipment for the ship smooth functioning
- CO4: Demonstrate competency skills on life saving appliance
- CO5: Survive at different condition of sea

TEXT BOOKS:

1. Graham Danton, "The theory and practice of seamanship", 11th Edition, Routledge, New york, USA and Canada, 1996.
2. Capt. J. Dinger, "Seamanship Primer", 7th Edition, Bhandarkar Publications, Mumbai 1998.
3. Kemp & Young, "Seamanship Notes", Stanford Maritime limited, 1997

REFERENCES

1. A.N. Cockcroft, "Seamanship and Nautical knowledge", 27th Edition, Brown son & Ferguson Ltd., Glasgow 1997.
2. Richards, " Principles of Modern Radar ", Yesdee Publishing's Pvt. Ltd., Indian Reprint 2012
3. Capt.P.M.Sarma , "Theory of Marine Gyro Compass"1st Ed. , Bhandarkar Publications, 2002

CO	PO										PSO					
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
1	1		1					1				1	1			
2	1							1								
3	1				1		1							1		1
4		1							1			1			1	
5				1				1				1		1		
Av g	3/2 =1.5	1/1 =1	1/1 =1	1/1 =1			1/1 =1	3/2 =1.5	1/1 =1			3/2 =1.5	1/1 =1	2/2 =1.5	1/1 =1	1/1 =1

MV3311

**MARINE HYDRAULICS AND FLUID MACHINERY
 LABORATORY**

L T P C
0 0 4 2

COURSE OBJECTIVE:

- To impart knowledge on properties of fluid
- To understand fluid kinematics and dynamics
- Learn laminar and turbulent flow of fluid

LIST OF EXPERIMENTS

(A) FLUID MECHANICS LAB

20

Buoyancy Experiment – Metacentric Height for Cargo and War ship models. Fluid flow measurement using Pitot tube, Flow nozzle, Rotameter, Notches etc. Cd of Venturimeter and orifice-meter. Determination of frictional losses in pipes.

(B) FLUID MACHINERY LAB

25

Centrifugal pumps- Performance characteristics of a constant speed pump, specific speed. Performance characteristics of multistage pump. Characteristics of Impulse and Reaction Turbine Specific speed and unit quantities. Positive displacement pumps. Performance characteristics of a deep well pump, Jet pump

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon Completion of the course, the students will be able to:

- CO1: Understand the flow behavior of fluids
- CO2: Calculate the frictional losses and C_d of fluids when it passes through various obstructions
- CO3: Calculate the performance characteristics of hydraulic pumps and turbines.

REFERENCES

1. Laboratory Manuals
2. Anthony Esposito, "Fluid Power with Applications", 6th Ed. Pearson, 2003
3. Schobert, "Fluid Mechanics for Engineers", 1st Ed. Springer, Indian Reprint 2013 (Yesdee Publishings Pvt. Ltd.)
4. Shesha Prakash, "Experiments in Hydraulics and Hydraulic Machines: Theory and Procedures", 1st Ed. PHI Learnings Pvt. Ltd., 2011

**LIST OF EQUIPMENTS FOR A BATCH OF 30 STUDENTS
 FLUID MECHANICS LABORATORY**

Sl.No.	Name of the Equipment	Qty.
01	Buoyancy Experiment Cargo Ship Model War Ship Model	01 01
02	Pitot tube Flow nozzle Rotameter Notches	01 01 02 02
03	Venturimeter	02
04	Orifice meter	01
05	Frictional Losses in pipes	01

SL.NO	NAME OF THE EQUIPMENT	QTY.
1.	UTM (Universal Testing Machine)	01
2.	Compression Testing Machine	01
3.	Deflection Testing Rig	01
4.	Hardness – Vickers, Brinell, Rockwell, Testing Machines	01
5.	Spring Testing Machines – Tension, Compression	01
6.	Impact Testing Machines – (Izod, Charpy)	01
7.	Load Cells	01
8.	Fatigue Testing Machine	01
SL.NO	NAME OF THE EQUIPMENT	QTY.
1.	Crucible furnace	01
2.	Sand Strength Testing Machine	01
3.	Permeability	01
4.	Shear Strength Testing Machine	01
5.	Compression Strength Testing Machine	01
6.	Transfer Strength Testing Machine	01

MV3401

MARINE ELECTRICAL MACHINES

L T P C
3 1 0 4**COURSE OBJECTIVES:**

- To expose the students to the Electrical equipment's fitted on boards ships, the concepts of electrical measurements and electrical distribution systems.
- To make the students to understand the concepts of Electricity production,
- To impart knowledge on measurements, cable faults and AC Machines used in Marine Engineering.
- To understand Principles of operation and construction details of synchronous motors, induction machines
- To impart knowledge on Speed control and trouble shooting in induction machines.

UNIT I PRINCIPLES OF D.C. MACHINES AND GENERATORS

9+3

Principles of DC machines – construction – winding and E.M.F equations – armature reaction – commutation – brush shift – compensating winding – D.C. generator – their characteristics- methods of excitation – parallel operation – performance equations.

D.C. Motor –their characteristics – starting and reversing – speed – torque equations – starters– speed control including electronic method of control – testing of D.C. machines for finding out the losses and efficiency – braking of D.C. motor, Ward-Leonard control.

UNIT II TRANSFORMERS

9+3

Transformers – types and applications – operating principle – E.M.F. Equations – phase diagrams under no load and load conditions – leakage resistance – equivalent circuits –voltage regulation – losses and efficiency – open circuit and short circuit tests – parallel operation – three phase transformers – core and shell type – current and potential transformers – auto- transformers (single phase and three phase) - specification of coolants.

UNIT III ALTERNATORS

9+3

Alternators – general arrangement – construction of salient pole and cylindrical rotor types – types of stator windings – E.M.F equation – distribution and pitch factor –waveform of E.M.F. generated – rotating magnetic field – armature reaction – voltage regulation – load characteristics – open circuit and short circuit tests – E.M.F and M.M.F. methods – parallel operation of alternators – KW and KVA sharing – Brushless alternator – static excitation system.

UNIT IV SYNCHRONOUS MOTORS

9+3

Principle of operation of 3-phase synchronous motor. – operation of infinite bus bars torque/angle characteristics – hunting – methods of starting – merits and limits of synchronous motor over others.

UNIT V INDUCTION MACHINES

9+3

Three phase induction motor –Principle of operation and theory of action – slip speed–rotor to stator relationship – rotor frequency – rotor e.m.f. and current – equivalent circuit relationship between rotor IR loss and rotor slip – torque/Slip characteristics – starting torque and maximum running Torque-Effect of change in supply voltage on Torque-Induction generator.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

- CO1: Operate D.C. Machines
- CO2: Operate and Maintain Transformers
- CO3: Design features of Alternators – their construction and operation.
- CO4: Synchronous the motor
- CO5: Operate and maintain induction machines

TEXT BOOKS:

1. Edmund G R, Kraallavers, “Advanced Electro-technology For Marine Engineers”, 2nd Ed. Reeds Vol 07, Adlard Coles Nautical, London, 2010
2. W. Laws, “Electricity Applied To Marine Engineering”, 4th edition, The Institute Of Marine Engineers, London, 1998.
3. IHerman, “Electrical Transformers and Rotating Machines”, 3rd Ed. Cengage, First Indian Reprint 2012 (Yesdee Publishings Pvt. Ltd.),
4. Edmund GR Kraal, Stanley Buyers, Christopher Lavers, “Basic electro-technology for marine engineers”, 4th Ed. Reeds Vol 06,2013
5. Hughes Edward, “Electrical technology”, 2nd edition, “ELBS with DP Publications”, USA, 1996.
6. I.J Nagrath and D.P Kothari, “Basic Electrical Engineering”, 2nd Edition, McGraw Hill Publishing Co., Ltd., New Delhi, 2002.

REFERENCES:

1. Uppal S.L. “Electrical Power”, 13th Edition, Khanna publishers, Mumbai, 2002.
2. Berde M.S.,” Electric Motor Drives”, 1st Edition, Khanna Publishers, Mumbai, 1995.
3. W. Laws, “Electricity Applied To Marine Engineering”, 4th edition, The Institute Of Marine Engineers, London, 1998.
4. Gorti Ramamurthi, “Handbook of Electrical Power Distribution”, 2nd Ed.Universities Press, 2009

MAPPING OF COS AND POS:

CO	PO												PSO			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	1	1										1			1	1
2	1	1										1			1	1
3	1		1									1				
4	1		1									1			1	1
5	1	1	1									1			1	1
Av g	5/5=1	3/3=1	3/3=1									5/5=1			4/4=1	4/4=1

COURSE OBJECTIVES:

To impart the knowledge of students in

- Reciprocating compressors
- basic refrigeration and air conditioning
- Marine refrigerating plants
- LMTD and NTU Methods

UNIT I RECIPROCATING COMPRESSORS

Ideal cycle for compressors work transfer in a single stage compressor – mass flow – volume flow – free air delivery – effect of clearance and volumetric efficiency in single stage compressors. Multi stage compression neglecting clearance volume. Condition for minimum work input and perfect inter cooling. Tandem in line arrangements in compressors. air motors.

UNIT II BASIC REFRIGERATION AND AIR CONDITIONING

Reversed Carnot cycle – vapour compression cycle – refrigerating effect – co-efficient of performance – cooling capacity – refrigerants used in marine practice and their justification - rating of refrigeration plant – methods for improving C.O.P. – use of vapour tables – applied problems.

UNIT III MARINE REFRIGERATING PLANTS

Typical marine refrigerating plants with multiple compression and evaporator system – heat pump cycles – refrigeration in liquefied gas carriers – applied problems.

UNIT IV MARINE AIR CONDITIONING

Principles of air conditioning – Psychrometric properties of air – comfort conditions – control of humidity – airflow and air conditioning capacity – calculation for ships plants.

UNIT V BASIC DESIGN OF HEAT EXCHANGERS

Introduction - types - LMTD and NTU method - double-pipe, shell and tube type, condenser and evaporator – problems

TOTAL: 75 PERIODS

COURSE OUTCOMES:

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

- CO1: Calculate the performance of Reciprocating compressors
- CO2: Understand the aspects of Marine refrigeration and air-conditioning
- CO3: Operate Marine refrigeration plants
- CO4: Apply the knowledge on maintaining air conditioning
- CO5: Efficient design of Heat Exchangers for Air conditioning and refrigeration plants.

TEXT BOOKS:

1. Arora C.P., “Refrigeration & Air Conditioning”, 1st Edition, Sri Eswar Enterprises, Chennai, 1993.
2. Stoecker, Wilbert .F Jones, Jerold. W., “Refrigeration and Air Conditioning”, 2nd Edition, Tata McGraw-Hill, Delhi, 1985.
3. Stott. J.R, “Refrigeration Machinery And Air Conditioning Plant”, Marine Engineering Practice, Vol-1 P Part-05, IMarEST, London, 1998

REFERENCES:

1. D.A. Taylor, “Introduction to Marine Engineering”, 2nd Edition, Butter Worth, London,1993.
2. J.R. Stott, “Refrigerating Machinery and Air Conditioning Plant”, 1st Edition, The Institute of Marine Engineers, London, 1974, Reprint 1998.
3. Ghoshdastidar, P.S., “ Heat transfer”, 2nd Edition, Oxford University Press, 2012
4. Sukhatme, S.P., “ Heat Transfer”,4th Ed. Universities Press, 2011
5. Roy, J. Dossat, “Principles Of Refrigeration”, 1st Ed., Pearson, 2006
Kuppan Thulukkanam, “Heat Exchanger Design Handbook”, 1st Ed., CRC Press, 2000

MAPPING OF COS AND POS:

C O	PO												PSO			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
1	1	1	1			1					1	1			1	
2		1					1	1								1
3	1				1				1	1			1		1	
4		1				1	1				1			1		
5			1	1	1						1			1		1
Av g	2/2=1	3/3=1	2/2=1	1/1=1	2/2=1	2/2=1	2/2=1	1/1=1	1/1=1	1/1=1	3/3=1	1/1=1	1/1=1	2/2=1	2/2=1	2/2=1

MV3403

SHIP'S FIRE PREVENTION AND CONTROL

**L T P C
3 0 0 3**

OBJECTIVES:

To impart knowledge in students on:

- Fire protection built in ships.
- Detection and safety systems.
- Firefighting Equipment.
- Fire control.
- Safety measures of firefighting equipment.

UNIT I FIRE PROTECTION BUILT IN SHIPS

SOLAS convention, requirements in respect of materials of construction and design of ships, (class A, B, type BHDS), fire detection systems, fire test, escape means, electrical installations, ventilation system and venting system for tankers. Statutory requirements for firefighting systems and equipment's on different vessels, fire doors & fire zones.

UNIT II DETECTION AND SAFETY SYSTEMS

Fire safety precautions on cargo ships, tankers and passenger ships during working. Types of detectors, selection of fire detectors and alarm systems and their operational limits. Commissioning and periodic testing of sensors and detection system. Description of various systems fitted on ships including micro mist and extinguishing system.

UNIT III FIRE FIGHTING EQUIPMENT

Fire pumps, hydrants and hoses, couplings, nozzles and international shore connection, construction, operation and merits of different types of portable, non-portable and fixed fire extinguishers installations for ships, properties of chemicals used, water-mist fire suppression system. Advantages of various fire extinguishing agents including vaporizing fluids and their suitability for ship's use. control of class A, C & class D fires, Combustion products & their effects on life safety.

UNIT IV FIRE CONTROL

Action required and practical techniques adopted for extinguishing fires in accommodation, machinery spaces, boiler rooms, cargo holds and galley. Fire fighting in port and dry dock. Procedure for re-entry after putting off fire, Rescue operations from affected compartments. First aid, fire organization on ships, shipboard organization for fire and emergencies. Combustion products and their effects on life safety, fire signal and muster. Fire drill. Leadership and duties, Fire control plan, human behaviour.

UNIT V SAFETY MEASURES

Special safety measures for preventing, fighting fire in tankers, chemical carriers, oil rigs, supply vessels, and fire fighting ships - Safe working practice with respect to fire on board ships and first aid for hazards arising from fire in ships.

TOTAL: 45 PERIODS**OUTCOMES:**

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

- Fire protection, Detection and Safety systems in ships.
- Construction, Operation and Maintenance of Fixed and portable Fire Extinguishers in ships.
- Fire prevention and control in oil tankers, LPG / LNG carriers, Chemical tankers, oil rigs, supply vessels
- Operation of Fire fighting ships
- Extinguish Major Fire and Follow safe working practices.

TEXT BOOKS:

- 1 Frank Rush Brook, "Fire Aboard", 3rd Edition, Brown, son & Ferguson Ltd., Glasgow 1988.
- 2 Victory.G, Owen.I.H, "Fire Fighting Equipment And Its Use In Ships", Marine Engineering Practice, Vol 1, Part 05, IMarEST, London, Reprint 1998
- 3 M.G. Stavitsky, V.I. Vostryakov, M.F.Kortunov, V.I. Martynenko & V.M. Sidoryok., "Fire Fighting Aboard ships Vol. I & Vol. II, Structural Design and Fire Extinguishing System", 1st Ed. Gulf publishing company, Houston, London, 1983.

MAPPING OF COS AND POS:

CO	PO									PSO						
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PS O1	PS O2	PSO 3	PSO 4
1	2	1	1	1		1	1							1		1
2	2	1	1		1										1	1
3	2	1			1	1						1			1	1
4					1					1						1
5	2	1			1		1			1		1			1	1
Av g	8/4 =2	4/4 =1	2/2 =1	1/1 =1	4/4 =1	2/2 =1	2/2 =1			2/2 =1		2/2 =1		1/1 =1	3/3 =1	5/5 =1

OBJECTIVES:

- To impart knowledge on various components of marine diesel engines and familiarisation on marine lubricating oils and associated systems
- To acquire peripheral knowledge on combustion of marine diesel engines, scavenging and turbocharging system.
- To impart knowledge on marine fuels and its properties, exhaust valve function.
- To impart brief knowledge on main engine safeties and associated systems.
- To understand the importance of reduction on marine air pollutant and acquire basic knowledge on modern intelligent engines.

UNIT I COMPONENTS OF MARINE DIESEL ENGINE AND LUBRICATION SYSTEM 12

Constructional details of Marine diesel engines- Welded construction for bedplates, Foundation bolts, 'A' frames, crosshead and guide shoes, main bearings, Crankshaft and its types - Cam shaft, connecting rod, stuffing box- Piston and piston rod, cylinder liners, cylinder heads and its mountings, tie rods, Engine chocks and its types- merits and demerits of chocks.

Auxiliary power transmission- chain and belt – gear transmission etc. Lubricating oils properties and testing of lubricating oils- Types of lubrications - Lubrication system- Main and crosshead bearing lubrication - Rocker arm- Cylinder liner lubrication. Lubricating oil contamination- microbial attack- remedies - Alpha lubricator - cylinder oil properties - Cylinder lubricating quills- significance of cylinder lubricating oil.

UNIT II SCAVENGING&TURBOCHARGING AND COMBUSTION PROCESS 12

Scavenging system in two stroke and four stroke engines - various types of scavenging in two stroke engines- Merits and demerits of various scavenging system- under piston scavenging - scavenge manifolds and scavenge cooler -auxiliary blowers and its importance. Turbo charging and supercharging- types of turbocharging system - pulse and constant pressure type – axial and radial flow turbo charging- merits and demerits -significance of Turbo charger – turbo charger seals and arrangements- wet and dry cleaning of turbocharger -expansion allowance in exhaust manifold- turbo charger lubrication system- turbocharger surging. various factors affecting the combustion- two stroke and four stroke engine piston - various types of piston rings – piston ring clearances- types of piston cooling system – merits and demerits of different type of piston cooling systems.

UNIT III MARINE FUEL OIL, FUEL SYSTEM AND ENGINE RATINGS 12

Fuel oil properties - fuel oil system – fuel oil mixing column, fuel pumps -jerk and common rail systems - VIT Super VIT & Electronic injection systems. fuel injector - Incorporation of FQSL along with the VIT system on the engine- Pre combustion and post combustion effects. Exhaust valve types and its operation- Rotocap mechanism - Exhaust valve timing in 2's and 4's Marine Diesel engine – Factors affecting the operation of exhaust valves. Combustion of fuel - Mean Piston speed- Mean effective pressure- Compression ratio- Reasons for variation in compression pressure and peak pressure and its effect on engines - critical speed- MCR & CSR ratings - Heat balance diagram - Fuel contaminants -Microbiological attack.

UNIT IV MAIN ENGINE SAFETIES AND ASSOCIATED SYSTEM 12

Starting and reversing systems of Marine diesel engines - Maneuvering system - Main Engine auto slowdown and shutdown -Crash maneuvering - Safety interlock system – turning gear arrangement and importance, Crankcase relief valve - crankcase inspection, oil mist detector and its operation, crankshaft deflection. main engine power delivery- Indicator instrument- Power card -simple draw cards and out of phase diagrams - significance of power diagram - power calculations- fault detection.

UNIT V EMISSION CONTROL AND MODERN INTELLIGENT ENGINES 12

Control of NO_x, SO_x in exhaust emission -deviation from ideal condition in actual engines, comparative study of slow speed, medium speed and high engines. Construction and Operation of Sulzer, MAN and B&W, Mitsui, Mitsubishi etc. Latest development in marine diesel engines–cam less engines, UMS– Operation, Intelligent engines - RT-flex engines.

TOTAL: 60 PERIODS

COURSE OUTCOMES Anna University, Polytechnic, Schools

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

1. Define and identify solution to Marine fuel injection systems.
2. Explain the combustion inside marine engines
3. Apply and recognize the need for the appropriate techniques to enhance fuel system.
4. Illustrate and Asses the Maneuverings systems of various marine diesel engines
5. Select the modern tools to distinguish emission controls.

TEXT BOOKS:

1. Wood yard, Doug, "Pounder's Marine Diesel Engines", 7th Edition, Butter Worth Heinemann Publishing, London, 2014.
2. Sanyal D.K, "Principle & Practice of Marine Diesel Engines", 2nd Edition, Bhandarkar Publication, Mumbai, 2010
3. D.A. Taylor, "Introduction to Marine Engineering", 2nd Edition, Butter worth – Heinemann, London, 1996

REFERENCE BOOKS:

1. Christensen, Stanley G "Lamb's Questions and Answers on The Marine Diesel Engine", 8th Edition, Butter Worth Publications, 2001
2. John Lamb, "Marine Diesel Engines", 8th Edition, Butter worth – Heinemann, London, 1990.
3. Christen Knak, "Diesel Motor Ships Engines and Machinery", 1st Edition, Marine Management Ltd., London, 1990.
4. C.C Pounder, "Marine Diesel Engines", 6th Edition, Butter worth – Heinemann, Scotland, 1995.
5. S. H. Henshall, "Medium and High-Speed Diesel Engines for Marine Use", 1st Edition, Institute of Marine Engineers, Mumbai, 1996.
6. VL Maleev, "Internal Combustion Engines", 2nd edition, McGraw-Hill book co., Singapore, 1987.
7. A.B. Kane, "Marine Internal Combustion Engines", 1st Edition, Shroff Publishers & Distributors, Mumbai, 1984.

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MAPPING OF COS AND POS:

CO	PO												PSO			
	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
1	2	1	1										1			
2	1														1	
3					1							1		1	1	
4				1		1										1
5					1		1							1		1
Avg	3/2= 1.5	1/1= 1	1/1= 1	1/1= 1	2/2= 1	1/1= 1	1/1= 1					1/1=1	1/1=1	2/2= 1	2/2= 1	2/2= 1

COURSE OBJECTIVE:

To Impart the knowledge to the students on

- Marine boilers and steam engines.
- Operation & Maintenance of Boilers
- The concept of marine steam plants operations
- Lubrication for Steam Engines and Turbines
- Operation and maintenance of turbines

UNIT I MARINE BOILERS & BOILER MOUNTINGS 9

Scotch Boiler, Cochran, Spanner, Clarkson thimble tube, Waste heat recovery calculation, Lamont exhaust gas boiler, Composite boilers, Water tube boilers – Babcock Wilcox, Foster Wheeler – D-type, Double evaporation boilers. Safety Valves – Improved High Lift, Full lift and full Bore type: Gauge glass – Ordinary plate type and remote Indicator; Automatic feed regulator, three element High & Low water level alarms, Main Steam stop valve, Retractable type Soot blower etc.

UNIT II OPERATION & MAINTENANCE OF BOILERS 9

Pre-commissioning procedures, Hydraulic tests, steam raising and Operating procedures, Action in the event of shortage of water. Regular boiler water tests on board. Blowing down of boiler, Laying up a boiler; general maintenance, External and internal tube cleaning. Tube renewals, etc., maintenance, inspection and survey of boilers. Refractory: Purposes of refractory, types of refractory and reasons for failure. Oil burning: Procedure of Liquid fuel burning in open furnace, Various types of atomizer, Furnace arrangement for oil burning, Boiler Control System i.e. master control, fuel control, air control and viscosity control, Introduction to Automation.

UNIT III MARINE STEAM PLANTS 9

Steam engines - History of multiple expansion marine reciprocating engines & steam turbines. Description of different types of steam turbines. Layout of plant - General layout of plant & description of a modern geared steam turbine installation including auxiliaries in modern use, open and closed feed system. Condensers - Types of condensers, constructional details, location & working principles, contraction and expansion allowances, leak test. Effect of change of temperature, circulating water quantity, change of main engine power, condenser surface.

UNIT IV LUBRICATION FOR STEAM ENGINES AND TURBINES 9

Suitable oils and their properties, lubrication of main bearings, thrust bearings and gears. Gravity and pressure lubrication-oil system and emergency lubrication arrangement.

UNIT V OPERATION AND MAINTENANCE OF TURBINES 9

Turbine drain system, turbine gland system, warming through a turbine plant, control of speed and power of propulsion, throttle valve control and nozzle control, emergency controls, emergency operation of turbines, vibration in marine steam turbine, steam turbine losses. Breakdown and faultfinding. Selection of materials: Materials used in various components like blades, rotors, casings, sealing glands, gears etc. & their justification.

TOTAL: 45 PERIODS**COURSE OUTCOMES:**

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

- CO1: Define the Waste heat recovery system and boiler mountings.
- CO2: Infer the Operation and Watch keeping of boilers.
- CO3: Demonstrate the Construction of steam turbines and steam engines.
- CO4: Illustrate The Various Method of Lubrication of turbines
- CO5: Define the operation and maintenance of steam turbines.

TEXT BOOKS:

1. J.H. Milton & R.M. Leach, "Marine Steam Boilers", 4th Edition, Butter worth, London, 1980
2. C. McBirnie, "Marine Steam Engines and Turbines", 4th Edition, Butter worth, London 1980.
3. Thomas D. Morton, "Steam Engineering Knowledge for Marine Engineers", 3rd Edition, Thomas Reed Publications, London 1979.

REFERENCES

1. GTH. Flanagan, "Marine Boilers" 3rd Edition, Butter worth, London, 2001.
2. K.M.B. Donald, "Marine Steam Turbines", 1st Edition, Institute of Marine Engineers, London, 1977.
3. Leslie Jackson and Thomas D. Morton, "General Engineering Knowledge for Marine Engineers, Reed's Vol.8, Thomas Reeds Publication, United Kingdom, 2003
4. Norros.A, "Operation of Machinery in Ships Steam Turbines, Boilers", Marine Engineering Practice, Vol 2, Part 15, IMarEST, London, 2000

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CO	PO												PSO			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PS O1	PS O2	PS O3	PS O4
1	1	1	1											1		
2			1	1					1	1			1			
3			1					1	1							1
4					1										1	
5			1									1				
Av g	1/1 =1	1/1 =1	4/4 =1	1/1 =1	1/1 =1			1/1 =1	2/2 =1	1/1= 1		1/1= 1	1/1= 1	1/1= 1	1/1= 1	1/1= 1

GE3451

ENVIRONMENTAL SCIENCE AND SUSTAINABILITY

L T P C
2 0 0 2**COURSE OBJECTIVES:**

1. To study the nature and its impacts on human life.
2. To study the environmental pollution, its types, control methods and protection acts
3. To provide the knowledge of about the energy management and energy resources
4. To study the concepts of Sustainability, global warming and Management
5. To study the Sustainability Practices and socio economical changes

UNIT I ENVIRONMENT AND BIODIVERSITY

9

Definition, scope and importance of environment – need for public awareness. Eco-system and Energy flow– ecological succession. Types of biodiversity: genetic, species and ecosystem diversity– values of biodiversity, India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ.

UNIT II ENVIRONMENTAL POLLUTION

9

Causes, Effects and Preventive measures of Water, Soil, Air and Noise Pollutions. Solid, Hazardous and E-Waste management. Case studies on Occupational Health and Safety Management system (OHSMS). Environmental protection, Environmental protection acts .

UNIT III RENEWABLE SOURCES OF ENERGY

9

Energy management and conservation, New Energy Sources: Need of new sources. Different types new energy sources. Applications of- Hydrogen energy, Ocean energy resources, Tidal energy conversion. Concept, origin and power plants of geothermal energy.

UNIT IV SUSTAINABILITY AND MANAGEMENT

9

Development , GDP ,Sustainability- concept, needs and challenges-economic, social and aspects of sustainability-from unsustainability to sustainability-millennium development goals, and protocols-Sustainable Development Goals-targets, indicators and intervention areas Climate change- Global, Regional and local environmental issues and possible solutions-case studies. Concept of Carbon Credit, Carbon Footprint. Environmental management in industry-A case study.

UNIT V SUSTAINABILITY PRACTICES

9

Zero waste and R concept, Circular economy, ISO 14000 Series, Material Life cycle assessment, Environmental Impact Assessment. Sustainable habitat: Green buildings, Green materials, Energy efficiency, Sustainable transports. Sustainable energy: Non-conventional Sources, Energy Cycles-carbon cycle, emission and sequestration, Green Engineering: Sustainable urbanization- Socio-economical and technological change.

TOTAL: 30 PERIODS**OUTCOMES:**

At the end of the course the students would be able to

- 1.Understand the nature and its impacts on human life.
- 2.The students have the knowledge and awareness of Environmental Pollution.
- 3.Understanding of the energy sources and scientific concepts/principles behind them
- 4.Understand the concepts of the Sustainability and Management
- 5.Understand the Sustainability Practices and socio economical changes

TEXT BOOKS:

1. Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6th Edition, New Age International Publishers ,2018.
2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2016.

REFERENCES:

1. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media. 38 .
2. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001.
3. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT. LTD, New Delhi, 2007.
4. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, 2005.
5. Erach Bharucha "Textbook of Environmental Studies for Undergraduate Courses" Orient Blackswan Pvt. Ltd. 2013.

MV3411**WELDING TECHNIQUES, LATHE AND SPECIAL MACHINE SHOP****L T P C****0 0 4 2****COURSE OBJECTIVE:**

To develop skill of the students on

- Welding and Welding techniques
- Usage of hand tools
- Sheet metal work and pipe work

LIST OF EXPERIMENTS

1. WELDING - Exercises in Electric Arc welding and Gas welding Advanced Techniques.
2. HAND TOOLS - Hand tools, sharpening, Powered hand tools, Measurements etc. Exercise involving above.
3. SHEET METAL WORKING - Simple Exercise.
4. PIPE WORK - Experiments involving thin pipes, Joining, bending, welding and inspection.

LATHE & SPECIAL M/C SHOP

5. Lathe – Straight turning, Step turning, under cut, taper turning, knurling and thread cutting exercises. Shaping Machine – Making square from round rod and grooving exercises. Exercises on milling machine. Grinding: Exercises to the required accuracy on universal cylindrical grinder and surface grinder. Slotting Machine: Slotting and Key-way cutting.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon Completion of the course, the students will be able to:

CO1: To carry out repair of Ship machinery and components by welding

CO2: To do any kind of sheet metal works

CO3: To make machine components using Lathes and Special machines such as milling, grinding and slotting machine.

REFERENCES:

1. Youssef, “Machining Technology”, 1st Vol. Taylor & Francis, Indian Reprint 2012 (Yesdee Publishing’s Pvt. Ltd.)
2. Kuppuswamy, G., “Principles of Metal Cutting”, 1st Ed. Universities Press, Reprint 2013
3. Mukherjee,S., “Metal Fabrication Technology”,1st Ed., PHI Learning Pvt. Ltd., 2010
4. Larry Jeffus, “ Welding and Metal Fabrication”, 1st. Ed. Cengage Learning, Indian Print,2012 (Yesdee Publishings Pvt. Ltd.)

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LIST OF EQUIPMENTS FOR A BATCH OF 30 STUDENTS

WELDING TECHNIQUES, LATHE AND SPECIAL MACHINE SHOP:

Sl. No.	Name of the Equipment	Qty.
1.	Light duty Lathe	01
2.	Medium duty Lathe	03
3.	Heavy duty Lathe	04
4.	Shaper	01
5.	Slotter	01
6.	Planner	01
7.	Radial drilling m/c	01
8.	Surface grinder	01
9.	Pedestal grinder	01
10.	Vertical milling m/c	01
11.	Universal milling m/c	03
12.	Tool & cutter grinder	01
13.	Gear hobber	01
14.	CNC Lathe Machine	01
15.	Capstan Lathe	01
16.	Cylindrical grinding m/c	01
17.	Power hacksaw	01
18.	Duplicating Lathe	01

WELDING WORK SHOP

Sl. No.	Name of the Equipment	Qty.
1.	Welding Transformer Air Cooled with Fan	04
2.	Maxi – MIG 400A Welding Set	01
3.	AOL make TIG Control Outfit	01
4.	Welding Rectifier Throluxe – 401 MMA	01
5.	Water Cooled Torch 0150102071 400 AMPS	02
6.	Bending Machine Pipe dia ½” to 3”	01
7.	Gas welding and cutting set	02

FITTING SHOP

Sl. No.	Name of the Equipment	Qty.
1.	Power Hacksaw	01
2.	Vernier Height Gauge	02
3.	Surface Plate with stand	02
4.	Fitting Bench Vice	40
5.	Hand tools (Different types)	01

MV3412 HEAT ENGINES, BOILER CHEMISTRY AND REFRIGERATION LABORATORY L T P C 0 0 4 2

COURSE OBJECTIVE:

To develop skill of the students on

- Demonstration ability to carry out the different tests on heat engines.
- Carrying out the Performance and Characteristics of heat engines.
- Performance tests on boiler feed water, oils, fuels and lubricants based on the test results
- Operation and Maintenance of Refrigeration and Air Conditioning.

HEAT ENGINES LAB

LIST OF EXPERIMENTS

1. Flue gas analysis by Orsat apparatus.
2. Study and performance characteristics of steam turbine.
3. Dryness fraction of steam using calorimeters.
4. Performance characteristics of a constant speed air blower.
5. Verification of fan laws and static efficiency of air blower.
6. Test on Reciprocating compressor.
7. C.O.P. of a Refrigeration plant.
8. Performance test on A/C plant.
9. Testing of fuels - calorific value, proximate analysis
10. Testing of fuels - Ultimate analysis, octane number, cetane number.
11. Testing of lubricants - flash point, fire point, pour point.
12. Testing of lubricants- Viscosity index, corrosion stability, carbon residue.
13. Testing of lubricants - Mechanical stability, ash content.
14. Wind Tunnel - Drag and lift measurements.
15. Performance test on IC Engine as per BIS specifications.

BOILER CHEMISTRY LAB

16. To determine hardness content of the sample of boiler water in P.P.M. in terms of CaCO₃.
17. To determine Chloride Content of the sample of water in P.P.M. in terms of CaCO₃.

18. To determine Alkalinity due to Phenolphthaleine, total Alk. and Caustic Alk. Of the sample of water (in P.P.M).
19. To determine Phosphate Content of the sample of water.
20. To determine dissolved Oxygen content of the sample of water.
21. To determine sulphate content of given sample of water.
22. To determine Ph-value of the given sample of water.
23. Boiler trial.
24. Water Testing - Dissolved oxygen, total-dissolved solids, turbidity.
25. Water Analysis (Fresh and sea water)- Chloride, sulphate, hardness.
26. Sludges and scale deposit - Silica, volatile and non-volatile suspended matter.

REFRIGERATION LABORATORY

27. Watch keeping: Parameters to be monitored during running of refrigeration unit.
28. Various cut-outs, viz, pressure, temperature
29. Determination of actual COP, theoretical COP and Carnot COP.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon Completion of the course, the students will be able to:

- CO1: To Perform various tests on the heat engines
- CO2: To Analyze the results to understand the performance characteristics of Engines
- CO3: To Perform Boiler water tests, Sea water and fresh water tests
- CO4: To Choose the best water, oils, fuels and lubricants based on the test results.

REFERENCES:

1. Laboratory Manuals
2. Skelly.J.D, "Water Treatment", Marine Engineering Practice , Vol-2 Part-14, IMarEST, London, 2004
3. Mathur, M.L., Sharma, R.P., "Internal Combustion Engines", 7th Ed. Dhanpat rai Publications, REPRINT 2002
4. Willard W. Pulkrabek, "Engineering Fundamentals of the Internal Combustion Engines", 1st Ed., PHI Learnings Pvt. Ltd., 2011
5. Flanagan,G.T.H, "Marine Boilers", 1st Ed. ,Elsevier, 1990

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS HEAT ENGINES LAB

Sl.No	Name of the Equipment	Qty.
1.	Orsat Apparatus	02 nos
2.	Steam Turbine	01
3.	Steam Calorimeter	01
4.	Air Blower	01
5.	Air Compressor	02 nos
6.	Vapour Compression Refrigeration test rig	01
7.	Vapour compression Air Conditioning test rig	01
8.	Bomb calorimeter and Junker's calorimeter	01
9.	Crucible Metener Burner, Electric Benser Hot air oven	01
10.	Flash & Fire point – closed cup apparatus	01
	Redwood's Viscometer	01
	Say bolt's Viscometer	01
11.	Carbon residue apparatus.	
12.	Wind Tunnel	01

SI.No	Name of the Equipment	Qty.
1.	Redwood Viscometer	01
2.	Saybolt's Viscometer	01
3.	Abel's flash point and fire point apparatus	01
4.	Closed cup apparatus (Pensky)	01
5.	Bomb Calorimeter with Beckman (Digital)	01
6.	Junker's Gas Calorimeter	01

BOILER CHEMISTRY LAB

SI.No	Name of the Equipment	Qty.
1.	Burette, Pipette, Beaker, Conical Flask, Bunsen Burner	01 each
2.	Burette, Pipette, Conical Flask, STD Flask 100ml	01 each
3.	Burette, Pipette, Conical Flask, STD Flask	01 each
4.	Burette, Pipette, Conical Flask.	01 each
5.	Do Bottle, Burette, Pipette, Conical Flask.	01 each
6.	Wephlo turbidity meter, STD Flask Pipette.	01 each
7.	PH meter, Buffer tablets, beaker.	01 each
8.	Petridish, Hot air Oven, Weighing Balance	01 each
9.	Water Analysis kit.	01 nos
10.	Burner, Silica, Crucible, Electric Bunsen, Petridish Hot air Oven	01 each
11.	Burette, Pipette, Conical Flask, turbidity meter, Bunsen Burner, Beaker, STD Flask	01 each

THERMAL ENGINEERING

SI.No	Name of the Equipment	Qty.
1.	Internal Combustion Engines Section	01
2.	Fuel and Lubrication Oil Testing Equipments	01
3.	Heat Transfer Equipments	01
4.	Steam Lab. Equipments	01
5.	Refrigeration and Air Conditioning Equipments	01 set
6.	Automobile Components	01
7.	Engine Research Centre	01
8.	Computers with UPS	01
9.	Miscellaneous Equipments	01

INTERNAL COMBUSTION ENGINES SECTION

SI.No	Name of the Equipment	Qty.
1.	Multi Cylinder Petrol Engine	01
2.	Twin Cylinder Diesel Engine	01
3.	Kirloskar Diesel Engine	01
4.	Greaves Cotton diesel engine	01
5.	Two Stroke Petrol Engine	03 nos
6.	Two Stroke Diesel Engine Model	01
7.	Four Stroke Petrol Engine	01
8.	Four Stroke Diesel Engine Model	01
9.	Two Stroke Petrol Engine Model	01
10.	Multi Cylinder Petrol Engine	01
11.	Four Stroke Single Cylinder Diesel Engine (Anil)	01
12.	MK-12 Petrol Start Kerosene run Engine	01
13.	Battery charger	01

MARINE AC & REFRIGERATION LABORATORY

Sl.No	Name of the Equipment	Qty.
01	Marine Refrigeration Plant (10 ton capacity)	01
02	Marine Air Conditioning Plant (10 ton capacity)	01
03	Vapour compression and Vapour Absorption refrigeration test RIG	01 each

POS:

CO	PO												PSO			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO1 2	PSO 1	PSO2	PSO 3	PSO 4
1	1	1	1		1							1				
2		1	1												1	1
3	1	1	1													
4				1	1							1				1
5		1		1			1	1					1			
Avg	2/2=1	4/4=1	3/2=1.5	2/2=1	2/2=1		1/1=1	1/1=1				2/2=1	1/1=1		1/1=1	2/2=1

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