SHIP OPERATIONS AND MANAGEMENT		Semester	V
Course Code	**BMR501**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination nature (SEE)	Theory		

Course objectives:

- To understand the concepts of Ship operations.
- To understand the concepts of Freight Rates, voyage planning, marine Insurance
- To understand the organizational structure of a shipping company.
- To get familiarized with various chartering methods, Bill of Lading and different paper works on board a merchant vessel

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk
3. Adopt flipped classroom teaching methods.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills
6. such as evaluating, generalizing, and analysing information.

Module-1

I**ntroduction to Ship Management**: Modern shipping practice. Marine vehicles and cargo, care of cargo against damage. Cargoes, stowage of cargo and cargo information. Stowage factor. Care and securing of cargo Damage of cargo Development in shipping and cargo handling. Multimodal transportation, Liner and tramp shipping services. Shipping companies- Owned and ship management company, organization structure.

Module-2

Agents and Agencies: Ports and other intermediaries – Stevedores, Agent and Agency-responsibilities. Port clearance, Custom clearance – Ship documents for inward and outward clearance and procedure. Import and export procedure and documents for import and export. Procedure to convert foreign going vessels into coastal vessels and vice versa.

Module-3

Marine Insurance:

Risk and risk control. Classification of insurance business. Principles of Marine insurance and Types. Important clauses of Hull, cargo and freight insurance and their importance. General average, Characteristics of General Average, Particular average , Characteristics , P&I clubs, Underwriting claims. Insurance companies in India. Reinsurance

Module-4

Chartering: Terms used in commercial shipping- Bill of lading and types. Clauses in Bill of lading. Issues with Bill of lading. Seaway bill Freight and type of freight, Lein, Chartering of vessel and types of charter party and surveyors. In Charter, out charter. Charter terminology – types of days in a Charter party. Charter party clauses. Fixation of vessel Voyage estimate

Module-5

Maritime Law:

International laws of the sea. Limitation of shipowner's liability. Carriage of Goods by Sea Act 1971. York – Antwerp rules Maritime safety and security – Employment of seafarers, ILO, MLC convention Maritime Business contracts. Maritime disputes and settlements, Arbitration. Maritime Jurisdictions (Admiralty courts) and Judicial process in India.

Course outcome (Course Skill Set)

At the end of the course, the student will be able to:

CO1: Describe the agents and agencies, conference systems, marine insurance, shipping act, shipping companies, Marine law (L1)

CO2: Classify marine vehicles, charter parties, types of marine insurance, ships papers, types of shipping companies, marine disputes. (L2)

CO3: Explain cargo handling, freight rates, P and I clubs, port procedures, manning of ships, marine arbitration (L2)

CO4: Illustrate - damage to cargo, rate fixation, loss adjusting principles, duties during emergencies, voyage planning, admiralty law. (L3)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB4.2, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.
- Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Edward F. Stevens & C.S.J. Butterfield, Shipping Practice, 11th Edition, 1981, ISBN:9788175980105'
2. John. W. Dicke. 2014, Reeds 21st Century Ship Management. Bloomsbury Publishing, U.K.

Reference Books:

1. John. W. Dicke. 2014,Reeds 21st Century Ship Management. Bloomsbury Publishing, U.K.
2. ICS .2011/12, Ship Operations and Management. London, UK.
3. Luny.H.V., Lai K.-H., Cheng T.C.E. Cheng. 2010, Shipping And Logistics Management." Springer, U.K.
4. Proshanto K.Mukherjee,Mark Brownrigg (2013), Farthing On International Shipping.4th Edition, Springer.

Web links and Video Lectures (e-Resources):

- www.consulting.xerox.com/case-studies/...shipping-co/enus.html (International Shipping Company Case Study)
- www.sugarcrm.com/industry/shipping-and-transport/case-study(CRM Shipping and Transport Case Studies)
- http://businesscasestudies.co.uk(Shipping Sector-Case Studies)
- www.tcs.com › Home › Resources › Case Studies(TCS Resources: Case Study Leading Indian Shipping)
- http://www.sbaglobal.com(SBA Global Logistics Services-Case Studies)

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Organise Industrial visits to ports
- Case studies on ship chartering.
- Mock company meeting
- Case studies on arbitration

MARINE IC ENGINES AND PROPULSION SYSTEM (IPCC)		Semester	V
Course Code	**BMR502**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 8-10 Lab slots	Total Marks	100
Credits	04	Exam Hours	03
Examination nature (SEE)	Theory		

Course objectives:

- Theoretical and practical knowledge of the IC engine systems on ships.
- Understand the working of main engine components and their materials
- Explain the working and use of main engine systems.
- Explain the safe operating procedure of main engine
- Explain the working of propulsion systems.

Teaching-Learning Process (General Instructions)

These are sample Strategies; that teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method
3. Adopt flipped classroom teaching methods.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.
6. Conduct Laboratory Demonstrations and Practical Experiments to enhance experiential skills.

MODULE-1
Principles of Internal Combustion Engines Review of basic cycles :4-Stroke and 2-Stroke cycles Deviation from Ideal Condition in actual engines, Timing Diagrams of 2- Stroke and 4-Stroke engines. Comparative study of slow speed, medium speed and high-speed diesel engines – suitability and requirements for various purposes, Mean Piston speed, M.C.R. & C.S.R. ratings. Development of long-stroke Engines, multiplication of stroke-bore ratio Measurement of engine speed, air flow, fuel consumption, Measurement of Brake Power and Indicated Power, indicator cards, Power Calculations, thermal efficiency, Performance curves, Heat Balance sheet and Multi cylinder Engines testing- Morse test. Makers Engine / Test bed Trials.
MODULE-2
Components of Marine Main Engine Cylinder head & its mountings -hydraulic exhaust valves, Liner and Jacket, piston & piston rings, piston rod , Cross head guides, bearing, Connecting rod – crank pin bearings, main bearing, crank shaft, crankcase relief valves, thrust bearing, thrust block, Bed Plate, A-frame- Welded construction for Bed plates & frames, Tie rods, chocks- metallic, resin.
MODULE-3
Main Engine Systems Main Lubricating system- Principles and lube oil properties, Cylinder lubricating system, L.O. treatments M/E Fuel oil system: Fuel and types: F.O. properties and requirements, F.O. treatments, F.O transfer system, fuel injection system - Jerk and Common rail systems, V.I.T &Electronic injection system. M/E cooling system: piston, cylinder head, liner cooling. M/E Air starting system, Main Sea water system, Scavenge air system- Uniflow, loop, cross loop and reverse loop, Turbocharging system, injector cooling system, camshaft lube oil system.
MODULE-4
Safe Operation of Main engine & modern practices Control air system, control air dryer, manoeuvring system, reversing systems, starting of main engine, governor, over speed trip, starting air interlocks. Vibrations & its types, dampers & detuners. Main engine alignment, crankshaft deflection, piston & piston ring calibration, shaft generator, main engine safety and alarm system (low lube oil cut-out etc.), mist detector Emission control: NOx and SOx control systems, Camless engine, Dual fuel engine
MODULE-5
Propulsion Systems Direct Propulsion System: Shafting, Thrust block, intermediate shaft & bearings, coupling bolts, muff coupling, propeller shaft, stern tube-water cooled & oil cooled, stern tube bearings, stern tube lube oil system, aft & forward seal details, propellers-keyed & keyless propellers, fixed pitch, controlled pitch propeller, pilgrim nut, aft liner. A-bracket on passenger vessel Electrical propulsion, jet propulsion, propeller cavitation

PRACTICAL COMPONENT OF IPCC *(May cover all / major modules)*

Sl.NO	Experiments
1	**Determination of calorific value of solid/liquid/ gaseous fuels**
2	Determination of Flash point and Fire point of lubricating oil using Abel Pensky and Marten's (closed) / Cleveland's (Open Cup) Apparatus.
3	Valve Timing diagram of 4 stroke engine and port timing diagram of 2 stroke engine
4-9	Performance Tests on I.C. Engines, Calculations of IP, BP, Thermal efficiency, Volumetric efficiency, Mechanical efficiency, SFC, FP, A:F Ratio, heat balance sheet for

	a. Four stroke Diesel Engine b. Four stroke Petrol Engine c. Multi Cylinder Diesel/Petrol Engine, (Morse test) d. Two stroke Petrol Engine e. Variable Compression Ratio I.C. Engine.
9	**Demo: Measurements of Exhaust Emissions of Petrol/diesel engine.**
10	**Demo: Exercises to reading and drawing of indicator diagram using planimeter and calculation of indicated power**
11	**Demo: Demonstration of p-θ , p-V plots using Computerized IC engine test rig**
12	**Demo: Sketch the layout of the fuel line/ cooling water line/ lube oil line**

Course outcomes (Course Skill Set):

At the end of the course, the student will be able to:

CO1: List basic cycles, Main engine parts, systems associated with Main engine and propulsion systems. (L1)

CO2: Explain timing diagrams, working of main engine components, fuel and Lube oil systems, control systems and propulsion systems (L2)

CO3: Select types of engines, components, piston rings and types of propulsion based on usage (L3)

CO4: Evaluate the performance of I C engines , components, systems and manoeuvring propulsion systems (L4)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

CIE for the theory component of the IPCC (maximum marks 50)

- IPCC means practical portion integrated with the theory of the course.
- CIE marks for the theory component are **25 marks** and that for the practical component is **25 marks**.
- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.
- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for **25 marks)**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

CIE for the practical component of the IPCC

- **15 marks** for the conduction of the experiment and preparation of laboratory record, and **10 marks** for the test to be conducted after the completion of all the laboratory sessions.
- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to **15 marks**.
- The laboratory test **(duration 02/03 hours)** after completion of all the experiments shall be conducted

for 50 marks and scaled down to **10 marks.**

- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **25 marks**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours**)

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.
- Marks scored by the student shall be proportionally scaled down to 50 Marks

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper may include questions from the practical component.

Suggested Learning Resources:

Books

1. Wood yard, Goug, "Pounder's Marine Diesel Engines''. 811, Edition, Butter Worth Heinemann Publishing, London, 2001.
2. S H Henshall, "Medium and High-Speed Diesel Engines for Marine Use", 11, Edition, Institute of Marine Engineers, Mumbai, 1996.
3. Ganeshan. V, "Internal Combustion Engines, Tata McGraw Hill, 4th Edition, 2012.

Additional References:

1. D K Sanyal, "Principle & Practice of Marine Diesel Engines", 2nd Edition, Bhandarkar Publication, Mumbai, 1998.
2. Denis Griffiths, Marine Low Speed Diesel Engines, Witherby, Revised Edition 2020, ISBN-10: 1856098796

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/112/103/112103262/
- http://vlabs.iitkgp.ernet.in/rtvlas/
- https://www.wartsila.com/encyclopedia/term/internal-combustion-engine

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Conduct interactive sessions on drawing of ship Indicator diagrams.
- Conduct Case studies on fires due to failure of I C engine systems.
- Group discussions on SOLAS Regulations Chapter II-4.
- Visit a ship in-campus to see the model of the Main engine and study the Main engine system.
- Design a prototype of an exhaust gas scrubber system.
- Review the papers on the latest advancements in Marine engine design.
- To observe the overhaul of the main engine piston in a ship-in campus.

THEORY OF MACHINES		Semester	V
Course Code	**BMR503**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	2:2:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination nature (SEE)	Theory		

Course objectives:

- To understand the concept of machines, mechanisms and to analyze a mechanism for displacement, velocity and acceleration at any point in a moving link.
- To understand the force-motion relationship in components subjected to external forces and analysis of standard mechanisms and governors
- To analyse the undesirable effects of imbalances resulting from prescribed motions in mechanism.
- To design and evaluate the performance of different cams and followers.
- To understand and appreciate the importance of vibrations in mechanical design of machine parts that operate in vibratory conditions

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk
3. Adopt flipped classroom teaching methods.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills
6. such as evaluating, generalizing, and analysing information.

Module-1

Introduction: Mechanisms and machines, Kinematic pairs-types, degree of freedom, Kinematic chains and their classification, Kinematic inversions, Velocity and Acceleration analysis of planar mechanisms Graphical method: Velocity and Acceleration Analysis of Mechanisms Velocity and acceleration analysis of four bar mechanism, slider crank mechanism. Mechanism illustrating Corioli's component of acceleration. Angular velocity and angular acceleration of links, velocity of rubbing. Velocity and Acceleration Analysis of Mechanisms (Analytical Method): Velocity and acceleration analysis of four bar mechanism, slider crank mechanism using complex algebra method.

Module-2

Static force analysis: Static equilibrium, analysis of four bar mechanism, slider crank mechanism, shaper mechanism. Dynamic force analysis: D'Alembert's principle, analysis of four bar and slider crank mechanism, shaper mechanism. Flywheel: Introduction to Flywheel and calculation of its size for simple machines like punching machine, shearing machine

Module-3

Spur Gears: Gear terminology, law of gearing, path of contact, arc of contact, contact ratio of spur gear. Interference in involute gears, methods of avoiding interference, condition and expressions for minimum number of teeth to avoid interference. Gear Trains: Simple gear trains, compound gear trains. Epicyclic gear trains: Algebraic and tabular methods of finding velocity ratio of epicyclic gear trains, torque calculation in epicyclic gear trains.

Module-4

Balancing of Rotating Masses: Static and Dynamic Balancing, Balancing of single rotating mass by balancing masses in the same plane and in different planes. Balancing of several rotating masses by balancing masses in the same plane and in different planes.

Balancing of Reciprocating Masses: Inertia Effect of crank and connecting rod, Single cylinder Engine, Balancing in multi cylinder-inline engine (primary and secondary forces)

Governors: Types of Governors; Force Analysis of Porter and Hartnell Governors. Controlling Force, Stability, Sensitiveness, Isochronism, Effort and Power.

Module-5

Free vibrations: Basic elements of vibrating system, Types of free vibrations, Longitudinal vibrations-Equilibrium method, D'Alembert's principle, Determination of natural frequency of single degree freedom systems, Damped free vibrations: Under damped, over damped and critically damped systems. Logarithmic decrement. Forced vibrations: Undamped forced vibration of spring mass system, Damped forced vibrations, Rotating unbalance, Reciprocating unbalance, Vibration isolation, Critical speed.

Course outcome (Course Skill Set)

At the end of the course, the student will be able to:

1. To identify and enumerate different link-based mechanisms with basic understanding of motion, understand types of vibration, SHM and methods of finding natural frequencies of simple mechanical systems (L1)
2. Understand the causes and effects of vibration in mechanical systems. (L2)
3. Develop schematic models for physical systems and formulate governing equations of motion and vibrations. (L3)
4. To analyse the mathematical models and to determine its response of real-life engineering systems(L4)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Theory of Machines", Rattan S.S, Tata McGraw-Hill Publishing Company Ltd., New Delhi, and 3rd Ed-2009
2. "Theory of Machines", Sadhu Singh, Pearson Education (Singapore) Pvt. Ltd, Indian Branch New Delhi, 2nd Ed 2006
3. Mechanical Vibrations, S. S. Rao, Pearson Education Inc, 4thedition, 2003.
4. Mechanical Vibrations, V. P. Singh, Dhanpat Rai & Company, 3rdedition, 2006.

Web links and Video Lectures (e-Resources):

https://nptel.ac.in/courses/112106270
https://onlinecourses.nptel.ac.in/noc20_me21/preview
https://nptel.ac.in/courses/112101096
https://nptel.ac.in/courses/112103111
https://nptel.ac.in/courses/112107212
https://nptel.ac.in/courses/112107087
http://edheads.org.

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Mini Group Projects on working of Mechanisms
- Visit to the vibration laboratory and demonstrate the working of Governors, working of cams, balancing of rotating masses.
- Bring in everyday examples of simple machines and demonstrate how they work.

DESIGN LABORATORY		Semester	**V**
Course Code	**BMRL504**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	01	Exam Hours	03
Examination nature (SEE)	Theory/**Practical**/Viva-Voce /Term-work/Others		

*** Additional one hour may be considered for instructions if required.**

Course objectives:

The students will be able

- To understand the concepts of natural frequency, logarithmic decrement, damping and damping ratio.
- To understand the techniques of balancing of rotating masses and influence of gyroscopic couple.
- To verify the concept of the critical speed of a rotating shaft.
- To illustrate the concept of stress concentration using Photo elasticity.
- To appreciate the equilibrium speed, sensitiveness, power and effort of a Governor.
- To illustrate the principles of pressure development in an oil film of a hydrodynamic journal bearing.
- To visualize different mechanisms and cam motions

Sl.NO	**Experiments**
1	Determination of natural frequency, logarithmic decrement, damping ratio and damping coefficient in a single degree of freedom vibrating systems (longitudinal and torsional)
2	Balancing of rotating masses
3	Determination of critical speed of a rotating shaft

4	Determination of equilibrium speed, sensitiveness, power and effort of Porter/Proell /Hartnel Governor.
5	Determination of Pressure distribution in Journal bearing
6	Determination of Principal Stresses and strains in a member subjected to combined loading using Strain rosettes.
7	Determination of stresses in Curved beam using strain gauge.
8	Study the principle of working of a Gyroscope and demonstrate the Effect of gyroscopic Couple on plane disc.
9	Determination of Fringe constant of Photo-elastic material using. a) Circular disc subjected to diametral compression. b) Pure bending specimen (four-point bending)
10	Determination of stress concentration using Photo-elasticity for simple components like plate with a hole under tension or bending, circular disk with circular hole under compression.
	Demonstration Experiments (For CIE)
11	Demonstration and study of operation of different Mechanisms and their Inversions: Slider crank chain, Double slider crank chain and its inversions, Quick return motion mechanisms-Peaucellier's mechanism. Geneva wheel mechanism, Ratchet and Pawl mechanism, toggle mechanism, pantograph, Ackerman steering gear mechanism.
12	Demonstration and Study of different types of cams, types of followers and typical follower motions. Obtain cam profile for any two types of follower motions and types of followers

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

CO1: Compute the natural frequency of the free and forced vibration of single degree freedom systems, critical speed of shafts.

CO2: Carry out balancing of rotating masses and gyroscope phenomenon and analyse the governor characteristics.

CO3: Determine stresses in disk, beams and plates using photo elastic bench and determination of Pressure distribution in Journal bearing.

CO4: Realize different mechanisms and cam motions.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation (CIE):

CIE marks for the practical course are**50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment is to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments are designed by the faculty who is handling the laboratory session and are made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled down to **30 marks** (60% of maximum marks).

- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus.
- In a test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The marks scored shall be scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and marks of a test is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners, one from other institute as external and one from the same institute as internal examiner, are appointed by the university.
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% of Marks allotted to the procedure part are to be made zero.

The minimum duration of SEE is 02 hours

Suggested Learning Resources:

1. Rattan S.S , Theory of Machines, Tata McGraw-Hill Publishing Company, 2014
2. M. M. Frotch, Experimental Stress analysis, McGraw-Hill

Control Systems		Semester	V
Course Code	**BMR515A**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination nature (SEE)	**Theory**		

Course objectives:

- Course objectives: Study the fundamental concepts of Control systems and their mathematical modelling.
- Study the concept of time and frequency response of the system.
- Study the stability analysis of the control system.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt teaching methods using PowerPoint presentation, Video demonstration.
2. Use of appropriate software tools to demonstrate the frequency response of the systems.
3. Adopt collaborative (Group Learning) learning in the class.
4. Adopt problem based learning which fosters student's analytical skills and develop thinking skills.

Module-1

Introduction: Concept of automatic controls, Open loop and closed loop systems, Concepts of feedback, requirements of an ideal control system.

Types of controllers: Proportional, Integral Proportional Integral, Proportional Integral Differential controllers.

Mathematical Models: Transfer function models, models of mechanical systems, models of electrical circuits, models of thermal systems and models of hydraulic systems.

Module-2

Block Diagrams and Signal Flow Graphs: Transfer Functions definition, block representation of systems elements, reduction of block diagrams, Signal flow graphs: Mason's gain formula. **System Compensation**: Series and feedback compensation, Lead compensator, Lag Compensator

Module-3

Transient and Steady State Response Analysis: Introduction, test inputs, first order and second order system response to step, ramp and impulse inputs, concepts of time constant and its importance in speed of response. Steady state error, error constants.

Module-4

System stability: Routh's stability Criterion

Root Locus Plots: Definition of root loci, General rules for constructing root loci, Analysis using root locus plots.

Module-5

Frequency Response Analysis: Polar plots, Nyquist stability criterion, Bode Plots, Determination of phase margin and gain margin using Bode plot.

Course outcome (Course Skill Set)

At the end of the course, the student will be able to :

1. Explain the control system and its types, control actions and develop system governing equations for physical models (Mechanical, Electrical, Thermal &Hydraulic Systems)
2. Analysis on the response of control system for standard test signals.
3. Apply block diagram & signal flow representations to obtain transfer function of control systems.
4. Analyse the stability of transfer functions in complex domain and frequency domain.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

Books

1. Modern Control Engineering, Katsuhiko Ogatta, Pearson Education, Fifth edition.
2. Modern Control Systems, Richard.C.Dorf and Robert.H.Bishop, Addison Wesley, Thirteenth Edition.
3. Control Systems Principles and Design, M.Gopal, Fourth Edition, TMH.
4. Automatic Control Systems, Benjamin C. Kuo, Farid Golnaraghi, McGraw Hill Education, Tenth Edition

Web links and Video Lectures (e-Resources):

https://onlinecourses.nptel.ac.in/noc22_ee31/preview
https://plccoep.vlabs.ac.in/exp/pidcontroller/index.html

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Frequency response of control system using MATLAB/SCILAB or any opensource software tools.

Autonomous Ships		Semester	5
Course Code	**BMR515B**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination nature (SEE)	Theory/practical/Viva-Voce /Term-work/Others		

Course objectives:

- To impart knowledge to the students on
- Remote Controlled Ship Operation
- Marine Situational Awareness and Autonomous Navigation
- Legal Implications of Remote and Autonomous Shipping
- Safety and Security in autonomous shipping
- Innovations to Markets, Redefining Shipping

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method
3. Adopt flipped classroom teaching methods.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information

Module-1

INTRODUCTION:

Background-AAWA Initiative-Vision of remote-controlled ship Operation-Voyage planning and initiation Unmooring and maneuvering out of Harbor-Operation modes at open Sea-Port approach and docking Applicability for different ship types

Module-2

TECHNOLOGIES FOR MARINE SITUATIONAL AWARENESS AND AUTONOMOUS NAVIGATION

Autonomous navigation of the Vessel-Situational awareness (SA) for autonomous ships-Off-ship communication

Module-3

SAFETY AND SECURITY IN AUTONOMOUS SHIPPING – CHALLENGES FOR RESEARCH AND DEVELOPMENT

Introducing of autonomous merchant ships for maritime Operation-Are 'unmanned ships' safe? Preconditions of safety and Security-Focal areas of risk – some selected examples Managing shipping safety and security in short and long Term-Building risk understanding for the future Recommendations

Module-4

LEGAL IMPLICATIONS OF REMOTE AND AUTONOMOUS SHIPPING

Introduction-Law at Sea-Technical Requirements-Liability Rules Summary.

Module-5

INNOVATIONS TO MARKETS – REDEFINING SHIPPING :

Redefining shipping – a transition to autonomous Shipping-Autonomous shipping – an issue of business relationships and Networks-Autonomous shipping – a renewed set of roles between the key Factors-Transition drivers to autonomous Shipping-Transition roadmap

Course outcome (Course Skill Set)

At the end of the course, the student will be able to :

CO1: Describe how autonomous shipping can redefine traditional shipping models and practices.[L2]

CO2: identify the relevant international maritime laws applicable to remote and autonomous shipping.[L2]

CO3: Analyze the potential risks associated with the introduction of autonomous merchant ships.[L3]

CO4: Evaluate the safety and security preconditions for the successful implementation of autonomous shipping.[L4]

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Arthur, W.B. (2009) The Nature of Technology: What It Is and How It Evolves, New York: Free Press.
2. Frenken, K. (2000) A complexity approach to innovation networks. The case of the aircraft industry.
3. Research Policy, 29(2), 257–272.
4. Geels, F.W. (2002) Technological transitions as evolutionary reconfiguration processes: multilevel.
5. perspective and a case-study. Research Policy, 31(8-9), 1257–1274. 6. F.W. Geels. (2005) Technological Transitions and System Innovations. Cheltenham, UK: Edward Elgar.

Web links and Video Lectures (e-Resources):

- https://www.imo.org/en/MediaCentre/HotTopics/Pages/Autonomous-shipping.aspx
- https://oceanexplorer.noaa.gov/
- http://www.youtube.com/watch?v=lVmnKZBiO9Q
- http://www.youtube.com/watch?v=xawSNzL2TgI

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- **Activity:** Students will create a hypothetical shipping route between two ports, considering factors such as weather patterns, underwater topography, marine traffic, and potential hazards.
- Students will use a simulation game or software to navigate an autonomous ship through various scenarios, such as encountering other vessels, avoiding obstacles, and responding to emergencies.

MEMS and Microsystems Technology		Semester	V
Course Code	**BMR515C**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination nature (SEE)	Theory/practical/Viva-Voce /Term-work/Others		

Course objectives:

1. Students are exposed to the MEMS technology & Miniaturization.
2. Students are taught the Process of Micro fabrication Techniques.
3. Students are made to understand the Operation of Microsystems.
4. Students are made to understand the Operation Electronics Circuits for Micro and Smart Systems.
5. Students are made to understand the Implementation of Controllers for MEMS & Case Studies of Integrated Microsystems.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method
3. Adopt flipped classroom teaching methods.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information

Module-1

Introduction to Micro and Smart systems: Miniaturization, Microsystems versus MEMS, Microfabrication, Smart Materials, Structures & Systems, Integrated Microsystems, Application of Smart Materials & Microsystems.

Module-2

Micro and Smart Devices and Systems: **Principles and Materials**: Definitions and salient features of sensors, actuators, and systems,

Sensors: silicon capacitive accelerometer, piezoresistive pressure sensor, Portable blood analyser, conductometric gas sensor.

Actuators: Micro mirror Array for Video Projection, Piezoelectric based inkjet print head, electrostatic combdrive, Magnetic micro relay.

Module-3

Micromachining Technologies: Silicon as a Material for Micromachining, Silicon wafer preparation, thin film deposition techniques, Lithography, Etching, Silicon micromachining: surface Micromachining bulk micromachining. Specialized Materials for Microsystems.

Module-4

Electronics Circuits for Micro and Smart Systems: Semiconductor devices: Diode, Schottky diode, Tunnel diode, MOSFET, CMOS circuits ,Electronics Amplifiers ,Op-Amp based circuits

Module-5
Implementation of Controllers for MEMS & Case Studies of Integrated Microsystems. Design Methodology, PID controller, Circuit Implementation, Digital controller, Microcontroller & PLC. Case Studies of Integrated Microsystems: BEL pressure sensor, design considerations, performance parameters, Smart Structure in vibration control.
Course outcome (Course Skill Set) At the end of the course, the student will be able to: 1. Demonstrate the working methodology of smart materials, Microsystems, electronic circuitry in MEMS devices. 2. Illustrate the process of silicon wafer preparation, thin film deposition techniques, lithography, etching, bulk & surface micromachining involved in MEMS fabrication. 3. Examine the behaviour of piezoresistive & piezoelectric materials required to fabricate pressure sensor & vibration control structures. 4. Measure the performance of pressure sensor & vibration control structure in real time applications.
Assessment Details (both CIE and SEE) The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together. **Continuous Internal Evaluation:** • For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks. • The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered • Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. • For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment. **Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.** **Semester-End Examination:** Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).** 1. The question paper will have ten questions. Each question is set for 20 marks. 2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module. 3. The students have to answer 5 full questions, selecting one full question from each module. 4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Micro and Smart Systems: G.K.Ananthasuresh, K.J.Vinoy, S.Gopalakrishnan, K.N.Bhat, V.K.Aatre, Wiley India 2010.
2. Design and Development Methodologies, Smart Material Systems and MEMS: V. Varadan,K. J. Vinoy, S. Goplakrishnan, Wiley.
3. MEMS Nitaigour Premchand Mahalik, TMH 2007.

Web links and Video Lectures (e-Resources):

- VTU eShikshana Program
- VTU EDUSAT Program.

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

Conduct Analysis of Stress and Strain on Cantilever beam structure on Ansys Tool. Prepare Models to exhibit FCC Structures and create patterns on sheets of paper to demonstrate different Micromachining Fabrication Processes.

SUPPLY CHAIN MANAGEMENT & INTRODUCTION TO SAP		Semester	V
Course Code	**BMR515D**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination nature (SEE)	**Theory**		

Course objectives:

- To acquaint with key drivers of supply chain performance and their inter-relationships with strategy.
- To impart analytical and problem-solving skills necessary to develop solutions for a variety of supply chain management & design problems.
- To study the complexity of inter-firm and intra-firm coordination in implementing programs such as e-collaboration, quick response, jointly managed inventories and strategic alliances.
- To understand the usage of SAP material management system

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different type of teaching methods to develop the outcomes through Power-Point Presentation and Video demonstration or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Discuss the case studies and how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
4. Adopt collaborative (Group Learning) Learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information.

Module-1

Introduction: Supply Chain – Fundamentals –Evolution- Role in Economy - Importance - Decision Phases – Supplier Manufacturer-Customer chain. - Enablers/ Drivers of Supply Chain Performance. Supply chain strategy - Supply Chain Performance Measures.

Strategic Sourcing Outsourcing – Make Vs buy - Identifying core processes - Market Vs Hierarchy - Make Vs buy continuum -Sourcing strategy - Supplier Selection and Contract Negotiation. Creating a world class supply base- Supplier Development - World Wide Sourcing.

Module-2

Warehouse Management Stores management-stores systems and procedures-incoming materials control stores accounting and stock verification Obsolete, surplus and scrap-value analysis-material handling transportation and traffic management -operational efficiency-productivity-cost effectiveness-performance measurement.

Module-3

Supply Chain Network optimization models. Impact of uncertainty on Network Design - Network Design, decisions using Decision trees. Planning Demand, -multiple item -multiple location inventory management. Pricing and Revenue Management.

Module-4

Current Trends: Supply Chain Integration - Building partnership and trust in Supply chain Value of Information: Bullwhip Effect - Effective forecasting - Coordinating the supply chain. Supply Chain restructuring,

Supply Chain Mapping - Supply Chain process restructuring, Postpone the point of differentiation – IT in Supply Chain - Agile Supply Chains -Reverse Supply chain. Future of IT in supply chain E-Business in supply chain.

Module-5

Introduction to SAP: SAP Material Management, Procurement process, Organization structure, Enterprise structure, Master data management, purchase Info record, source list, procurement cycle, purchase requisition, request for quotation, purchase order, inventory management, invoice verification, service management, transaction code

Course outcome (Course Skill Set)

At the end of the course, the student will be able to :

CO1: Understand the framework and scope of supply chain management, basics of SAP, impact of IT on Supply chain.

CO2: Understand how to manage a competitive supply chain using strategies, models, techniques and information technology.

CO3: Apply planning for demand, inventory and supply

CO4: Optimize supply chain network.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of

assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.
- Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Janat Shah, Supply Chain Management– Text and Cases, Pearson Education, 2nd edition 2. Sunil Chopra and Peter Meindl, Supply Chain Management-Strategy Planning and Operation, PHI Learning / Pearson Education, 6th edition.
3. David Simchi-Levi, Philip Kaminsky, Edith Simchi-Levi, Designing and Managing the Supply Chain: Concepts, Strategies, and Cases, Tata McGraw-Hill.
4. Ballou Ronald H, Business Logistics and Supply Chain Management, Pearson Education 5. Ashfaque Ahmed, The SAP Materials Management Handbook, CRC Press Publication. 2014 edition.
6. Martin Murray & Jawad Akhtar, Materials Management with SAP ERP: Functionality and Technical Configuration, SAP Press; Fourth edition.
7. P. Gopalakrishanan, M. Sundaresan, Materials Management: An Integrated Approach, Prentice Hall India

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc21_mg45/preview
- https://nptel.ac.in/courses/110106045
- https://www.udemy.com/course/sap-mm-training/
- https://www.udemy.com/course/sap-s4hana-mm-sourcing-and-procurement/
- https://nptel.ac.in/courses/110105095

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Case study of companies' example Amazon, Flipkart, Parle, DMart, Reliance etc can be discussed

MARINE THERMAL ENGINEERING (IPCC)		Semester	VI
Course Code	**BMR601**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 8-10 Lab slots	Total Marks	100
Credits	04	Exam Hours	03
Examination nature (SEE)	Theory		

Course objectives:

- To understand the fundamentals of heat transfer
- To study the steady and transient heat conduction
- To understand the mechanism of free and forced convection
- To understand radiation heat transfer mechanism and performance parameters of heat exchangers.
- To analyse refrigeration and air conditioning systems

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Adopt flipped classroom teaching method.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as Evaluating, generalizing, and analyzing information.
6. Conduct Laboratory Demonstrations and Practical Experiments to enhance experiential skills.

MODULE-1

I**ntroductory Concepts and definition**: Review of basics of Modes of Heat Transfer

Conduction-Basic Equations: General form of one-dimensional heat conduction equation. Boundary conditions of first, Second and third kinds. Steady state conduction: Overall heat transfer coefficient for a composite medium; thermal contact resistance; critical thickness of insulation.

Extended surfaces: Steady state conduction in fins of uniform cross section long fin, fin with insulated tip and fin with convection at the tip; fin efficiency & effectiveness

MODULE-2

Concepts and Basic Relations in Boundary layers: Flow over a flat plate -Velocity boundary layer, Thermal boundary layer; Prandtl number; general expression for local heat transfer coefficient; Average heat transfer coefficient.

Forced Convection: Physical significance of Dimensionless numbers. Use of various Correlations for hydro dynamically and thermally developed flows; Use of correlations for flow over a flat plate, cylinder and flow inside the duct.

Free or Natural Convection: Physical significance of dimensionless numbers. Use of correlations for free convection from or to vertical, horizontal and inclined flat plates, vertical and inclined cylinder.

MODULE-3

Radiation Heat transfer: (Review of basic laws of thermal radiation) Intensity of radiation and solid angle; Concept of thermal radiation resistance, Radiation network, view factor, Radiation heat exchange between two parallel infinite black surfaces, between two parallel infinite gray surfaces

Heat Exchangers: Classification of heat exchangers; Overall heat transfer coefficient, Fouling, Scaling factors; LMTD and NTU methods of analysis of heat exchangers, Compact heat exchangers.

MODULE-4

Refrigeration: Vapour compression refrigeration system; description, analysis, refrigerating effect, capacity, power required, units of refrigeration, COP, reversed Carnot cycle, vapour absorption refrigeration system and Air refrigeration system. Use of refrigeration tables and p-h chart- numerical. Typical marine refrigerating plants with multiple compression and evaporator system.

MODULE-5

Psychrometrics: Atmospheric air and Psychrometric properties: DBT, WBT, DPT, partial pressure, specific and relative humidity and relation between the enthalpy and adiabatic saturation temperatures, psychrometric charts. Analysis of various processes: Heating, cooling, dehumidifying and humidifying. Adiabatic mixing of streams of moist air. -numerical
Marine air conditioning-Air circulation system, container cooling system, air cooler fans, air conditioning system in cargo ship.

PRACTICAL COMPONENT OF IPCC *(May cover all / major modules)*

Sl.NO	Experiments
1	Determination of Thermal Conductivity of a Metal Rod.
2	Determination of Overall Heat Transfer Coefficient of a Composite wall.
3	Determination of Effectiveness on a Metallic fin.
4	Determination of Heat Transfer Coefficient in free Convection
5	Determination of Heat Transfer Coefficient in a Forced Convention
6	Determination of Emissivity of a Surface and Determination of Stefan Boltzmann Constant.
7	Determination of LMDT and Effectiveness in a Parallel Flow and Counter Flow Heat Exchangers.
8	Experiment on Transient Conduction Heat Transfer.
9	Using one dimensional transient conduction, experimentally demonstrate estimation of thermal conductivity and thermal diffusivity
10	Performance test on Vapour compression refrigeration -test rig.
11	Performance test on Air conditioning-test rig.
12	Experiments on Boiling of Liquid and Condensation of Vapour (Demonstration).

Course outcomes (Course Skill Set):
At the end of the course the student will be able to:
CO1: Explain the basic modes of heat transfer
CO2: Apply the laws of heat transfer for engineering problems
CO3: Solve thermal problems using correlations and charts/tables
CO4: Analyze various thermal systems by applying fundamental laws

Assessment Details (both CIE and SEE)
The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

CIE for the theory component of the IPCC (maximum marks 50)

- IPCC means practical portion integrated with the theory of the course.
- CIE marks for the theory component are **25 marks** and that for the practical component is **25 marks**.
- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.
- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for **25 marks)**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

CIE for the practical component of the IPCC

- **15 marks** for the conduction of the experiment and preparation of laboratory record, and **10 marks** for the test to be conducted after the completion of all the laboratory sessions.
- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to **15 marks**.
- The laboratory test **(duration 02/03 hours)** after completion of all the experiments shall be conducted for 50 marks and scaled down to **10 marks.**
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **25 marks**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours**)

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored by the student shall be proportionally scaled down to 50 Marks

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper may include questions from the practical component.

Suggested Learning Resources:

Books

1. Heat & Mass transfer, Tirumaleshwar, Pearson education 2006
2. Heat transfer, a practical approach, Yunus A. Cengel , Tata Mc Graw Hill Fifth edition
3. Heat transfer-A basic approach, N. Ozisik, Tata McGraw Hill 2002
4. Fundamentals of Heat and Mass Transfer Incropera, F. P. and DeWitt, D. P, John Wiley and, Sons, New York 5th Edition 2006
5. Basic and Applied Thermodynamics, P K Nag, 2nd Ed., Tata McGraw Hill Publications, 2017.

Web links and Video Lectures (e-Resources):

- Heat Transfer, IIT Guwahati, Dr. Anil Verma, https://nptel.ac.in/courses/103103032
- Heat and Mass Transfer, IISc Bangalore, Prof. Pradip Dutta, https://nptel.ac.in/courses/112108149

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Visit to thermal power plant and make a report
- Make presentations on latest research work in the field of heat transfer
- Visit to refrigerator/ air conditioner manufacturing/service units and make report
- Visit to ports and make a study report on thermal systems used on board ships

NAVAL ARCHITECTURE		Semester	VI
Course Code	**BMR602**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	4:0:0:0	SEE Marks	50
Total Hours of Pedagogy	52	Total Marks	100
Credits	04	Exam Hours	03
Examination nature (SEE)	**Theory**/practical/Viva-Voce /Term-work/Others		

Course objectives:

- An ability to apply knowledge of mathematics, science, and engineering within naval architecture and marine engineering.
- To understand Basic hydrostatics, Geometry of ship;
- Calculations of ship forms and various coefficients: Calculating the area of wetted surface, volume etc.
- An understanding of the various types of Propellers and Rudders.
- An understanding of and experience in marine system conceptual and preliminary design using industrial capability.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk
3. Adopt flipped classroom teaching methods.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

Module-1

Hydrostatics and Simpson's Rule

Hydrostatics: Geometry of Ship, Hydrostatic Calculations Ships lines, Displacement Calculation, pressure exerted by a liquid, load on immersed plane, centre of pressure, load diagram shearing force on bulkhead stiffener.

Simpson's Rule: Simpson's first rule, application to volumes, use of intermediate ordinates application to first and second moments of area. Familiarisation with hydrostatic curves of the ship, problems.

Module-2

T.P.C, Coefficient of forms, Centre of Gravity

T.P.C, Coefficient of forms: Concept of DWT, GT and NT, Tonnes per Cm. Immersion, Coefficient of forms, wetted surface area, Similar figures, shearing force and bending moment

Centre of gravity: Effect of addition and removal of masses, Effect of movement of mass, Effect of suspended mass calculations.

Module-3

Stability of Ship

Stability of ships Statical stability at small angles of heel. Calculation on BM, metacentric diagram inclining experiment, free surface effect, stability at large angle of heel, stability of wall sided vessel. Problems.

Module-4

Trim, Resistance

Trim: Change in draughts due to added masses, change in mean draught and end draught due to density, change in mean draught and end draught due to bilging MCTI, change of L.C.B. with change of trim, Change

of trim due to adding or deducting weights, change in draft & trim because Of' filling/flooding several tanks with different densities, Change in draft due to change in density. Problems.

Resistance: Frictional, residuary and total resistance, Admiralty coefficient, fuel co-efficient and consumption, problems.

Module-5

Propeller, Rudder

Propeller: Definitions, Geometry of screw propeller, types of propeller, Blade element theory, Apparent and real slip, wake, thrust, relation between powers, built and solid propellers, measurement of pitch, cavitation.

Rudder: Force on rudder, types of rudders, model experiments and turning trails, torque on stock, angle of heel due to force on rudder, angle of heel when turning, problems.

Course outcome (Course Skill Set)

At the end of the course, the student will be able to :

CO1: Define and explain various terms related to geometry of ship, hydrostatics, and stability of ship, propellers and rudders.(L2)

CO2: Apply the principle of hydrostatics, numerical integration (simpson's rule), forces on rudder and various conditions of stability of ships.(L3)

CO3: Analyse the stability of ships using the principle of hydrostatics.(L4)

CO4: Examine the conditions for stability of ships in real world scenarios.(L4)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books:

1. Munro-Smith, R.. Ships and Naval Architecture. United Kingdom, Witherby, 2020.
2. Stokoe, E A, and Pemberton, Richard. Reeds Vol 4: Naval Architecture for Marine Engineers. United Kingdom, Bloomsbury Publishing, 2018.

Reference Books:

1. K. J. Rawson and E. C. Tupper, "Basic ship theory" (vol II), 5TH edition, Butterheinmann London 2001
2. E A Stokoe , "Naval Architecture for Marine Engineers" vol 4, reeds publications, 2000
3. G.N. Hatdh," creative naval architecture", 1st Edition, Thomas reed publications, London 1971

Web links and Video Lectures (e-Resources):

https://nptel.ac.in/courses/114105003
https://www.courses.com/indian-institute-of-technology-kharagpur
https://www.courses.com/indian-institute-of-technology-kharagpur
https://www.courses.com/indian-institute-of-technology-kharagpur
https://www.courses.com/indian-institute-of-technology-kharagpur

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Study the basics of one design software for naval architecture.
- Design an experiment to find out TPC.
- Study the design changes that have happened because of SOLAS on merchant vessels.

SPECIAL DUTY VESSELS		Semester	VI
Course Code	**BMR613A**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination nature (SEE)	Theory/practical/Viva-Voce /Term-work/Others		

Course objectives:

- To give the students a knowledge of Oil Tankers and their construction.
- To make the student aware of Gas Tankers and their systems.
- To gain a knowledge of cargo operation on Tankers.
- To have a knowledge of dangerous cargo and the precautions to be taken.
- To have a knowledge of the operation of special duty vessels.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method
3. Adopt flipped classroom teaching methods.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information

Module-1

Oil Tankers basics and crude oil tankers:

Origin of double hull ships, their usefulness and superiority over conventional single skin ships, IMO requirements, schedule for phasing out single hull tank vessels of different sizes. Types and classification, construction, cargo pumps and Pipeline systems – Ring main – Direct Line – Combined – Free flow system – Stripping lines. Safety devices associated with loading and discharging.

Module-2

Gas Tankers:

Principles of Gas Carrier Design: Design standards and ship types, Cargo containment systems, materials of construction and insulation, Gas carrier types.

Equipment And Instrumentation: Cargo pipelines and valves, cargo pumps, cargo heaters, cargo vaporizers, reliquification plants and boil off control, cargo compressors and associated equipment, IG and nitrogen gas systems, electrical equipment in gas Dangerous spaces.

Module-3

Oil tanker cargo and IG operations:

Lining up pipelines and cargo operations – loading more than one grade – discharging –ballasting – precautions – ship / shore check list safety goods – sources of ignition on – static electricity – precautions to prevent ignition due to static electricity cargo operations when not secured alongside – procedure if oil spill occurs – oil record books. Uses of inert gas during tanker operating cycle. Tank washing: Procedure – portable and fixed machines – tank washing with water –washing atmospheres – crude oil washing (COW) – advantages and disadvantages of

COW – operating and safety procedures – gas freeing – pressure vacuum values – "Load on Top" system (LOT) regulations and operation – Segregated Ballast Tanks (SBT).

Module-4

Chemical Tankers and product tankers

Chemical cargo types, properties and Hazards, Cargo information. IBC code. Tankers for chemicals, general arrangement and survival capability and tank location. Cargo tanks material and coating. Cargo heating system. Cargo pumps – Deep well Framo pump, Firefighting system, Product tanker - Compliance of MARPOL – Products as specified in MARPOL.

Module-5

Operation of Special Duty vessels:

Introduction to operations on: Bulk carriers – Bulk Grain and ore, Container ships size and layout , Passenger ships - General Arrangement –Difference between Cruise ships and special trade passenger ships (only in India). Indian Passenger ship requirement for construction and operation. Solid blast. Charged fire main. Sprinkler system. Passenger ship A certificate and B certificate

Course outcome (Course Skill Set)

CO1: Identify and define various types Tankers, special duty vessels and its operations (L1)
CO2: Classify the tankers and special duty vessels (L2)
CO3: Explain cargo operations and regulations for safety for all types of tankers, passenger and Special duty vessels (L2)
CO4: Apply principles of cargo operations to specific scenarios of all types of tankers, passenger and special duty vessels. (L3)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Lavery, "Ship board operation",2nd Edition, 2018, Routledge, ISBN-13 : 978-1138132634
2. David House, Seamanship Techniques: Shipboard and Marine Operations, 5th Edition, 2018, Routledge, ISBN-13 978-1138676114
3. D. J. House, Cargo Work for Maritime Operations,8th edition,2005, Elsevier Butterworth- Heinemann, ISBN:9780750665551

Reference Books:

1. International Maritime Organization, IMDG code: International Maritime dangerous goods code, 39th edn, 2018, IMO, ISBN-10: 9280116827

Web links and Video Lectures (e-Resources):

- https://www.imo.org/en/OurWork/Safety/Pages/DangerousGoods-default.aspx
- https://www.dtwd.wa.gov.au/sites/default/files/teachingproducts/MAR041_CCBY.PDF
- https://www.imo.org/en/OurWork/Safety/Pages/Cargoes.aspx
- https://www.dieselduck.info/index.html
- https://www.youtube.com/watch?v=wiT_SillgEc

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Organise Industrial visits to ports
- Case study on cargo operations and spills
- Talks from engineers working on tankers and gas carriers.

MARINE CORROSION AND PREVENTION		Semester	VI
Course Code	**BMR613B**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination nature (SEE)	Theory		

Course objectives:

- To impart knowledge to the students about Corrosion and their influence on Materials and how to prevent corrosion with latest techniques.
- Knowledge of the chemistry of corrosion.
- Knowledge of the corrosion process and the degradation of metals.
- Knowledge of corrosion in engines.
- Knowledge of the corrosion preventive techniques

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method
3. Adopt flipped classroom teaching methods.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.
6. Conduct Laboratory Demonstrations and Practical Experiments to enhance experiential skills.

Module-1
Electrochemistry of Corrosion: Introduction, definitions and types, Electrochemical cells -definitions and principles, Potential measurements – galvanic cells and concentration cells, EMF and Galvanic series, Eh-pH diagrams – fundamental aspects, Construction of Eh – pH diagrams. FeH2O-O2 diagram, Copper, Aluminum and general corrosion diagrams. Different forms of corrosion - uniform, galvanic, crevice, pitting, intergranular, selective leaching, erosion, stress corrosion cracking - their characteristic features, causes and remedial measures
Module-2
Corrosion and Degradation of Metals: Understanding of corrosion types such as oxidation, passivity, stress corrosion cracking, and weld decay. degradation of ceramics and polymers, Degradation of Metals. Applications to current materials degradation problems in marine environments, petrochemical and metallurgical industries.
Module-3
Microbial Corrosion: Mechanisms and Control: Definitions, Biological aspects of corrosion, Microbial influenced corrosion (MIC), MIC–Bacterial transport, attachment and affected materials, MIC - Role of aerobic and anaerobic microorganisms, Mechanisms and models for SRB corrosion, MIC and Biofilms, biofilm studies, MIC – Prevention and control.
Module-4
Corrosion Prevention in Marine Systems: Corrosive wear of cylinder liners – Reasons and remedies. Corrosion In Boiler, Effect of corrosion while boiler not in service – preservation to avoid corrosion, Hull preparation during building and repair periods - Atmospheric corrosion Mill scale – flame cleaning – Acid Pickling – Blast cleaning – causes of paint failure – shipboard preparations for painting – power wire brushing – power discing – air hammer – high pressure water blasting – sand blasting ,shot blasting.
Module-5
Corrosion And Its Prevention: Mechanism of corrosion – Chemical corrosion – Electrochemical corrosion – Anodic & cathodic protection – forms of metallic coatings – anodizing – phosphating, Physical vapour deposition technologies, ion plating, sputter deposition, , magnetron sputtering, general aspects of PVD (production sequence, advantages and disadvantages, microstructure), summary of applications, Basic facts of corrosion - cathodic and anodic coatings, coating defects. Galvanization and tinning .
Course outcome (Course Skill Set) At the end of the course, the student will be able to : CO1: Understand the basics of Corrosion (L2) CO2: Understand the mechanism of marine corrosions and the microbial corrosions (L2) CO3: Identify the factors affecting corrosion (L3) CO4: Select appropriate prevention methods of Corrosion (L3)
Assessment Details (both CIE and SEE) The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. W.D. Callister, Jr., D.G. Rethwisch, Materials Science and Engineering: An Introduction, John Wiley & Sons , 2009, 978- 0-470-41997-7.
2. J.R. Davis, Corrosion: Understanding the Basics, ASM International, 2000, 0-87170-641-5.
3. M.G. Fontana, Corrosion Engineering, McGraw-Hill, 1986, 0-07-021463-8.
4. Lavery, H.I.,"Shipboard operations" Institute of Marine Engineers Publication.
5. Schweitzer, „ Fundamentals of Corrosion",1st Ed. Taylor & Francis, Indian Reprint 20129 (Yesdee Publishing Pvt. Ltd.).

Additional References:

1. Francis Laurence LaQue , " Marine corrosion: causes and prevention", 1st Ed., Wiley, 1975
2. Claire Hellio, Diego M. Yebra, Pinturas Hempel S.A., "Advances in Marine Antifouling Coatings and Technologies", Woodhead Publishing, 2009

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc21_mm36/preview
- https://www.sciencedirect.com/topics/engineering/marine-corrosion
- https://link.springer.com/chapter/10.1007/978-3-319-16649-0_6
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5506973/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Devise an experiment to study the corrosion of a steel bar in salt water and report the findings.
- Review of research papers on marine corrosion.
- Case studies on marine corrosion of offshore structures.

SHIP FIRE PREVENTION AND SAFETY		Semester	VI
Course Code	**BMR613C**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination nature (SEE)	Theory/practical/Viva-Voce /Term-work/Others		

Course objectives:

- Conceptual knowledge of basics of the chemistry of fire.
- Knowledge of rules and regulations governing passive and active firefighting on board ships.
- Knowledge of fixed and portable firefighting equipment and their operation.
- Understanding of the dangers to human life because of fire.
- Knowledge of emergency procedures for firefighting on ships.
- Human behavior affecting firefighting and team management during firefighting.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method
3. Adopt flipped classroom teaching methods.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information

Module-1

Basics of firefighting

Chemistry of fire, fire triangle and fire tetrahedron, aspects of combustion-types of combustion including spontaneous combustion, flash point, fire point, limits of flammability, UEL, LEL, classification of fire and the properties of materials in each class of fire, firefighting mediums and their properties, combustion products and their effect on human life and safety

Module-2

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 and extinction systems, fire test, escape means, electrical installations, ventilation system and venting system for tankers. Statutory requirements for firefighting systems and equipment8 on different vessels, fire doors & fire zones

Module-3

Fire Fighting Equipment and Detection Systems

Types of detectors, selection of fire detectors and alarm systems and their operational limits. Commissioning and periodic testing of sensors and detection systems. 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, water-mist fire suppression system.

Module-4

Fire Control and Safety Systems on Ships

Action required and practical techniques adopted for extinguishing fires in accommodation, machinery spaces, boiler rooms, cargo holds, galley, etc. Firefighting in port and dry dock. Procedure for re-entry after

putting off fire, fire organization on ships, shipboard organization for fire and emergencies. Fire signal and muster. Fire drill. Fire control plan, Leadership and duties, human behaviour

Module-5

Safety Measures and First Aid

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. First aid, Rescue operations from affected compartments

Course outcome (Course Skill Set)

CO1: Identify and define various types fires, firefighting equipment, control measures, first aid(L1)
CO2: Classify fires, fire protection, detection systems, safety measures and safety systems (L2)
CO3: Explain fires chemistry, fire protection in construction, types of detection systems, safety measures onboard and first aid(L2)
CO4: choose portable extinguishers, fire protection, detection systems, safety procedures depending on the fire and ship (L3)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Rushbrook, Frank. Rushbrook's Fire Aboard: The Problems of Prevention and Control in Ships, Port Installations and Offshore Structures. United Kingdom, Brown, Son & Ferguson, 1998.
2. Cowley, James. Fire Safety at Sea. United Kingdom, Institute of Marine Engineering, Science and Technology, 2002.

3. FSS Code: International Code for Fire Safety Systems. United Kingdom, International Maritime Organization, 2016.

Reference Books:

1. SOLAS Consolidated Edition 2020, International Maritime Organization; 7th ed.,2020,ISBN-13 : 978-9280116908
2. MARPOL Consolidated Edi□on 2018 (Vol A & B), Bhandarkar Publications; 2016th edi□on, 2018,ASIN : B071DFXF3H
3. R. H. B. Sturt, "The Collision Regulations", 2nd Edition, Lloyd"s of London Press Ltd., London,
4. Gupta, R.S.,"A Hand Book of Fire Technology", 2nd Ed., University Press, 2011

Web links and Video Lectures (e-Resources):

- https://www.sqlearn.com/fire-protection-and-fire-fighting-on-ships/
- https://www.imo.org/en/OurWork/Safety/Pages/FireProtection-default.aspx
- https://rules.dnv.com/docs/pdf/gl/maritimerules2016July/gl_vi-3-4_e.pdf
- https://nptel.ac.in/courses/110105094

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Organise visit to fire stations
- Case study on fire accidents on board ships
- Report and presentation on first aid for burns.
- Presentation on latest review on research papers in firefighting technology.

INTRODUCTION TO SHIPS AND SHIPPING		Semester	VI
Course Code	**BMR654A**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination nature (SEE)	Theory/practical/Viva-Voce /Term-work/Others		

Course objectives:

- The student will gain the knowledge of the basics of ships and their construction.
- The student will gain a knowledge of the fundamentals of engine room machinery.
- The student will gain a knowledge of navigation and survival at sea.
- The student will gain a knowledge of the rules and organisations that govern shipping.
- The student will gain a knowledge of the basics of the business of shipping.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method
3. Adopt flipped classroom teaching methods.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information

Module-1

Ships: Brief history of ships, Types of ships, Merchant vessels, Types of cargo carried by the ships, sections and parts of a ship, Longitudinal view of a general cargo ship, Mid ship section of some ships, Ranks and job descriptions of ships crew.

Module-2
Engine room machinery: Lay out of the engine room, Types of machinery in the engine room, Main propulsion machinery- main engine and its parts, auxiliary machinery - Brief introduction to Auxiliary engine, pumps, MARPOL equipment, heat exchangers, boilers and cargo handling equipment.
Module-3
Navigation and seamanship: Introduction to Navigation, types of navigation, Bridge and its equipment, LSA and FFA equipment, Lifeboats and Life Rafts - items on a lifeboat and life raft and its uses, types, survival in a lifeboat.
Module-4
IMO and shipping: Organisations associated with shipping, IMO and DG shipping, IMO conventions, MARPOL, STCW, SOLAS,ILO,ISPS
Module-5
Business of shipping and port operations: Geography of sea trade, imports and exports using ships, volume of scale, ports in India and major ports around the world, cargo operations in ports, cargo equipment in ports for various cargo ownership and management companies, containerisation, chartering, shipping documents.

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

CO1: Identify and define various types of Tankers, special duty vessels and its operations (L1)

CO2: Classify the tankers and special duty vessels (L2)

CO3: Explain cargo operations and regulations for safety for all types of tankers and Special duty vessels (L2)

CO4: Identify ship layouts, vessel types; requirements of competence and apply principles of seamanship to specific emergency scenarios. (L3)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.

2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. J. K. Dhar, Basic Marine Engineering, 11th Edition,2019, G-Maritime Publications, ISBN: GMPISBN01.
2. David House, Seamanship Techniques: Shipboard and Marine Operations, 5th Edition, 2018, Routledge, ISBN-13 978-1138676114.
3. John W Dickie, Reeds 21st Century Ship Management, London ; New York : Adlard Coles Nautical, ISBN:9781472900685, 2014

Reference Books:

1. SOLAS Consolidated Edition 2020, International Maritime Organization; 7th ed.,2020, ISBN-13: 978-9280116908
2. MARPOL Consolidated Edi□on 2018 (Vol A & B), Bhandarkar Publications; 2016th edition, 2018, ASIN : B071DFXF3H
3. R. H. B. Sturt, "The Collision Regulations", 2nd Edition, Lloyd‟s of London Press Ltd., London,
4. Gupta, R.S.,"A Hand Book of Fire Technology", 2nd Ed., University Press, 2011

Web links and Video Lectures (e-Resources):

- https://www.imo.org/en/KnowledgeCentre/ConferencesMeetings/Pages/SOLAS.aspx
- https://www.imo.org/en/About/Conventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-(MARPOL).aspx
- https://www.youtube.com/watch?v=Q7Espb0afMw
- https://www.dieselduck.info/index.html
- https://www.youtube.com/channel/UClH53bXYykb-erNZ_kVBtOQ

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Organise Industrial visits to ports
- Case study on SOLAS and MARPOL
- Ship models to be made in groups to study various ship structures
- Presentations on various shipping accidents and their case studies.

SUPPLY CHAIN MANAGEMENT		Semester	VI
Course Code	**BMR654B**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination nature (SEE)	**Theory**		

Course objectives:

- To acquaint with key drivers of supply chain performance and their inter-relationships with strategy.
- To impart analytical and problem-solving skills necessary to develop solutions for a variety of supply chain management & design problems.
- To study the complexity of inter-firm and intra-firm coordination in implementing programs such as e-collaboration, quick response, jointly managed inventories and strategic alliances.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different type of teaching methods to develop the outcomes through Power-Point Presentation and Video demonstration or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Discuss the case studies and how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
4. Adopt collaborative (Group Learning) Learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information.

Module-1

Introduction: Supply Chain – Fundamentals –Evolution- Role in Economy - Importance - Decision Phases – Supplier Manufacturer-Customer chain. - Enablers/ Drivers of Supply Chain Performance. Supply chain strategy - Supply Chain Performance Measures.

Module-2

Strategic Sourcing Outsourcing – Make Vs buy - Identifying core processes - Market Vs Hierarchy - Make Vs buy continuum -Sourcing strategy - Supplier Selection and Contract Negotiation. Creating a world class supply base- Supplier Development - World Wide Sourcing. Introduction to SAP

Module-3

Warehouse Management Stores management-stores systems and procedures-incoming materials control stores accounting and stock verification Obsolete, surplus and scrap-value analysis-material handling transportation and traffic management -operational efficiency-productivity-cost effectiveness-performance measurement.

Supply Chain Network Distribution Network Design – Role - Factors Influencing Options, Value Addition – Distribution Strategies - Models for Facility Location and Capacity allocation. Distribution Center Location Models.

Module-4

Supply Chain Network optimization models. Impact of uncertainty on Network Design - Network Design, decisions using Decision trees. Planning Demand, -multiple item -multiple location inventory management. Pricing and Revenue Management.

Module-5

Current Trends: Supply Chain Integration - Building partnership and trust in Supply chain Value of Information: Bullwhip Effect - Effective forecasting - Coordinating the supply chain. Supply Chain restructuring,

Supply Chain Mapping - Supply Chain process restructuring, Postpone the point of differentiation – IT in Supply Chain - Agile Supply Chains -Reverse Supply chain. Future of IT in supply chain E-Business in supply chain.

Course outcome (Course Skill Set)

At the end of the course, the student will be able to:

CO1: Understand the framework and scope of supply chain management, basics of SAP, impact of IT on Supply chain.

CO2: Understand how to manage a competitive supply chain using strategies, models, techniques and information technology.

CO3: Apply planning for demand, inventory and supply

CO4: Optimize supply chain network.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Janat Shah, Supply Chain Management– Text and Cases, Pearson Education, 2nd edition
2. Sunil Chopra and Peter Meindl, Supply Chain Management-Strategy Planning and Operation, PHI Learning / Pearson Education, 6th edition.
3. David Simchi-Levi, Philip Kaminsky, Edith Simchi-Levi, Designing and Managing the Supply Chain: Concepts, Strategies, and Cases, Tata McGraw-Hill.
4. Ballou Ronald H, Business Logistics and Supply Chain Management, Pearson Education
5. Ashfaque Ahmed, The SAP Materials Management Handbook, CRC Press Publication. 2014 edition.
6. Martin Murray & Jawad Akhtar, Materials Management with SAP ERP: Functionality and Technical Configuration, SAP Press; Fourth edition.
7. P. Gopalakrishanan, M. Sundaresan, Materials Management: An Integrated Approach, Prentice Hall India

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc21_mg45/preview
- https://nptel.ac.in/courses/110106045
- https://www.udemy.com/course/sap-mm-training/
- https://www.udemy.com/course/sap-s4hana-mm-sourcing-and-procurement/
- https://nptel.ac.in/courses/110105095
- https://www.tutorialspoint.com/sap_mm/sap_mm_overview.htm

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Case study of companies example Amazon, Flipkart, Parle, DMart, Reliance etc can be discussed

ANALYSIS AND SIMULATION LABORATORY		Semester	VI
Course Code	**BMRL606**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0-0-2-0	SEE Marks	50
Credits	01	Exam Hours	03
Examination nature (SEE)	**Practical**		

Course objectives:

- To acquire basic understanding of Modelling and Analysis software
- To understand the concepts of different kinds of loading on bars, trusses and beams, and analyze the results pertaining to various parameters like stresses and deformations
- To compare the results of analytical models introduced in lecture to the actual behavior of manufacturing
- To discuss and practice standard programming techniques of manufacturing and their applications•

Sl.NO	**Experiments**
1	Study of a FEA package, modelling and stress analysis of Bars of constant cross section area, tapered cross section area and stepped bar
2	Modelling and stress analysis of Trusses – (Minimum 2 exercises of different types)
3	Modelling and stress analysis of Beams – Simply supported, cantilever, beams with point load, UDL, beams 4 with varying load etc. (Minimum 4 exercises
4	Thermal Analysis – 1D & 2D problem with conduction and convection boundary conditions (Minimum 2 exercises of different types)

5	Manual CNC part programming using ISO Format G/M codes for 2 turning and 2 milling parts. Selection and assignment of tools, correction of syntax and logical errors, and verification of tool path using CNC program verification software
6	CNC part programming using CAM packages: Simulation of Turning simulations to be carried out using simulation packages like: Cadem CAMLab-Pro, Master-CAM.
7	CNC part programming using CAM packages: Simulation of Milling simulations to be carried out using simulation packages like: Cadem CAMLab-Pro, Master-CAM.
8	Simulation using packages like MATLAB 1. Falling sphere with viscous drag – Investigate velocity versus time plot; & simulate the fall.
	Demonstration Experiments (For CIE)
9	Simple 3D Printing Model: Creating Simple 3D model (example cube, gear, prism etc) in CAD software and printing the model using any 3D Printer (FDM/SLA/SLS printer)

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

CO1: Use the modern tools to formulate the problem, create geometry, descritize, apply boundary conditions to solve problems of bars, truss, beams, and plate to find stresses with different-loading conditions

CO2: Simulate the manufacturing processes and vibration related problems

CO3: Create components through additive manufacturing technique

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation (CIE):

CIE marks for the practical course are**50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment is to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments are designed by the faculty who is handling the laboratory session and are made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled down to **30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus.
- In a test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The marks scored shall be scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and marks of a test is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.

- SEE shall be conducted jointly by the two examiners, one from other institute as external and one from the same institute as internal examiner, are appointed by the university.
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% of Marks allotted to the procedure part are to be made zero.

The minimum duration of SEE is 02 hours

Suggested Learning Resources:

1. A first course in the Finite Element Method, Logan, D. L, Cengage Learning, 6th Edition 2016.
2. Finite Element Method in Engineering, Rao, S. S, Pergaman Int. Library of Science 5th Edition 2010.
3. https://nptel.ac.in/courses/112102103
4. https://onlinecourses.nptel.ac.in/noc19_me46/preview
5. https://nptel.ac.in/courses/112103306

ECONOMICS FOR ENGINEERS		Semester	VI
Course Code	**BMR657A**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	1-0-0-0	SEE Marks	50
Total Hours of Pedagogy	16	Total Marks	100
Credits	01	Exam Hours	01
Examination nature (SEE)	Theory		

Course objectives:

- Comprehend Economic Principles
- Apply Financial Analysis Techniques
- Analyze Economic Systems
- Evaluate Economic Policies and Their Impact
- Integrate Engineering and Economic Concepts

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

1. . The faculty member is expected to explore and be acquainted with the existing Indian Knowledge in the domain of the course and share with the students.
2. The students are expected to do the necessary study of the existing Indian Knowledge in the domain of the course, prepare the report, and submit the same to the concerned faculty member at the end of the semester.
3. The faculty member will evaluate the reports and award marks to the students with maximum cap being the equivalent of attendance component marks.

Module-1

Economic Decisions Making –

Overview, Problems, Role, Decision making process. Price and Income Elasticity of Demand in the real world. Principles of economics, how markets work: market forces of supply and demand, Elasticity and its application, Consumer equilibrium.

Module-2

Cash Flow, Interest and Equivalence:

Cash Flow – Diagrams, Categories & Computation, Time Value of Money, Debt repayment, Nominal & Effective Interest.

Module-3

Financial and Engineering Economy-

Financial system: financial institutions, markets and instruments. Engineering Economy: Time value of money, Alternatives' comparing techniques: Present worth analysis, annual worth analysis, rate of return analysis.

Module-4

Indian Economy, Foreign Trade & Investment-

Indian Economy: monetary, fiscal policies and their implications. Trade and investment factors, trade protectionism; balance of payment, devaluation and exchange rate determination.

Module-5

Inflation And Price Change –

Definition, Effects, Causes, Price Change with Indexes, Types of Index, Composite vs Commodity Indexes, Use of Price Indexes In Engineering Economic Analysis, Cash Flows that inflate at different Rates.

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

1. Describe the principles of economics that govern the operation of any organization under diverse market conditions
2. Comprehend macroeconomic principles and decision making in diverse business set up
3. Explain the Inflation & Price Change as well as Present Worth Analysis
4. Apply the principles of economics through various case studies

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of 01 mark. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Books

1. James L.Riggs,David D. Bedworth, Sabah U. Randhawa : Economics for Engineers 4e , Tata McGraw-Hill
2. Donald Newnan, Ted Eschembach, Jerome Lavelle : Engineering Economics Analysis, OUP
3. John A. White, Kenneth E.Case,David B.Pratt : Principle of Engineering Economic Analysis, John Wiley
4. Sullivan and Wicks: Engineering Economy, Pearson
5. R.Paneer Seelvan: Engineering Economics, PHI
6. Michael R Lindeburg : Engineering Economics Analysis, Professional Publications

Web links and Video Lectures (e-Resources):

- .Websites Recommended: www.finmin.nic.in ,
- www.rbi.org.in ,
- www.planningcommission.nic.in

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Analyze real-world case studies where companies made significant economic decisions, such as pricing strategies or market entry/exit, and discuss the outcomes and lessons learned.
- Create a simulated business scenario where students develop and interpret cash flow diagrams, calculate the time value of money, and compare repayment schedules for loans with different interest rates.
- Conduct a hands-on workshop where students evaluate various engineering projects using present worth, annual worth, and rate of return analyses, allowing them to compare and select the most viable project.

Sensors and actuators		Semester	VI
Course Code	**BMR657B**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	0:2:0:0	SEE Marks	50
Total Hours of Pedagogy	30	Total Marks	100
Credits	01	Exam Hours	1
Examination nature (SEE)	Theory/practical/Viva-Voce /Term-work/Others		

Course objectives:

- To provide the fundamental knowledge about sensors and measurement system.
- To impart the knowledge of static and dynamic characteristics of instruments and understand the factors in selection of instruments for measurement.
- To discuss the principle, design and working of transducers for the measurement of physical time varying quantities.
- To Understand the working of various actuators suitable in industrial process control systems

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method
3. Adopt flipped classroom teaching methods.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information

Module-1

Sensors and measurement system: Sensors and transducers, Classifications of transducers-primary & secondary, active & passive, analog and digital transducers. Smart sensors.
Measurement: Definition, significance of measurement, instruments and measurement systems. Mechanical, electrical and electronic instruments.

Module-2

Static and Dynamic Characteristics: Static calibration and error calibration curve, accuracy and precision, indications of precision, static error, scale range and scale span, factors influencing the choice of transducers/instruments.
Dynamic response – Dynamic characteristics, natural frequency and Damping ratio.

Module-3

Measurement of Temperature: RTD, Thermistor, Thermocouple, Thermopile, AD590.
Measurement of Displacement: Introduction, Principles of Transduction, Variable resistance devices, variable Inductance Transducer, Variable Capacitance Transducer

Module-4

Measurement of Strain: Introduction, Types of Strain Gauges, Theory of operation of resistance Strain gauges, Applications.

Measurement of Force & Torque: Introduction, Force measuring sensor –Load cells, Hydraulic load cell, electronic weighing system. Torque measurement

Module-5

Actuators and process control system: Introduction. Block diagram and description of process control system with an example, Actuators, Control elements. Electrical actuating systems: Solid-state switches, Solenoids. Pneumatic Actuators, Hydraulic Actuators

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

CO1: Understand the fundamental concepts of sensors and actuator system.(L2)
CO2: Describe the principle and working of different types of sensors and actuators used in industrial application.(L2)
CO3: Illustrate the applications of different transducers for temperature, displacement, level, strain, force and torque measurements

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of 01 mark. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Books

1. Electrical and Electronic Measurements and Instrumentation, A K Sawhney, 17th Edition, (Reprint 2004), Dhanpat Rai & Co. Pvt. Ltd., 2004.
2. Instrumentation: Devices and Systems, C S Rangan, G R Sarma, V S V Mani, 2nd Edition (32 Reprint), McGraw Hill Education (India), 2014.

3. Process Control Instrumentation Technology by C D Johnson, 7th Edition, Pearson Education Private Limited, New Delhi 2002.

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc21_ee32/preview
- https://archive.nptel.ac.in/courses/108/108/108108147/
- https://www.youtube.com/watch?v=HMNYf1QQ83U

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- A small project to use sensors to study home activities.
- Design Smart Digital School Bell with Timetable Display.
- Design contactless water level controller.

DIGITAL MARKETING		Semester	VI
Course Code	**BMR657C**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	0:2:0:0	SEE Marks	50
Total Hours of Pedagogy	30	Total Marks	1
Credits	01	Exam Hours	
Examination nature (SEE)	Theory/practical/Viva-Voce /Term-work/Others		

Course objectives:

- To provide with the knowledge about business advantages of the digital marketing and its importance for marketing success;
- To develop a digital marketing plan;
- To make SWOT analysis; To define a target group;
- To get introduced to various digital channels, their advantages and ways of integration;
- To integrate different digital media and create marketing content;
- To optimize a Website and SEO optimization;
- To create Google AdWords campaigns; social media planning;
- To get basic knowledge of Google Analytics for measuring effects of digital marketing and getting insight of future trends that will affect the future development of the digital marketing.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method
3. Adopt flipped classroom teaching methods.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information

Module-1

Introduction to the Course and Work plan, Introduction of the digital marketing, Digital vs. Real Marketing, Digital Marketing Channels Creating initial digital marketing plan, Content management, SWOT analysis, Target group analysis, Web design, Optimization of Web sites, MS Expression Web

Module-2

SEO Optimization, Writing the SEO content Google AdWords- creating accounts, Google AdWords- types Introduction to CRM, CRM platform, CRM models

Module-3
Introduction to Web analytics, Web analytics – levels, Introduction of Social Media Marketing Creating a Facebook page, Visual identity of a Facebook page, Types of publications Business opportunities and Instagram options, Optimization of Instagram profiles, Integrating Instagram with a Web Site and other social networks, keeping up with posts
Module-4
Business tools on LinkedIn, Creating campaigns on LinkedIn, Analyzing visitation on LinkedIn Creating business accounts on YouTube, YouTube Advertising, YouTube Analytics Facebook Ads, Creating Facebook Ads, Ads Visibility
Module-5
E-mail marketing, E-mail marketing plan, E-mail marketing campaign analysis, keeping up with conversions Digital Marketing Budgeting- resource planning, cost estimating, cost budgeting, cost control
Course outcome (Course Skill Set) At the end of the course the student will be able to: CO1: Identify the importance of the digital marketing for marketing success, [L1] CO2: Explain customer relationships across all digital channels and build better customer relationships[L2] CO3: Analyze a digital marketing plan, starting from the SWOT analysis and defining a target group, then identifying digital channels, their advantages and limitations [L3]
Assessment Details (both CIE and SEE) The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together. **Continuous Internal Examination (CIE)** • For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks. • The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered • Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. • For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment. **Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.** **Semester End Examinations (SEE)** SEE paper shall be set for 50 questions, each of 01 mark. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Books

1. Ryan, D. (2014). Understanding Digital Marketing
2. Marketing Strategies for Engaging the Digital Generation, Kogan Page Limited
3. The Beginner's Guide to Digital Marketing (2015). Digital Marketer
4. Pulizzi,J.(2014) Epic Content Marketing, Mc-graw Hill Education.

Web links and Video Lectures (e-Resources):

- https://learndigital.withgoogle.com/digitalgarage/
- https://academy.hubspot.com/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Create a Social Media Marketing Campaign for the department
- Conduct a Keyword Research Exercise