

RN SHETTY TRUST ®



ESTD.: 2001
An Institute with a Difference

RNS INSTITUTE OF TECHNOLOGY

Autonomous Institution affiliated to Visvesvaraya Technological University, Belagavi

Approved By AICTE, New Delhi. Accredited by NAAC 'A+' Grade

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Dr. R N Shetty
Founder



DEPARTMENT OF MECHANICAL ENGINEERING

BACHELOR OF ENGINEERING

Scheme and Syllabus of V - VIII Semesters

2024 SCHEME



 www.rnsit.ac.in



RN Shetty Trust ®
RNS INSTITUTE OF TECHNOLOGY

An Autonomous Institute under VTU
Accredited with NAAC A+ Grade

Department of Mechanical Engineering (ME)
Autonomous Scheme (Effective from Academic Year 2025 – 26)

Scheme and Syllabus Batch 2024-2028

(As per NEP-2020)
(Effective from the academic year 2025 – 26)

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About RNSIT

RNS Institute of Technology, familiar as RNSIT was established in the year 2001. It is the brainchild of Dr. R. N. Shetty, well known industrialist, and a great philanthropist. The institution was established with a sole purpose of imparting quality education in Engineering, Technology and Management. Being one of the premier engineering colleges in the country RNSIT is marching towards placing itself in the global map by excelling in academics and placements.

Lush green campus, state of the art infrastructure, well equipped laboratories, hundreds of activities, numerous new initiatives, consistent VTU ranks, path breaking placements, cultural extravaganza, Sports events, 4000 + students and 300 + faculty – with all these RNSIT has become dream destination for engineering aspirants across the country.

Vision

Building RNSIT into a World Class Institution

Mission

To impart high quality education in Engineering, Technology and Management with a difference, enabling students to excel in their career by

- Attracting quality Students and preparing them with a strong foundation in fundamentals so as to achieve distinctions in various walks of life leading to outstanding contributions
- Imparting value based, need based, choice based and skill based professional education to the aspiring youth and carving them into disciplined, World class Professionals with social responsibility
- Promoting excellence in Teaching, Research and Consultancy that galvanizes academic consciousness among Faculty and Students
- Exposing Students to emerging frontiers of knowledge in various domains and make them suitable for Industry, Entrepreneurship, Higher studies, and Research & Development
- Providing freedom of action and choice for all the Stakeholders with better visibility

About Mechanical Engineering Department

The department of Mechanical Engineering was started in the year 2011. It provides an outstanding learning environment and it is a regular practice to invite people from industry & academia by arranging guest lectures/ seminars in order to provide an exposure of practical aspects of Mechanical Engineering.

Department has been consistently achieving 95-90% results in VTU examination. Yantra is a department student forum under which technical & cultural activities are conducted annually. In our department students are nurtured to become best engineering professionals in Industry ready. The department regularly organizes workshops and FDP's. The department is fully equipped for effective delivery of courses and Laboratories. The Department organizes regularly Industrial visits and guest lectures by experts in the field of Mechanical engineering. The Department has MoUs with various industries. Many students from our department will make indelible mark nationally and internationally in the field of Mechanical Engineering and make us proud. We have dynamic faculty, whose expertise spans the range of disciplines in design, thermal and production streams. The Department believes in building careers, enriching that lasts a lifetime.

Vision

To excel in mechanical engineering education and nurture technically skilled and socially responsible engineers.

Mission

M-1: To provide state-of-the-art infrastructure facilities with a team of dedicated, experienced faculty by providing ample teaching, learning and research skills.

M-2: To teach the basics of mechanical engineering by using modern tools to solve a variety of problems and do engineering analysis.

M-3: To prepare students for successful careers in India and around the world, meeting the needs of the industry by cultivating skilled graduates.

M-4: To cultivate problem-solving and collaborative abilities in students through their participation in interdisciplinary projects that need teamwork.

M-5: To equip students for lifelong learning by familiarizing them with professional ethics and sustainable development.

Programme Educational Objectives

A Graduate of Mechanical Engineering will be able to:

PEO-1: Mechanical engineering graduates are technical and managerial leaders in design, manufacturing, materials, thermal, automation, and management domains.

PEO-2: Mechanical engineering graduates demonstrate leadership qualities, possess strong communication skills, and are capable of working both collaboratively and independently.

PEO-3: Mechanical engineering graduates engage in professional practices that meet societal needs and environmental concerns while committing to lifelong learning.

Program Outcomes (Revised)

1. **PO1: Engineering Knowledge:** Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.
2. **PO2: Problem Analysis:** Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
3. **PO3: Design/Development of Solutions:** Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)
4. **PO4: Conduct Investigations of Complex Problems:** Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK9).
5. **PO5: Engineering Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)
6. **PO6: The Engineer and The World:** Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).
7. **PO7: Ethics:** Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
8. **PO9: Individual and Collaborative Teamwork:** Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
9. **PO9: Communication:** Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences
10. **PO10: Project Management and Finance:** Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

11. **PO11: Life-Long Learning:** Recognize the need for and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK9)

Programme Specific Outcomes (PSOs)

The Mechanical Engineering graduates will have

PSO-1: To apply specific program principles to design, fabricate, test, operate, or document the basic mechanical systems or processes.

PSO-2: To develop and test the products for quality and functionality as needed by the society from time to time.

PSO-3: To engage in manufacturing or processing such quality products with utmost environment safety and committed for sale of products and provide good service to customer.



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Department of Mechanical Engineering
Autonomous Scheme (Effective from the Academic Year 2024 – 25)

5th – Semester (Mechanical Engineering Stream)													
SL NO	COURSE	COURSE CODE	COURSE TITLE	TD/PSB	TEACHING HOURS PER WEEK			Term work (TW)+ Self learning (SL) per semester	EXAMINATION				CREDITS
					THEORY LECTURE (L)	TUTO RIAL (T)	PRACTIC AL/ DRAWIN G (P)		DURATION IN HOURS	CIE MAR KS	SEE MAR KS	TOTAL MARKS	
1	HSMS	BME501	ENGINEERING ECONOMICS AND FINANCIAL MANAGEMENT	ME	3	2	0	45	3	50	50	100	4
2	IPCC	BME502	FLUID MECHANICS AND TURBO MACHINERY	ME	3	0	2	45	3	50	50	100	4
3	PCC	BME503	MACHINE DESIGN -I	ME	3	2	0	45	3	50	50	100	4
4	PCCL	BMEL504	DIGITAL MANUFACTURING	ME	0	0	2	0	3	50	50	100	1
5	PEC	BME515x	PROFESSIONAL ELECTIVE I (REFER List)	ME	3	0	0	45	3	50	50	100	3
6	PROJ	BME586	MINI PROJECT	ME	0	0	2	30	3	100	0	100	2
7	BSC	BENS507/ BBOE507	ENVIRONMENTAL STUDIES / BIOLOGY FOR ENGINEERS	ANY DEPT	2	0	0	30	2	50	50	100	2
8	AEC	BRMK557	RESEARCH METHODOLOGY AND IPR	ME	2	0	0	30	2	50	50	100	2
9	MC	BNSK559	NATIONAL SERVICE SCHEME(NSS)	NSS coordinator	0	0	2	0		100	0	100	0
		BPEK559	PHYSICAL EDUCATION(PE) (SPORTS AND ATHLETICS)	Physical Education Director									
		BYOK559	YOGA	Yoga Teacher									
	TOTAL									550	350	900	22

PEC (PROFESSIONAL ELECTIVE COURSES)-BME515X	
BME515A	OPERATION RESEARCH
BME515B	INTRODUCTION TO COMPOSITE MATERIALS
BME515C	TOOL DESIGN
BME515D	REFRIGERATION AND AIR CONDITIONING

Note: Courses similar to earlier or later Semester Courses should not be offered

Mini-project work:

- Mini Project is a laboratory-oriented/hands on course that will provide a platform to students to enhance their practical knowledge and skills by the development of small systems/applications etc. Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary Mini- project can be assigned to an individual student or to a group having not more than 4 students.
- CIE procedure for Mini-project: (i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two faculty members of the Department, one of them being the Guide. The CIE marks awarded for the Mini-project work shall be based on the evaluation of the project report, project presentation skill, and question and answer session in the ratio of 50:25:25. The marks awarded for the project report shall be the same for all the batches mates. (ii) Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level with the participation of all the guides of the project. The CIE marks awarded for the Mini-project, shall be based on the evaluation of the project report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates. No SEE component for Mini-Project.

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6th - Semester(Mechanical Engineering Stream)													
SL NO	COURSE	COURSE CODE	COURSE TITLE	TD/PSB	TEACHING HOURS PER WEEK			Term work(TW) + Self learning (SL) per semester	EXAMINATION				CREDITS
					THEORY LECTURE(L)	TUTORIAL (T)	PRACTICAL / DRAWING (P)		DURATION IN HOURS	CIE MARKS	SEE MARKS	TOTAL MARKS	
1	IPCC	BME601	HEAT TRANSFER IN ENGINEERING APPLICATIONS	ME	3	0	2	45	3	50	50	100	4
2	PCC	BME602	MACHINE DESIGN -II	ME	3	2	0	45	3	50	50	100	4
3	PEC	BME613X	PROFESSIONAL ELECTIVE II (REFER LIST)	ME	3	0	0	45	3	50	50	100	3
4	OEC	BME654X	OPEN ELECTIVE (REFER LIST)	ME	3	0	0	45	3	50	50	100	3
5	PROJ	BME685	MAJOR PROJECT PHASE -1	ME	0	0	4	0	3	100	0	100	2
6	PCCL	BMEL606	COMPUTER AIDED MODELLING AND ANALYSIS LAB	ME	0	0	2	0	3	50	50	100	1
7	AEC/SEC	BMET/L657X	Bucket List Provided	ME	IF COURSE IS THEORY				2	50	50	100	1
					1	0	0	15					
					IF COURSE IS PRACTICAL				3				
					0	0	2	0					
8	MC	BIKS608	INDIAN KNOWLEDGE SYSTEM	ANY	1	0	0	0	2	100		100	0
9	MC	BNSK659	NATIONAL SERVICE SCHEME(NSS)	NSS coordinator	0	0	2	0	2	100		100	0

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		BPEK659	PHYSICAL EDUCATION(PE) (SPORTS AND ATHLETICS)	Physical Education Director									
		BYOK659	YOGA	Yoga Teacher									
	TOTAL										600	300	900
											18		

Note: Major Project Phase-I : Students have to discuss with the mentor /guide and with their help he/she has to complete the literature survey and prepare the report and finally define the problem statement for the project work.

Note: Courses similar to earlier or later Semester Courses should not be offered

Bucket List Provided -Professional Elective BME613X	
BME613A	COMPUTER INTEGRATED MANUFACTURING
BME613B	ADDITIVE MANUFACTURING
BME613C	ROBOTICS AND AI
BME613D	BASICS OF CFD

Open Elective BME654X	
BME654A	ENERGY AND ENVIRONMENT
BME654B	RENEWABLE ENERGY POWER PLANTS
BME654C	AUTOMOTIVE ENGINEERING
BME654D	PROJECT MANAGEMENT

AEC/SEC BMET/L657X	
BMEL657A	BASICS OF MAT LAB
BMET657B	INTRODUCTION TO MACHINE LEARNING FOR MECHANICAL ENGINEERS
BMEL657C	INTRODUCTION TO CLOUD-BASED CRM PLATFORM LAB
BMEL657D	IOT LAB

Department of Mechanical Engineering
Autonomous Scheme (Effective from the Academic Year 2024 – 25)

7th – Semester (Mechanical Engineering Stream)													
SL NO	COURSE	COURSE CODE	COURSE TITLE	TD/ PSB	TEACHING HOURS PER WEEK			Term work(TW)+ Self learning(SL) per semester	EXAMINATION				CREDITS
					THEORY LECTURE (L)	TUTORIAL (T)	PRACTICAL/ DRAWING (P)		DURATION IN HOURS	CIE MARKS	SEE MARKS	TOTAL MARKS	
1	PCC	BME701	FINITE ELEMENT METHODS	ME	3	0	2	45	3	50	50	100	4
2	IPCC	BME702	INDUSTRIAL AUTOMATION WITH HYDRAULICS & PNEUMATICS	ME	3	0	2	45	3	50	50	100	4
3	PCC	BME703	CONTROL ENGINEERING	ME	3	2	0	45	3	50	50	100	4
4	PEC	BME714 X	PROFESSIONAL ELECTIVE (PROVIDE LIST)	ME	3	0	0	45	3	50	50	100	3
5	OEC	BME755 X	OPEN ELECTIVE (PROVIDE LIST)	RES DEP	3	0	0	45	3	50	50	100	3
6	PROJ	BME786	MAJOR PROJECT PHASE-2	ME	0	0	12	0	3	100	100	200	6
TOTAL										350	350	700	24

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PROVIDE BUCKET LIST

Professional Elective BME714X			
BME714A	TRIBOLOGY	BME714C	ENTREPRENEURSHIP & DEVELOPMENT
BME714B	POWER PLANT ENGINEERING	BME714D	TOTAL QUALITY MANAGEMENT

Open Elective BME755X			
BME755A	OPERATION RESEARCH	BME755C	SOLAR ENERGY & AUTONOMOUS VEHICLES
BME755B	MECHATRONICS & MICROPROCESSOR	BME755D	NON TRADITIONAL MACHINING

Note: Courses similar to earlier or later Semester Courses should not be offered

MAJOR PROJECT PHASE-II: The objective of the Project work is

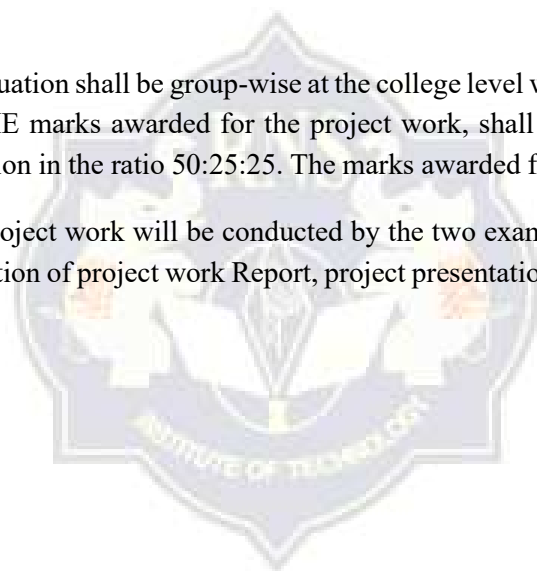
- (i) To encourage independent learning and the innovative attitude of the students.
- (ii) To develop interactive attitude, communication skills, organization, time management, and presentation skills.
- (iii) To impart flexibility and adaptability.
- (iv) To inspire team working.
- (v) To expand intellectual capacity, credibility, judgment and intuition.
- (vi) To adhere to punctuality, setting and meeting deadlines.
- (vii) To install responsibilities to oneself and others.
- (viii) To train students to present the topic of project work in a seminar without any fear, face the audience confidently, enhance communication skills, involve in group discussion to present and exchange ideas.

CIE procedure for Project Work:

(1) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide. The CIE marks awarded for the project work, shall be based on the evaluation of the project work Report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

(2) Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable. The CIE marks awarded for the project work, shall be based on the evaluation of project work Report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

SEE procedure for Project Work: SEE for project work will be conducted by the two examiners appointed by the University. The SEE marks awarded for the project work shall be based on the evaluation of project work Report, project presentation skill, and question and answer session in the ratio 50:25:25.



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8th - Semester(Mechanical Engineering Stream)													
SL NO	COURSE	COURSE CODE	COURSE TITLE	TD/ PSB	TEACHING HOURS PER WEEK			Term work (TW)+ Self learning(SL) per semester	EXAMINATION				CREDITS
					THEORY LECTURE(L)	TUTORIAL (T)	PRACTICAL/ DRAWING (P)		DURATION IN HOURS	CIE MARKS	SEE MARKS	TOTAL MARKS	
1	PEC	BME811X	PROFESSIONAL ELECTIVE (PROVIDE LIST) (ONLINE)	ME	3	0	0	45	3	50	50	100	3
2	OEC	BME852X	OPEN ELECTIVE (PROVIDE LIST)(ONLINE)	ME	3	0	0	45	3	50	50	100	3
3	INT	BME803	INTERNSHIP (INDUSTRY/RESEARCH-MINIMUM 14 WEEKS)	ME	0	0	20	0	3	100	100	200	10
TOTAL										200	200	400	16

PROVIDE BUCKET LIST

Professional Elective BME811X			
BME811A	Quality Design & Control (Available in NPTEL)	BME811C	Machinery Fault Diagnosis and Signal Processing (Available in NPTEL)
BME811B	Modelling & Analytics for Supply Chain Management (Available in NPTEL)	BME811D	Strategies for Sustainable Design (Available in NPTEL)

Open Elective BXX852X			
BME852A	Fundamentals of Automotive systems (Available in NPTEL)	BME852C	Product Design and Manufacturing (Available in NPTEL)
BME852B	Computer Integrated Manufacturing (Available in NPTEL)	BME852D	Business Planning & Project Management (Available in Swayam Portal)

Note: Courses similar to earlier or later Semester Courses should not be offered



CORE COURSES V SEMESTER

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B.E. (Mechanical Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER - V			
COURSE TITLE	ENGINEERING ECONOMICS AND FINANCIAL MANAGEMENT		
COURSE CODE	BME501	CIE MARKS	50
L : T : P : S	3 : 2 : 0 : 0	SEE MARKS	50
CREDITS	04	EXAM HOURS	03
TOTAL HOURS OF PEDAGOGY	45 hours	Total Marks	100
COURSE LEARNING OBJECTIVES: The purpose of the course is to facilitate the learner to: ➤ To understand financial statements and profit planning concepts. ➤ To understand budgeting methods and budgetary control. ➤ To understand basic economic principles and interest calculations. ➤ To impart knowledge with respect to investment evaluation techniques and rate of return. ➤ To help students learn costing methods, depreciation, and taxation concepts			
MODULE – 1			9 Hours
Statements of Financial Information: Introduction, Source of financial information, financial statements, Balance sheet, Profit and Loss account, relation between Balance sheet and Profit and Loss account. Introduction, Financial planning, Profit planning, Objectives of profit planning, Essentials of profit planning, Introduction to a financial accounting software. Simple Numerical Teaching Learning Process: Chalk and Talk/PPT			
MODULE – 2			9 Hours
Budget administration: type of budgets, preparation of budgets, advantages, problems and dangers of budgeting. Introduction to Bench Marking of Manufacturing Operation. Types of budgets – Flexible budgets, preparation of cash budgets, purchase and production budgets and master budget, Budgetary control, advantages & limitations of budgeting. Simple numerical Teaching Learning Process: Chalk and Talk/PPT			
MODULE – 3			9 Hours
Introduction to Engineering economics: Laws of demand and supply, Difference between Microeconomics & Macroeconomics, elasticity of demand, price elasticity, income elasticity. Law of Returns, Interest and interest factors, simple interest and compound interest, Cash flow diagrams, personal loans and EMI payment calculation with flexible interest rates, Simple numerical Teaching Learning Process: Chalk and Talk/PPT			
MODULE – 4			9 Hours
Present, future and annual worth and rate of returns: Basic present worth comparisons, Present worth- equivalence, Assets with unequal lives and infinites lives, future worth comparisons, payback comparisons, Equivalent annual worth comparisons, situations for annual worth comparisons. Simple numerical Teaching Learning Process: Chalk and Talk/PPT			
MODULE – 5			9 Hours
Costing and depreciation: Components of costs, estimation of selling price, marginal cost, first cost, all kinds of overheads, indirect cost estimation with depreciation, mensuration and estimation of material cost, cost estimation of mechanical process, Product costing (approaches to product costing), causes of			

depreciation, methods of computing depreciation charges, straight line method, declining balance method, sum of years method, service output methods, taxation concepts, personal income taxes and corporate taxes,. Simple numerical

Teaching Learning Process: Chalk and Talk/PPT

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Explain financial statements and basic profit planning
CO2	Develop and analyse budgets and budgetary control systems
CO3	Apply economic principles, interest, and cash flow analysis.
CO4	Evaluate investments using worth and rate of return methods.
CO5	Analyse costs, estimate pricing, and compute depreciation and taxes.

2, 3 and 4-Credit Theory Courses			
Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
- The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE. - If any courses of 3 credits are of Integrated Course type, for such courses the method suggested for 4 credits IPCC shall be followed.			

Suggested Learning Resources:

Text Books:

- Mechanical Estimation T.R. Banga & S.C. Sharma Khanna Publishers 17th Edition, 2015

2. Engineering Economy Riggs J.L McGraw Hill 4th Edition
3. Financial Management, Khan & Jain, text & problems TMH ISBN 0-07-460208-A. 20001
4. Financial Accounting, Costing and Management Accounting, S. M. Maheshwari, 2000

Reference Books:

1. Engineering Economy William G. Sullivan, Elin M. Wicks & Joseph H. Wilck Pearson 18th Edition, 2024
2. Engineering Economics R. Panneerselvam PHI 2nd Edition
3. Engineering Economics: Text & Cases D.N. Dwivedi, H.L. Bhatia & S.N. Maheshwari Vikas Publishing 2024 Edition

Web links and video lectures (E-Resources):

1. <https://freevideolectures.com/course/4861/nptel-engineering-economic-analysis>
2. <https://www.classcentral.com/course/youtube-financial-management-for-managers-47463>

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

1. Term Projects
2. Course seminar



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B.E. (Mechanical Engineering)			
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)			
SEMESTER –V			
Course Title:	FLUID MECHANICS AND TURBO MACHINERY		
Course Code:	BME502	CIE MARKS	50
L : T : P: S	3:0:2:0	SEE MARKS	50
Credits:	04	EXAM HOURS	03
Total Hours of Pedagogy	45 hours Theory+ 10 to 12 Lab slots	Total Marks	100
COURSE LEARNING OBJECTIVES: The purpose of the course is to facilitate the learner to:			
➤ To have a working knowledge of the basic properties of fluids and understand the continuum approximation. ➤ To understand the flow characteristic and dynamics of flow field for various Engineering applications. ➤ Understand typical construction of a Turbo machine, their working principle, application and conversion of fluid energy to mechanical energy in Turbo machine with utilization factor and degree of reaction. ➤ Understand the concept of dynamic similarity and how to apply it to experimental modelling. ➤ Understand the working principle of hydraulic turbines and centrifugal pumps ➤ Understand the working principle of centrifugal fans, blowers and steam turbine.			
MODULE – 1		(9 hours)	
BASICS OF FLUID MECHANICS: Introduction, Properties of fluids-mass density, weight density, specific volume, specific gravity, viscosity, surface tension, capillarity, vapour pressure, compressibility and bulk modulus. Concept of continuum, types of fluids etc, pressure at a point in the static mass of fluid, variation of pressure, Pascal’s law, Absolute, gauge, atmospheric and vacuum pressures pressure measurement simple, differential manometers.			
FLUID KINEMATICS: Types of Flow-steady, unsteady, uniform, non-uniform, laminar, turbulent, one, two and three dimensional, compressible, incompressible, rotational, irrotational, streamlines, path lines, streak lines, continuity equation in Cartesian co-ordinates.			
Teaching Learning Process: Chalk and Talk / PPT			
MODULE – 2		(9 hours)	
FLUID DYNAMICS: Momentum equation, Impacts of jets- force on fixed and moving vanes, flat and Curved (no numerical). Euler’s equation, Integration of Euler’s equation to obtain Bernoulli’s equation, Bernoulli’s theorem, Application of Bernoulli’s theorem such as venturi meter, orifice meter.			
DIMENSIONAL ANALYSIS: Derived quantities, dimensions of physical quantities, dimensional homogeneity, Rayleigh method, Buckingham Pi-theorem, dimensionless numbers (No numericals)			
Teaching Learning Process: Chalk and Talk / PPT			
MODULE – 3		(9 hours)	
INTRODUCTION TO TURBO MACHINES:			
Definition of turbo machine, parts of turbo machines, Classification, Dimensionless parameters and their significance, Unit and specific quantities, model studies and its numerical.			

Energy exchange in Turbo machines:

Euler's equation, Velocity triangles for different values of degree of reaction, Components of energy transfer, Degree of Reaction, utilization factor, Relation between degree of reaction and Utilization factor, Problems.

Teaching Learning Process: Chalk and Talk / PPT

MODULE – 4

(9 hours)

HYDRAULIC TURBINES:

Classification of hydraulic turbines, Various heads and efficiencies, working principle, Velocity triangles, work done, efficiencies etc in Pelton wheel, Francis turbine and Kaplan turbine. Types of Draft tubes and its functions.

CENTRIFUGAL PUMPS:

Main Parts of centrifugal pump, Various heads and efficiencies, work done, minimum speed for starting centrifugal pump, Classifications- Performance characteristics of centrifugal pumps, Cavitation in pumps and NPSH.

Teaching Learning Process: Chalk and Talk / PPT

MODULE – 5

(9 hours)

STEAM TURBINES:

Classification, Single stage impulse turbine, condition for maximum blade efficiency, stage efficiency, Need and methods of compounding, Multi-stage impulse turbine, expression for maximum utilization factor, Numerical

Reaction turbine: Parsons's turbine, condition for maximum utilization factor, reaction staging. Numerical.

Loss of head due to friction in pipes, Major and minor losses, pipes in series and parallel.(Only for CIE).

Teaching Learning Process: Chalk and Talk / PPT

PRACTICAL COMPONENT OF IPCC

Sl. No.	Experiments
1	Determine the viscosity of oil using Red wood viscometer and Say-bolt viscometer.
2	Working principle of different flow meters and their calibration (orifice plate, venture meter)
3	Impact of jet on flat and curved plates
4	Performance analysis of Pelton Wheel
5	Performance analysis of Francis turbine
6	Performance analysis of Kaplan turbine
7	Performance analysis of centrifugal pump
8	Major and Minor losses experiments

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Identify and calculate the key fluid properties used in the analysis of fluid behaviour.
CO2	Apply the knowledge of fluid dynamics while addressing problems of mechanical and chemical engineering. Apply dimensional analysis to form dimensionless numbers in terms of input output variables.

CO3	Explain the construction, classification and working principle of the Turbo machines and apply of Euler's turbine equation to evaluate the energy transfer and other related parameters.
CO4	Classify, explain and analyse the various types of hydraulic turbines and centrifugal pumps.
CO5	Classify, explain and analyse various types of steam turbines.

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE- IA Tests (A)	20	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 20 marks.
Continuous and Comprehensive Evaluation (B)	10	-	Any one Assessment methods as per 24RNBE4.2 scaled to 10 marks.
Total CIE Theory (A+B)	30	12	Marks of Tests and Assignments awarded for a maximum of 30.
CIE Practical	12	-	Marks awarded for Weekly Conduction of Experiments and Submission of Laboratory records, scaled to 12 marks.
CIE Practical Test	8	-	Average of marks of Two tests, each conducted for 100 marks covering all experiments, scaled to 8.
Total CIE Practical (C)	20	8	Marks of Experiments, Record and Test awarded for a maximum of 20 marks.
CIE: Theory + Practical (A + B + C)	50	20	CIE Evaluation is done for a maximum of 50 marks.
SEE (D)	50	18	SEE is a theory exam, conducted for 100 marks and scaled down to 50 marks. Exam duration shall before 3 hours.
CIE+SEE (A+B+C+D)	100	40	Final marks shall be the sum of marks scored in Components A, B, C and D



- The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included in their respective modules only.

Suggested Learning Resources:

Reference Books

1. A textbook of Fluid Mechanics and Hydraulic Machines, Dr. R K Bansal, Laxmi publishers. 11th Edition (2024–2025)
2. Cimbala, J.M., Cengel, Y. A. , Fluid Mechanics: Fundamentals and Applications, McGraw-Hill. 5th Edition (2025-2026).
3. Frank M White., Fluid Mechanics, 9th Edition (2022), McGraw-Hill.
V. Kadambi and Manohar Prasad, An Introduction to Energy Conversion, Volume III, Turbo machinery, New Age International Publishers, reprint 2008.

Reference Books

1. M. S. Govinde Gowda, A Text of Turbo machines, 1st Edn, 2024, Iterative International Publishers (IIP), ISBN: 978-93-6252-884-1.
2. B.K Venkanna, Fundamentals of Turbo Machinery, PHI Publishers

Web links and Video Lectures (e-Resources):

- NPTEL Video Course: NOC: Fluid Dynamics and Turbomachines
- NPTEL Video Course: Introduction to Turbomachines

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

- Fluid Properties & Pressure Measurement Demonstration Activity
- Flow Visualization & Continuity Equation Activity Turbomachines & Pump Performance Analysis Activity

ESTD : 2001

An Institute with a Difference

B.E. (Mechanical Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – V			
COURSE TITLE	MACHINE DESIGN-I		
COURSE CODE	BME503	CIE MARKS	50
L : T : P : S	3 : 2 : 0 : 0	SEE MARKS	50
CREDITS	04	EXAM HOURS	03
TOTAL HOURS OF PEDAGOGY	45 hours	Total Marks	100
COURSE LEARNING OBJECTIVES: The student will be able: ➤ To understand the various steps involved in the Design Process. ➤ To explain the principles involved in design of machine elements, subjected to different kinds of forces, from the considerations of strength, rigidity, functional and manufacturing requirements. ➤ To understand and interpret different failure modes and application of appropriate criteria for design of machine elements. ➤ To learn to use national and international standards, standard practices, standard data, catalogs, and standard components used in design of machine elements. ➤ Develop the capability to design elements like shafts, couplings, welded joints, screwed joints, and power screws.			
MODULE – 1			9 Hours
Introduction: Design Process: Definition of design, phases of design, and review of engineering materials and their properties and manufacturing processes; use of codes and standards, selection of preferred sizes. Review of axial, bending, shear and torsion loading on machine components, combined loading, two-dimensional stresses, principal stresses.			
Design for static strength: Factor of safety and service factor. Failure mode: definition and types, Failure of brittle and ductile materials; even and uneven materials; Theories of failure: maximum normal stress theory, maximum shear stress theory, distortion energy theory, strain energy theory, Columba – Mohr theory and modified Mohr's theory.			
<i>Teaching Learning Process: Chalk and Talk</i>			
MODULE – 2			9 Hours
Stress concentration: Introduction, stress concentration factor and methods of reducing stress concentration.			
Fatigue loading: Introduction to fatigue failure, Mechanism of fatigue failure, types of fatigue loading, S-N Diagram, Low cycle fatigue, High cycle fatigue, Endurance limit. Modifying factors: size effect, surface effect, Stress concentration effects Notch sensitivity, Soder berg and Goodman relationships, stresses due to combined loading.			
<i>Teaching Learning Process: Chalk and Talk</i>			
MODULE – 3			9 Hours
Design of shafts: Torsion of shafts, solid and hollow shaft design with steady loading based on strength and rigidity, ASME and BIS codes for power transmission shafting, design of shafts subjected to combined bending, torsion and axial loading. Design of shafts subjected to fluctuating loads.			

Design of keys and couplings: Keys: Types of keys and their applications, design considerations in parallel and tapered sunk keys, Design of square and rectangular sunk keys. Couplings: Rigid and flexible coupling-types and applications, design of Flange coupling.

Teaching Learning Process: Chalk and Talk

MODULE – 4

9 Hours

Design of Permanent Joints: Types of permanent joints-Riveted and Welded Joints. Riveted joints: Types of rivets, rivet materials, Caulking and fullering, analysis of riveted joints, joint efficiency, failures of riveted joints, boiler joints, riveted brackets.

Welded joints: Types, strength of butt and fillet welds, eccentrically loaded welded joints

Teaching Learning Process: Chalk and Talk

MODULE – 5

9 Hours

Design of Temporary Joints: Types of temporary joints- cotter joints, knuckle joint and fasteners. Design of Cotter and Knuckle Joint.

Power screws: Mechanics of power screw, stresses in power screws, efficiency and self-locking, design of power screws.

Teaching Learning Process: Chalk and Talk

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Apply fundamental design principles, stress analysis methods, and theories of failure to design machine components under static loading conditions.
CO2	Analyze and design machine components subjected to impact and fatigue loading using appropriate fatigue theories and design criteria.
CO3	Design shafts, keys, and couplings for power transmission systems considering steady, combined, and fluctuating loads as per relevant standards.
CO4	Analyze and design riveted and welded permanent joints to ensure adequate strength and joint efficiency under various loading conditions.
CO5	Design cotter joints, knuckle joints, threaded fasteners, and power screws to withstand static, dynamic, and eccentric loading safely and efficiently.

2, 3 and 4-Credit Theory Courses			
Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.

Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
- The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE. - If any courses of 3 credits are of Integrated Course type, for such courses the method suggested for 4 credits IPCC shall be followed.			

Suggested Learning Resources:

Text Books:

- Shigley's Mechanical Engineering Design Richard G. Budynas, and J. Keith Nisbett McGraw-Hill Education 10th Edition, 2015
- Fundamentals of Machine Component Design Juvinall R.C, and Marshek K.M John Wiley & Sons Third Edition 2007 Wiley student edition
- Design of Machine Elements V. B. Bhandari Tata McGraw Hill 4th Ed 2016

Reference Books:

- Machine Design- an integrated approach Robert L. Norton Pearson Education 2nd edition
- Design and Machine Elements Spotts M.F., Shoup T.E Pearson Education 8th edition, 2006
- Machine design Hall, Holowenko, Laughlin (Schaum's Outline Series adapted by S.K.Somani Tata McGraw Hill Publishing Company Ltd Special Indian Edition, 2008
- Elements of Machine Design H.G.Patil, S.C.Pilli, R.R.Malagi, M.S.Patil IK International First edition, 2019
- Hand book of Mechanical Design G. M. Maithra and L.V.Prasad Tata McGraw Hill 2nd edition, 2004

Design Data Hand Books:

- Design Data Hand Book, K.Lingaiah, McGraw Hill, 2nd edition, 2003
- Design Data Hand Book, K.Mahadevan and Balaveera Reddy, CBS publication
- Design Data Hand Book, H.G.Patil, I.K.International Publisher, 2010
- PSG Design Data Hand Book, PSG College of technology, Coimbatore

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

- Term Projects
- Course seminar

B.E. (Mechanical Engineering)			
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)			
SEMESTER – V			
Course Title:	DIGITAL MANUFACTURING LAB		
Course Code:	BMEL504	CIE MARKS	50
L : T : P + (SL)	0 : 0 : 2	SEE MARKS	50
Credits:	1	EXAM HOURS	3
Total hours of Pedagogy	15 sessions	TOTAL MARKS	100
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> ➤ To expose the students to the techniques of CNC programming and cutting tool path generation through CNC simulation software by using G-Codes and M-codes. ➤ To educate the students on the usage of CAM packages. ➤ To expose the students on the usage of 3D Printing Technology ➤ To make the students understand the importance of automation in industries through exposure to FMS, Robotics, and Hydraulics and Pneumatics.			
Sl. No	Experiments		
1.	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.		
2.	CNC part programming using CAM packages: Simulation of Turning simulations to be carried out using simulation packages like: Cadem CAM Lab-Pro, Master-CAM.		
3.	CNC part programming using CAM packages: Simulation of Drilling simulations to be carried out using simulation packages like: Cadem CAM Lab-Pro, Master-CAM.		
4.	CNC part programming using CAM packages: Simulation of Milling simulations to be carried out using simulation packages like: Cadem CAM Lab-Pro, Master-CAM.		
5.	Internal and external threading : Write a CNC program to create internal and external threading on a cylindrical blocks		
6.	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)		
7.	Assembly Model-1: Creating an 3D CAD model of NUT and Bolt (example size M12x50), print the model using any 3D Printer and Check the assembly		
Demonstration Experiments (For CIE)			
8.	Pneumatics and Hydraulics, Electro-Pneumatics: 3 typical experiments on Basics of these topics to be conducted.		
9.	FMS (Flexible Manufacturing System): Programming of Automatic storage and Retrieval system (ASRS) and linear shuttle conveyor Interfacing CNC lathe, milling with loading unloading arm and ASRS to be carried out on simple components.		
10.	Simple strength testing of 3D Printed Parts		

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Students will have knowledge of G-code and M-code for machining operations.
CO2	Students will able to perform CNC programming for turning, drilling, milling and threading operation.

CO3	Students will able to visualize the 3D models using CAD software's
CO4	Students will able to use 3D printing technology
CO5	Students are able to understand FMS

1-Credit Lab Course			
Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE Practical (A)	30	-	Marks awarded for Weekly Conduction of Experiments and Submission of Laboratory records, scaled to 30 marks.
CIE Practical Test (B)	20	-	Average of marks of Two tests, each conducted for 100 marks covering all experiments, scaled to 20.
Total CIE Practical (A+B)	50	20	Sum of Marks of Experiments, Record and Test shall be CIE marks awarded for a maximum of 50.
SEE (C)	50	20	SEE is a lab exam, conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

SUGGESTED LEARNING RESOURCES: https://nptel.ac.in/courses/112102103 https://onlinecourses.nptel.ac.in/noc19_me46/preview https://nptel.ac.in/courses/112103306 https://archive.nptel.ac.in/courses/112/105/112105211/ https://onlinecourses.nptel.ac.in/noc20_me50/preview
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Department of Mechanical Engineering (ME)
Autonomous Scheme (Effective from Academic Year 2024 – 25)

PROFESSIONAL ELECTIVE-I V- SEMESTER

ESTD : 2001

An Institute with a Difference

B.E. (Mechanical Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – V			
COURSE TITLE	OPERATIONS RESEARCH		
COURSE CODE	BME515A	CIE MARKS	50
L : T : P : S	3 : 0 : 0 : 0	SEE MARKS	50
CREDITS	03	EXAM HOURS	03
TOTAL HOURS OF PEDAGOGY	45 hours	Total Marks	100
COURSE LEARNING OBJECTIVES: The purpose of the course is to facilitate the learner to: ➤ Understand the meaning, definitions, scope, need, phases and techniques of operations research. ➤ Summarize the optimal solutions to linear programming problems by graphical method, Simplex method. ➤ Develop the optimum solutions for transportation, Assignment and travelling salesman problems. ➤ Explore and Construct network diagrams and determine critical path, floats for deterministic and PERT networks including crashing of Networks ➤ Compare minimum processing times for sequencing of n jobs-2 machines, n jobs-3 machines, n jobs-m machines and 2 jobs-n machines using Johnson's algorithm			
MODULE – 1			9 Hours
INTRODUCTION: Evolution of OR, Definitions of OR, Scope of OR, Applications of OR, Phases in OR study. Characteristics and limitations of OR. FORMULATION: Linear Programming Problem (LPP), Generalized LPP- Formulation of problems as L.P.P. Solutions to LPP by graphical method (Two Variables) Teaching Learning Process: Chalk and Talk/PPT			
MODULE – 2			9 Hours
LPP: Simplex method, Canonical and Standard form of LP problem, slack, surplus and artificial Variables, Solutions to LPP by Simplex method, Degeneracy in LPP. Concept of Duality, writing Dual of given LPP. Solutions to L.P.P by Dual Simplex Method. Teaching Learning Process: Chalk and Talk/PPT			
MODULE – 3			9 Hours
TRANSPORTATION PROBLEM: Formulation of transportation problem, types, initial basic feasible solution using North-West Corner rule, Vogel's Approximation method. Optimality in Transportation problem by Modified Distribution (MODI) method. ASSIGNMENT PROBLEM- Formulation, Solutions to assignment problems by Hungarian method, unbalanced, Maximization assignment problems. Travelling Salesman Problem (TSP). Teaching Learning Process: Chalk and Talk/PPT			
MODULE – 4			9 Hours
NETWORK ANALYSIS: Introduction, Construction of networks, Fulkerson's rule for numbering the nodes, AON and AOA diagrams; Critical path method to find the expected completion time of a project,			

determination of floats in networks, PERT networks, determining the probability of completing a project, predicting the completion time of project; Cost analysis in networks.

QUEUING THEORY: Queuing systems and their characteristics, Pure-birth and Pure-death models (only equations), Kendall & Lee's notation of Queuing, empirical queuing models – Numerical on M/M/1 and M/M/C Queuing models.

Teaching Learning Process: Chalk and Talk/PPT

MODULE – 5

9 Hours

GAME THEORY: Definition, Pure Strategy problems, Saddle point, Max-Min and Min-Max criteria, Principle of Dominance, Solution of games with Saddle point. Mixed Strategy problems. Solution of $2 \times n$ and $m \times 2$ games by graphical method.

SEQUENCING: Basic assumptions, Johnson's algorithm, sequencing 'n' jobs on single machine using priority rules, sequencing using Johnson's rule-'n' jobs on 2 machines, 'n' jobs on 3 machines, 'n' jobs on 'm' machines. Sequencing of 2 jobs on 'm' machines using graphical method.

Teaching Learning Process: Chalk and Talk/PPT

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Understand the meaning, definitions, scope, need, phases and techniques of operations research.
CO2	Summarize the optimal solutions to linear programming problems by graphical method, Simplex method.
CO3	Develop the optimum solutions for transportation, Assignment and travelling salesman problems.
CO4	Explore and Construct network diagrams and determine critical path, floats for deterministic and PERT networks including crashing of Networks
CO5	Compare minimum processing times for sequencing of n jobs-2 machines, n jobs-3 machines, n jobs-m machines and 2 jobs-n machines using Johnson's algorithm

2, 3 and 4-Credit Theory Courses			
Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.



Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
- The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE. - If any courses of 3 credits are of Integrated Course type, for such courses the method suggested for 4 credits IPCC shall be followed.			

Suggested Learning Resources:

Text Books:

- Operations Research, P. K. Gupta and D. S. Hira, S. Chand and Company LTD. Publications, New Delhi – 2022
- Operations Research, An Introduction, Eleventh Edition, Hamdy A. Taha, Pearson Education, 2022

Reference Books:

- Operations Research, Theory and Applications, Sixth Edition, J K Sharma, Trinity Press, Laxmi Publications Pvt. Ltd., New Delhi – 2024
- Operations Research, Third Edition, R. Panneerselvam, PHI Learning Pvt. Ltd., New Delhi – 2023
- Operations Research, Second Edition, A M Natarajan and P Balasubramani, Pearson Education, New Delhi – 2014
- Introduction to Operations Research, Twelfth Edition, Hillier and Lieberman, McGraw Hill, New York – 2024

Web links and video lectures (E-Resources):

- <https://elearn.nptel.ac.in/shop/nptel/operations-research/>
- <https://www.digimat.in/nptel/courses/video/112106134/112106134.html>

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

- Term Projects
- Course seminar

B.E. (Mechanical Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER –V			
Course Title:	INTRODUCTION TO COMPOSITE MATERIALS		
Course Code:	BME515B	CIE MARKS	50
L : T : P + (SL)	3:0 :0 (45 Hours/Sem)	SEE MARKS	50
Credits:	03	EXAM HOURS	03
Total Hours of Pedagogy	45 hours Theory	Total Marks	100
COURSE LEARNING OBJECTIVES: The purpose of the course is to facilitate the learner to: ➤ To get an understanding about what composite materials are and how they are classified. ➤ To study the manufacturing methods for producing PMC's and MMC's ➤ To study the various physical, mechanical and elevated temperature properties of MMC's ➤ To study the different machining/ joining and recycling methods used for composites			
MODULE – 1			(9 hours)
Introduction to composite Materials: Definition and Classification of composites based on matrix and reinforcement, Characteristics of composite Materials, Role of Matrix and Reinforcements, Fibrous composites, Laminated Composites and Particulate composites Factors which determine the properties of composites, Benefits of composites. Properties and types of matrices and reinforcements, Interface in composites, types and bonds at the interface Teaching Learning Process: Chalk and Talk / PPT			
MODULE – 2			(9 hours)
MANUFACTURING PROCESS FOR MMC'S: Introduction, Metallic matrices, Classification of MMC's, Need for production of MMC's, Interface Reactions, Processing methods like powder metallurgy, diffusion bonding. Melt Stirring, Compo/Rheo Casting, Squeeze casting, Liquid melt Infiltration, spray deposition and In-situ Processes Properties of MMC's: Physical, Mechanical, Wear, Machinability and other properties. Effect of Size, Shape and distribution of particulate on properties) Teaching Learning Process: Chalk and Talk / PPT			
MODULE – 3			(9 hours)
Polymer Matrix Composites (PMC): Processing of PMC's; Processing of Thermoset Matrix Composites, Thermoplastic Matrix Composites, Sheet Moulding Compound and carbon reinforced polymer composites. Interfaces in PMC's, Structure & Properties of PMC's, applications. FIBER REINFORCED PLASTIC PROCESSING: Layup and curing, fabricating process- open and closed mould process- hand layup techniques, structural laminate bag molding, production procedures for bag molding- filament winding, pultrusion, pulforming, thermo-forming, injection, injection molding, liquid molding, blow molding Teaching Learning Process: Chalk and Talk / PPT			

MODULE – 4	(9 hours)
Introduction, types of ceramic matrices, Advantages of CMC's over other composites, Processing of CMC's: Cold Pressing & Sintering, Hot Pressing, Reaction Bonding Processes, Infiltration, Directed Oxidation, In Situ Chemical Reaction Technique, Sol-Gel, Polymer Infiltration & Pyrolysis, Electrophoretic Deposition, Self-Propagating High Temperature Synthesis. Application of Composites: Automobile, Aircrafts, missiles, Space hardware, Electrical and electronics, marine, recreational and Sports equipment, future potential of composites. Teaching Learning Process: Chalk and Talk / PPT	
MODULE – 5	(9 hours)
FABRICATION OF COMPOSITES: Cutting and Machining of Composites: Water jet cutting, Laser Beam Cutting, Reciprocating Knife Cutting, Cutting of Cured Composite, Abrasive water jet cutting. Joining of Composites: Mechanical Fastening, Adhesive Bonding and Welding processes Recycling of Composite Materials: Introduction, Definition, Need of recycling of composites, Classification of recycling methods (Mechanical, Thermal and Chemical recycling) and its working mechanisms, Applications of recycled composites and case studies. Teaching Learning Process: Chalk and Talk / PPT	

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Describe the properties and synthesis of fibre reinforcements, matrix materials and identify matrix-reinforcement combination for given engineering application
CO2	Select an appropriate MMC's synthesizing process for engineering applications such as Filters, Piston, Bearings, connecting rod etc., conforming to given specifications and also compare the advantages of MMC's with monolithic materials.
CO3	Identify and select a suitable manufacturing technique for FRP's with an understanding the limitations of the technique
CO4	Identify and describe the processing methods employed in CMC's to achieve machining in composites.
CO5	Identify and describe the joining and recycling methods employed in composite

2, 3 and 4-Credit Theory Courses			
Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.

Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.

- The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.
- If any courses of 3 credits are of Integrated Course type, for such courses the method suggested for 4 credits IPCC shall be followed.

Suggested Learning Resources:

Text Books

1. Composite Science and Engineering By K.K.Chawala Springer Verlag 1998.
2. Introduction to composite materials by Hull and Clyne, Cambridge University Press, 2nd edition, 1990
3. Composite Materials: Engineering and Science – F. L. Mathew and R. D. Rawlings, Woodhead Publishing Limited

Reference Books

1. Meing Schwaitz, “Composite materials hand book”, McGraw Hill Book Company. 1984
2. Composite Materials – Production Properties, Testing and Applications – Narosa Publishing House
3. Robert M. Jones, “Mechanics of composite Materials”, McGraw Hill Kogakusha Ltd. 1998.
4. Forming MetalHand Book 9th edition, ASM handbook, and v15. 1988, P327-38.
5. Mechanics of composites by Artar Kaw, CRC Press. 2002.
6. Composite materials By S.C. Sharma Narora Publishing house, 2000.Principles of Composite Materials Mechanics By Ronald,F. Gibson,Mc Graw Hill Interanational,1994

Web links and Video Lectures (e-Resources):

1. VTU, E- learning
2. NPTEL Courses: Composite Materials and Manufacturing
3. MOOCs: Coursera / edX – Sustainable Materials & Circular Economy

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

1. Case studies
2. Quiz
3. Topic Seminar presentation
4. Assignments

B.E. (Mechanical Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – V			
Course Title:	TOOL DESIGN		
Course Code:	BME515C	CIE MARKS	50
L : T : P + (SL)	3 : 0 : 0 + (45 Hours/Sem)	SEE MARKS	50
Credits:	03	EXAM HOURS	03
Total Hours of Pedagogy	45 hours	Total Marks	100
COURSE LEARNING OBJECTIVES: The purpose of the course is to facilitate the learner to: ➤ To develop capability to design and select single point and multipoint cutting tools for various machining operations. ➤ Exposure to variety of locating and clamping methods available. ➤ To enable the students to design jigs and fixtures for simple components. ➤ To expose the students to the design/selection procedure of press tools and die casting dies.			
MODULE – 1			9 Hours
Introduction to tool design: Tooling, requirements of a tool designer, general tool design procedure, tool engineering functions and its importance to enhance productivity and quality. Review of cutting tool materials. Tool angles and signature, Carbide inserts grades - ISO designation and applications, tool holders for turning-ISO designation.			
Design of single point cutting tools: Design of shank dimensions using strength and rigidity considerations for rectangular, square and round cross section and selection of tool geometry.			
<i>Teaching Learning Process: Chalk and Talk / PPT</i>			
MODULE – 2			9 Hours
Design of Multi Point Cutting Tools: Types of drills, Drill bit design - elements like back taper, web thickness, land width, margin, flute length and cross section and selection of tool geometry. Re-sharpening of drill bit. Tool holders for milling, different tapers used for mounting tool holders in milling, ISO designation. Tool mounting systems.			
Design of milling cutters: Design of elements like number of teeth and height, circular pitch, body thickness, chamfer width, fillet radius and selection of tool geometry. Profile sharpened and form relieved milling cutters.			
<i>Teaching Learning Process: Chalk and Talk / PPT / Video</i>			
MODULE – 3			9 Hours
Jigs and Fixtures: Functions and differences between jigs and fixtures, advantages in mass production, design principles, economics of jigs and fixtures. Location: 3-2-1 Principle of location, different types of locating elements.			
Drill jigs: Different types, exercises of designing jigs for simple components. Fixture Design: Turning fixtures, milling fixtures, grinding fixtures, fixturing for CNC machining centers, and modular fixtures. Design exercises on fixtures for turning and milling for simple components.			

Teaching Learning Process: Chalk and Talk / PPT	
MODULE – 4	9 Hours
Press tools: Classification and working of power presses. Concept and calculations of press tonnage and shut height of a press, components of a simple die, press tool operation, die accessories, shearing action in punch & die, clearance, shear on punch and die, Centre of pressure, and strip layout. Simple, progressive, compound, combination and inverted dies. Bending dies – Introduction, bend allowance, spring back, edge bending die design. Teaching Learning Process: Chalk and Talk / PPT	
MODULE – 5	9 Hours
Drawing dies – Single action, double action and triple action dies, factors affecting drawing and drawing die design. Design of drawing dies for simple components. Die casting: Die casting alloys, terminology- core, cavity, sprue, slug, fixed and movable cores, finger cams, draft, ejector pins and plates, gate, goose nozzle, over-flow, platen, plunger, runner, vent, water-line etc. Types of Dies: Single cavity, multi cavity dies, combination dies, unit dies, advantages and disadvantages of types of dies; finishing, trimming and inspection of die casting components, safety, and modern trends in die casting dies. Teaching Learning Process: Chalk and Talk / PPT	

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Select appropriate cutting tools required for producing a component.
CO2	Understand and interpret cutting tool and tool holder designation systems.
CO3	Analyze and design a jig/fixture for a given simple component.
CO4	Understand various press tools and press tool operations.
CO5	Classify and explain various die casting and injection moulding dies.

2, 3 and 4-Credit Theory Courses			
Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.

Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
- The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE. - If any courses of 3 credits are of Integrated Course type, for such courses the method suggested for 4 credits IPCC shall be followed.			

Suggested Learning Resources:

Text Books

1. Tool Design Cyril Donaldson, George H. Lecain, V.C. Goold, Mc Graw Hill Education 5th edition, 2017
2. Manufacturing technology P.N. Rao, Mc Graw Hill Education 4th edition, 2013 Azaroff, L.V., (2001) Introduction to solids, 1st Edition, McGraw Hill Book Company.

Reference Books

1. Jigs and Fixtures P.H. Joshi Mc Graw Hill Education 3rd edition, 2017.
2. Fundamentals of Tool Design John.G. Nee, William Dufraine, John W. Evans, Mark Hill Society of Manufacturing Engineers 2010
3. Fundamentals of Tool Design Frank W. Wilson PHI publications. 2010.
4. An introduction to Jig and Tool design Kempester M.H.A VIVA Books Pvt.Ltd. 2004
5. Production Technology HMT Tata Mc Graw Hill 2013.

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

1. Case studies
2. Quiz
3. Topic Seminar presentation
4. Assignments

B.E. (Mechanical Engineering)			
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)			
SEMESTER –V			
Course Title:	REFRIGERATION AND AIR CONDITIONING		
Course Code:	BME515D	CIE MARKS	50
L : T : P: S	3:0:0:0	SEE MARKS	50
Credits:	03	EXAM HOURS	03
Total Hours of Pedagogy	45 hours Theory	Total Marks	100
COURSE LEARNING OBJECTIVES: The purpose of the course is to facilitate the learner to learn:			
➤ Study the basic definition, ASHRAE Nomenclature for refrigerating systems ➤ Understand the working principles and applications of different types of refrigeration systems ➤ Study the working of air conditioning systems and their applications. ➤ Identify the performance parameters and their relations of an air conditioning system			
MODULE – 1		(9 hours)	
Introduction to Refrigeration –Basic Definitions, ASHRAE Nomenclature, Air Refrigeration Cycle - reversed Carnot cycle, Bell Coleman cycle analysis, Air Refrigeration systems merits and demerits and applications; Aircraft refrigeration cycles, Joule Thompson coefficient and Inversion Temperature, Linde, Claude and Stirling cycles for liquefaction of air. Industrial Refrigeration: Chemical and process industries, Dairy plants, Petroleum refineries, Food processing and food chain, Miscellaneous Module Teaching Learning Process: Chalk and Talk / PPT			
MODULE – 2		(9 hours)	
Vapour Compression Refrigeration System(VCRS): Comparison of Vapour Compression Cycle and Gas cycle, Vapour Compression Refrigeration system Working and analysis, Limitations, Superheat horn and throttling loss for various refrigerants, efficiency, Modifications to standard cycle – liquid suction heat exchangers, Actual cycles with pressure drops, Complete Vapour Compression Refrigeration System, Multi Pressure, multi evaporator systems or Compound Vapour Compression Refrigeration Teaching Learning Process: Chalk and Talk / PPT			
MODULE – 3		(9 hours)	
Vapour Absorption Refrigeration Systems: Absorbent – Refrigerant combinations, Water Ammonia Systems, Practical problems, Lithium Bromide System, Contrast between the two systems, Modified Version of Aqua Ammonia System with Rectifier and Analyzer Assembly. Practical problems – crystallization and air leakage, Commercial systems. Teaching Learning Process: Chalk and Talk / PPT			
MODULE – 4		(9 hours)	
Refrigerants: Primary and secondary refrigerants, Designation of Refrigerants, Desirable properties of refrigerants including solubility in water and lubricating oil, material compatibility, toxicity, flammability, leak detection, cost, environment and performance issues Thermodynamic properties of refrigerants, Synthetic and natural refrigerants, Comparison between different refrigerants vis a vis			

applications, Special issues and practical implications Refrigerant mixtures – zeotropic and azeotropic mixtures. Refrigeration systems Equipment: Compressors, Condensers, Expansion Devices and Evaporators, A brief look at other components of the system. Teaching Learning Process: Chalk and Talk / PPT
MODULE – 5 (9 hours)
Air Conditioning: Introduction to Air-conditioning, Basic Definition, Classification, power rating, Mathematical Analysis of Air-conditioning Loads, Related Aspects, Different Air-conditioning Systems Central – Station Air-conditioning System, Unitary Air-conditioning System, Window Air Conditioner and Packaged Air Conditioner, Components related to Air-conditioning Systems. Cryogenics: Introduction, fundamentals of extremely low temperatures, their definition, history, and common cryogenic fluids. Thermophysical properties, phase behavior and Joule–Thomson effect Teaching Learning Process: Chalk and Talk / PPT

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Understand the principles, nomenclature and applications of refrigeration systems
CO2	Explain vapour compression refrigeration system and identify methods for performance improvement
CO3	Illustrate the working principles of air, vapour absorption, thermoelectric and steam jet and thermo acoustic refrigeration systems
CO4	Estimate the performance of air-conditioning systems using the principles of psychometric.
CO5	Compute and Interpret cooling and heating loads in an air-condition

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Average of Two Internal Assessment Tests each of 50 marks, scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
Suggested Learning Resources:			

Textbooks

1. Roy J. Dossat, Principles of Refrigeration, Wiley Limited
2. Arora C.P., Refrigeration and Air-conditioning, Tata Mc Graw –Hill, New Delhi, 3rd Edition (2009, reprinted 2017).

Reference Books

1. Stoecker W.F., and Jones J.W., Refrigeration and Air-conditioning, Mc Graw Hill, New Delhi 2nd edition, 1982/1986 revision (latest reprint).
2. S C Arora & S Domkundwar, Refrigeration and Air-conditioning Dhanpat Rai Publication

Web links and Video Lectures (e-Resources):

- <https://nptel.ac.in/courses/112105128>

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning:
Real-Life Observation/ Group Discussion/ Role Play/ Problem-Based Learning



ESTD : 2001

An Institute with a Difference



B.E. (Common to All Branches)			
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)			
SEMESTER – IV/V			
Course Title:	ENVIRONMENTAL STUDIES		
Course Code:	BENS407 / 507	CIE MARKS	50
(L :T : P) + SL	(2:0:0) + (30 Hours/Sem)	SEE MARKS	50
Credits:	2	EXAM HOURS	2 hrs
COURSE LEARNING OBJECTIVES:			
The purpose of the course is to facilitate the learner to:			
1. Introduce the basic concepts of ecology and ecosystem functioning, including biodiversity and biogeochemical cycles.			
2. Understand various types of environmental pollution, their sources, impacts, and preventive measures.			
3. Explore causes of environmental degradation and methods of conservation with special emphasis on Indian biodiversity.			
4. Create awareness about climate change, global warming, environmental legislation, and significant environmental movements in India.			
Module-1		6 Hours	
Ecology: Basic concepts of ecosystem. Ecosystems (structure and function)- forest, desert, wetlands, river, oceanic and lake. Biotic and Abiotic components; Food chain; Ecological pyramid.			
Biogeochemical Cycles: carbon cycle, nitrogen cycle, phosphorus cycle, water cycle Sustainability: 17 Sustainable Development Goals (SDG)- history, targets, implementation, capacity development.			
Module-2		6 Hours	
Environmental Pollution: Surface and ground water pollution, noise pollution, soil pollution, air pollution and marine pollution - sources, impacts on living beings, impacts on environment, preventive measures. case-study on marine pollution.			
Water Chemistry: Significance and effect of pH, total dissolved solids and hardness. Case study on impact of fluoride on human health.			
Module-3		6 Hours	
Environmental Degradation: Causes and effects of deforestation, desertification, soil erosion and glacier melting.			
Environmental Conservation: Significance and key features of national parks, wildlife sanctuaries, reserved forest and mangrove forest. Importance of western ghats as biodiversity hotspot (flora and fauna)			
Module-4		6 Hours	
Indian Monsoon and Global Warming Climate- Impact on monsoons, significance of El Nino and La Nina on India climate.			
Global warming: Causes, greenhouse gases, effects on environment and human health. Causes and effects of acid rain and ozone depletion. Air sampler and its importance in assessing pollutants.			
Module-5		6 Hours	
Environmental Legislation: Environmental Protection Act 1984: Definition, Significance and key features.			
Indian Environmental Movements: Bishnoi Movement, Chipko & Appiko movement.			

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Describe the components and functions of ecosystems and explain major
CO2	Understand various forms of pollution and environmental degradation, along with their impacts on ecosystems and human health.
CO3	Demonstrate awareness of climate issues, Indian environmental legislation, and the role of community-based movements in environmental protection.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	12	Average of Two Internal Assessment Tests (MCQs) each conducted for 30 marks
Continuous and Comprehensive Evaluation (B)	20	8	Any two Assessment methods as per 24RNBE4.2, scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks.
SEE (C)	50	18	Question papers having 50 MCQs with each question carrying 01 mark, and Exam duration shall be for 2 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 out of allotted 50 marks to appear for SEE, with minimum 40 % scored in every component of CIE.			

Textbooks

1. Benny Joseph, “Environmental studies”, 3rd ed., Tata McGraw-Hill, 2017. 2. S M Prakash, “Environmental studies”, 3rd ed., Pristine publishing house, 2018.

Reference Books: -

1. M.Anji Reddy, “Textbook of environmental science and Technology”, revised ed., BS publications, 2014.
2. Dr. B.S Chauhan, “Environmental studies”, 1st ed., University of science press, 2008.

B.E. (Common to all branches) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – IV/ V			
Course Title:	BIOLOGY FOR ENGINEERS		
Course Code:	BBOE407/507	CIE MARKS	50
L: T: P	2:0:0	SEE MARKS	50
Total hours of pedagogy	25	TOTAL MARKS	100
Credits:	2	EXAM HOURS	2
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> 1.Familiarize the students with the basic biological concepts and their engineering applications. 2.Enable the students with an understanding of biodesign principles to create novel devices and structures. 3.Provide the students an appreciation of how biological systems can be re-designed as substitute products for natural systems. 4.Motivate the students to develop interdisciplinary vision of biological engineering.			
Module-1			5 hrs
Introduction to fundamentals of life. Structure and functions of a cell. Biomolecules: Properties and functions of Carbohydrates, Nucleic acids, Proteins, Enzymes and Lipids.			
Module-2			5 hrs
Introduction to applications of biomolecules, Carbohydrates in cellulose-based water filters production, PHA and PLA in bioplastics production, Nucleic acids in vaccines and diagnosis, Proteins in food production, Enzymes in biosensors fabrication, food processing, enzymes in biobleaching, Lipids in biodiesel and detergents production.			
Module-3			5 hrs
Introduction to adaptations of anatomical principles for bioengineering design, Brain as a CPU system. Eye as a Camera system. Heart as a pump system. Lungs as purification system. Kidney as a filtration system.			
Module-4			5 hrs
Introduction to nature inspired biomaterials and mechanisms, Echolocation, Photosynthesis. Bird flying, Lotus leaf effect, Plant burrs, Shark skin, Kingfisher beak. Artificial blood - haemoglobin-based oxygen carriers (HBOCs) and perfluorocarbons (PFCs).			
Module-5			5 hrs
Introduction to trends in bioengineering, Tissue engineering, stem cells and their applications, Bioprinting techniques and materials. Electrical tongue and electrical nose in food science,			

DNA origami and Biocomputing, Bioimaging and Artificial Intelligence for disease diagnosis. Bioconcrete.

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Corroborate the concepts of biomimetics for specific requirements.
CO2	Understand the basic biological concepts for relevant industrial applications. adaptation.
CO3	Evaluate the principles of design and development, for exploring engineering knowledge in biological
CO4	Think critically towards exploring innovative biobased solutions for socially relevant problems.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Average of Two Internal Assessment Tests (MCQs) each conducted for 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2, scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	Question papers having 50 MCQs with each question carrying 01 mark, and Exam duration shall be for 2 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.

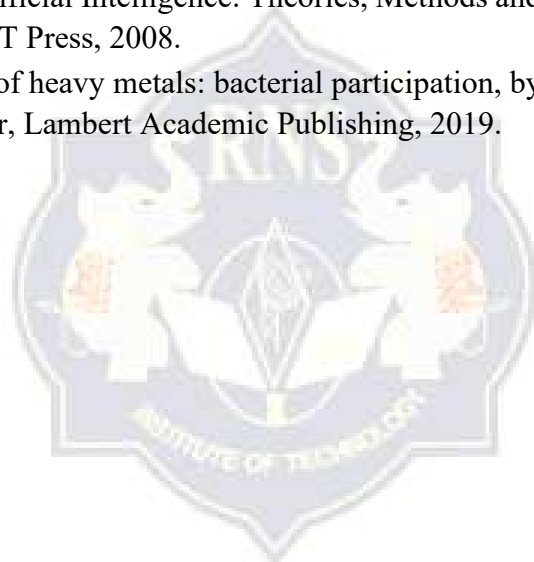
The minimum marks to be secured in CIE is 20 out of allotted 50 marks to appear for SEE, with minimum 40 % scored in every component of CIE.

Text Books

1. Basuchandra's Biology for Engineers, Chandra shekara. B.M, Basavaraju B.C, 2025.
2. Biology for Engineers, Rajendra Singh C and Rathnakar Rao N, Rajendra Singh C and Rathnakar Rao N Publishing, Bengaluru, 2023.

Reference Books: -

1. Human Physiology, Stuart Fox, Krista Rompolski, McGraw-Hill eBook. 16th Edition, 2022
2. Biology for Engineers, Thyagarajan S., Selvamurugan N., Rajesh M.P., Nazeer R.A., Thilagaraj W.
3. Barathi S., and Jaganthan M.K., Tata McGraw-Hill, New Delhi, 2012.
4. Biology for Engineers, Arthur T. Johnson, CRC Press, Taylor and Francis, 2011
5. Biomedical Instrumentation, Leslie Cromwell, Prentice Hall 2011.
6. Biology for Engineers, Sohini Singh and Tanu Allen, Vayu Education of India, New Delhi, 2014.
7. Biomimetics: Nature-Based Innovation, Yoseph Bar-Cohen, 1st edition, 2012, CRC Press.
8. Bio-Inspired Artificial Intelligence: Theories, Methods and Technologies, D. Floreano and C. Mattiussi, MIT Press, 2008.
9. Bioremediation of heavy metals: bacterial participation, by C R Sunil kumar, N Geetha, A C Udaya shankar, Lambert Academic Publishing, 2019.



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ABILITY ENHANCEMENT COURSES

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B.E. (Common to all Branches)			
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)			
SEMESTER – V			
Course Title:	RESEARCH METHODOLOGY AND IPR		
Course Code:	BRMK557	CIE MARKS	50
(L :T : P) + SL	(2:0:0) + (30 Hours/Sem)	SEE MARKS	50
Credits:	2	EXAM HOURS	2 hrs
COURSE LEARNING OBJECTIVES:			
➤ Understand the fundamental concepts of research and its various types. ➤ Apply the principles of literature review, technical reading, attribution, and citation in academic research. ➤ Demonstrate awareness of ethical practices in engineering research. ➤ Explain the concepts and significance of Intellectual Property Rights (IPR) in engineering.			
Module-1		6 Hours	
Introduction: Meaning of Research, Objectives of Engineering Research, and Motivation in Engineering Research, Types of Engineering Research, Finding and Solving a Worthwhile Problem. Ethics in Engineering Research, Ethics in Engineering Research Practice, Types of Research Misconduct, Ethical Issues Related to Authorship.			
Module-2		6 Hours	
Literature Review and Technical Reading: Introduction to literature review and technical reading, understanding new and existing knowledge, and techniques for analysis and synthesis of prior art. Overview of bibliographic databases such as Web of Science, Google, and Google Scholar. Effective search strategies and approaches for technical reading. Conceptualizing research through critical and creative reading practices			
Attributions and Citations: Importance of giving proper credit through attributions and citations. Functions and attributes of citations, and the role of titles and keywords in enhancing citation impact. Understanding knowledge flow through citations and the practice of citing datasets. Overview of citation styles, along with guidelines for acknowledgments and proper attribution in academic writing			
Module-3		6 Hours	
Introduction To Intellectual Property: Role of IP in the Economic and Cultural Development of the Society, IP Governance, IP as a Global Indicator of Innovation, Origin of IP History of IP in India. Major Amendments in IP Laws and Acts in India.			
Patents: Conditions for Obtaining a Patent Protection, To Patent or Not to Patent an Invention. Rights Associated with Patents. Enforcement of Patent Rights. Inventions Eligible for Patenting. Non-Patentable Matters. Patent Infringements. Avoid Public Disclosure of an Invention before Patenting. Process of Patenting			
Module-4		6 Hours	
Process of Patenting: Prior Art Search. Choice of Application to be Filed. Patent Application Forms. Jurisdiction of Filing Patent Application. Publication. Pre-grant Opposition. Examination. Grant of a Patent. Validity of Patent Protection. Post-grant Opposition. Commercialization of a Patent. Need for a Patent Attorney/Agent. Can a Worldwide Patent be Obtained? Do I Need First to File a Patent in India? Patent Related Forms. Fee Structure			

Copyrights and Related Rights: Classes of Copyrights. Criteria for Copyright. Ownership of Copyright. Copyrights of the Author. Copyright Infringements. Copyright Infringement is a Criminal Offence. Copyright Infringement is a Cognizable Offence. Fair Use Doctrine. Copyrights and Internet. Non-Copyright Work. Copyright Registration. Judicial Powers of the Registrar of Copyrights. Fee Structure. Copyright Symbol. Validity of Copyright.

Module-5

6 Hours

Trademarks: Eligibility Criteria. Who Can Apply for a Trademark. Acts and Laws. Designation of Trademark Symbols. Classification of Trademarks. Registration of a Trademark is Not Compulsory. Validity of Trademark. Types of Trademark Registered in India.

Famous Case Law: Coca-Cola Company vs. Bisleri International Pvt. Ltd.

Industrial Designs: Eligibility Criteria. Acts and Laws to Govern Industrial Designs. Design Rights. Enforcement of Design Rights. Non-Protectable Industrial Designs India. International Treaties.

Famous Case Law: Apple Inc. vs. Samsung Electronics Co.

Geographical Indications: Acts, Laws and Rules Pertaining to GI. Ownership of GI. Rights Granted to the Holders. Registered GI in India. Identification of Registered GI.

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Comprehend the fundamental principles of research and its various classifications
CO2	Analyze and apply concepts of literature review, technical reading, attribution, and citation in research contexts.
CO3	Demonstrate an understanding of ethical practices in engineering research.
CO4	Interpret and explain the role and significance of Intellectual Property Rights (IPR) in engineering and innovation.
CO5	Under standing the basic principles of design rights

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Average of Two Internal Assessment Tests (MCQs) each conducted for 30 marks
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2, scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks.
SEE (C)	50	18	Question papers having 50 MCQs with each question carrying 01 mark, and Exam duration shall be for 2 hours.



CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

Textbook

1. Dr. Santosh M Nejakar, Dr. Harish Bendigeri “Research Methodology and Intellectual Property Rights”, ISBN 978-93-5987-928-4, Edition: 2023-24.

Reference Book:

1. David V. Thiel “Research Methods for Engineers” Cambridge University Press, 978-1-107-03488-4 2. Intellectual Property Rights by N.K.Acharya Asia Law House 6th Edition. ISBN: 978-93-81849-

Weblinks and Video Lectures (e-Resources):

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

- Quizzes
- Assignments
- Seminars



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B.E. (Common to All Branches) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – V			
Course Title:	NSS-National Service Scheme		
Course Code:	BNSK559	CIE MARKS	100
L : T : P:	0:0:0:30	SEE MARKS	0
Credits:	0	EXAM HOURS	-
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> 1. Identify the needs and problems of the community and involve the problem-solving. 2. Develop among them a sense of social & civic responsibility & utilize their knowledge in finding practical solutions to individual and community problems. 3. Develop competence required for group-living and sharing of responsibilities & gain skills in mobilising community participation to acquire leadership qualities and democratic attitudes.			
Module-1			
Waste management– Public, Private and Govt organization, 5 R's.			
Module-2			
Automation of local Activities			
Module-3			
Organic farming, Indian Agriculture (Past, Present and Future), Connectivity for marketing.			
Module-4			
Spreading public awareness under rural outreach Programs.			
Module-5			
Food preservation and Packaging			

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Understand the motto and concepts of NSS
CO2	Develop overall personality of volunteers and make them as leaders and responsible citizens of our nation
CO3	Analyze the environmental and societal problems/issues and will be able to design solutions for the same.
CO4	Communicate effectively with the community and with the officials.



ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
Evaluation based on Reports (A)	100	-	5 modules Reports, 5 modules X 10 M each = 50 M
Total CIE Theory (A)	100	40	
SEE (B)	-	-	-
CIE+SEE (A+B)	100	40	Final marks shall be the sum of marks scored in Components A, B
- The minimum marks to be secured in CIE is 40 out of allotted 50 marks with minimum 40 % scored in every component of CIE. - No SEE for this subject			

Suggested Learning Resources:

Reference Books:

- 1) NSS Course Manual, Published by NSS Cell, VTU Belagavi.
- 2) Government of Karnataka, NSS cell, activities reports and its manual.
- 3) Government of India, NSS cell, Activities reports and its manual.

Web links:

- 1) <https://nss.gov.in/>
- 2) <https://pledge.mygov.in/>

ESTD : 2001

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B.E. (Common to all Branches) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – V			
Course Title:	Physical Education		
Course Code:	BPEK559	CIE MARKS	100
L: T: P: S	0:0:1: 0	SEE MARKS	-
Credits:	---	EXAM HOURS	---
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> 1. Understand the fundamental concepts of Physical Education, games and sports skills, Health, Nutrition and Fitness 2. Familiarization of health-related Exercises, Sports for overall growth and development 3. Participate in the competition at regional/state / national / international levels. 4. Create consciousness among the students on Health, Fitness and Wellness in developing and maintaining a healthy lifestyle.			
Module-1: Title: Athletics - Track		Events - 110 & 400 Mtrs Hurdles	3 HOURS
110 Mtrs and 400Mtrs: Hurdling Technique: Lead leg Technique, Trail leg Technique Crouch start (its variations) use of Starting Block.			
Module-2: Title: Athletics - Jumps			3 HOURS
High Jump A) Approach Run B) Take-off C) Bar Clearance (Straddle) D) Landing			
Module-3: Title: Athletics - Throws			3 HOURS
Discuss Throw A) Holding the Discus B) Initial Stance Primary Swing C) Rotation D) Release and Recovery (Rotation in the circle)			
Module-4: Title: Football			3 HOURS

A. Fundamental skills

1. Kicking: Kicking the ball with inside of the foot, Kicking the ball with Full Instep of the foot, Kicking the ball with Inner Instep of the foot, Kicking the ball with Outer Instep of the foot and Lofted Kick.
2. Trapping: Trapping- the Rolling ball, and the Bouncing ball with sole of the foot.
3. Dribbling: Dribbling the ball with Instep of the foot, Dribbling the ball with Inner and Outer Instep of the foot.
4. Heading: In standing, running and jumping condition.
5. Throw-in: Standing throw-in and Running throw-in.
6. Tackling: Simple Tackling, Slide Tackling.
7. Goal Keeping: Collection of Ball, Ball clearance- kicking, throwing and deflecting.
8. Game practice with application of Rules and Regulations

B Rules and their interpretation and duties of the officials

Module-5: Title: Hockey

3 HOURS

A. Fundamental skills

1. Passing: Short pass, Long pass , push pass, hit
2. Trapping.
3. Dribbling and Dozing.
4. Penalty stroke practice.
5. Penalty corner practice.
6. Tackling: Simple Tackling, Slide Tackling.
7. Goal Keeping, Ball clearance- kicking, and deflecting.
8. Game practice with application of Rules and Regulations

B. Rules and their interpretation and duties of the officials

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Understand and demonstrate fundamental techniques of track events including 110m and 400m hurdles, with proper use of starting blocks and hurdling skills.
CO2	Apply technical knowledge of athletic jumps , particularly high jump, including approach run, take-off, bar clearance, and landing techniques.
CO3	Develop skills and perform throwing events , specifically discus throw, with correct techniques such as grip, stance, rotation, release, and recovery.
CO4	Demonstrate fundamental skills of football such as kicking, trapping, dribbling, heading, throw-in, tackling, and goalkeeping along with understanding rules and officiating.
CO5	Exhibit basic skills and techniques in hockey , including passing, trapping, dribbling, tackling, penalty strokes/corners, and understand rules and duties of officials.

ASSESSMENT DETAILS (Both CIE and SEE)			
Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	60	---	Sum of Two Internal Assessment Tests (MCQs) each conducted for 30 marks.
Project (B)	40	---	-----
Total CIE (A+B)	100	40	CIE Evaluation is done for a maximum of 100 marks
The minimum marks to be secured in CIE is 40 (40%) out of 100 marks allotted to Pass.			

Textbooks:

1. Health and Physical Education by V.K. Sharma
2. Introduction to Physical Education, Fitness, and Sport by Daryl Siedentop
3. Physical Education Activities, Sports and Games: The Origin and Background, Rules of Play, Teaching Hints and Fundamentals by Louis E. Means

Reference Books:

1. Saraswati Health and Physical Education Textbook
2. Foundations of Physical Education, Exercise Science and Sport by Deborah A. Wuest

ESTD : 2001

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B.E. (Common to all Branches) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – V			
Course Title:	Yoga		
Course Code:	BYOK559	CIE MARKS	100
L: T: P: S	0:0:1:0	SEE MARKS	---
Credits:	---	EXAM HOURS	---
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> - Physical, Mental & spiritual Objectives of Yoga - Explain the meaning of Yoga. - Discuss the importance of the Yoga and its scope. - Describe the aims and objectives of Yoga. - Clarify the misconceptions on Yoga			
Module-1: Title: Suryanamaskara			3 HOURS
Suryanamaskar 12 count 6 rounds - Suryanamaskar prayer. - Meaning, need & Importance - Benefits of Suryanamaskara			
Module-2: Title: Yoga			3 HOURS
- Meaning and definition. - Brief introduction of yogic practices for the common man - Rules and regulations - Misconceptions of Yoga			
Module-3: Title: Asanas - Sitting & Standing:			3 HOURS
Need & importance of different Asana, Asana its meaning by name, technique, precautionary measures and benefits of each asana. Sitting - Ardha Ushtrasana - Yogamudra in Padmasana Standing - Hastapadasana - Utkatasana			
Module-4: Title: Asanas - Supine line			3 HOURS
Need & importance of different Asana, Asana its meaning by name, technique, precautionary measures and benefits of each asana. Supine line - Sarvangasana - Chakraasana			

Module-5: Title: Pranayama	3 HOURS
Kapalabhati - Revision of practice 40 strokes/min - 3 rounds Pranayama -- 1. Ujjayi 2. Sheetali Meaning, Need, importance of Pranayama. Different types. Meaning by name, technique, precautionary measures and benefits of each Pranayama	

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Explain the meaning, definition, scope, and objectives of Yoga and its role in physical, mental, and spiritual well-being.
CO2	Demonstrate Suryanamaskara (12 counts, 6 rounds) with correct technique and understand its importance and benefits.
CO3	Apply knowledge of yogic practices, rules, and regulations while identifying and correcting common misconceptions of Yoga.
CO4	Perform sitting, standing, and supine Asanas with proper technique, precautions, and awareness of their benefits.
CO5	Practice Pranayama techniques (Kapalabhati, Ujjayi, Sheetali) to improve breathing control, concentration, and overall health.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	60	---	Sum of Two Internal Assessment Tests (MCQs) each conducted for 30 marks.
Project (B)	40	----	-----
Total CIE (A+B)	100	40	CIE Evaluation is done for a maximum of 100 marks
The minimum marks to be secured in CIE is 40 (40%) out of 100 marks allotted to Pass.			

Suggested Learning Resources:

Text books:

1. The Yoga Sutras of Patanjali – Sri Swami Satchidananda.
2. Light on Yoga — B.K.S Iyengar.

Reference Books:

1. The Heart of Yoga — T.K.V Desikachar.
2. Asana Pranayama Mudra Bandha by Swami Satyananda Saraswati.



ESTD : 2001

An Institute with a Difference



CORE COURSES VI SEMESTER

ESTD : 2001

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B.E. (Mechanical Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER –VI			
Course Title:	HEAT TRANSFER IN ENGINEERING APPLICATIONS		
Course Code:	BME601	CIE MARKS	50
L : T : P: S	3:0:2:0	SEE MARKS	50
Credits:	04	EXAM HOURS	03
Total Hours of Pedagogy	45 hours Theory+ 10 to 12 Lab slots	Total Marks	100
COURSE LEARNING OBJECTIVES: The purpose of the course is to facilitate the learner to learn: ➤ Principle of Heat Transfer ➤ Steady and transient heat transfer, obtain the differential equation of heat conduction in various coordinate system. ➤ Physical mechanism of convection and visualize the development of velocity and thermal boundary layers during flow over a surface. ➤ Radiation heat transfer mechanism ➤ The mechanisms of boiling and condensation and understand performance parameters of heat exchangers.			
MODULE – 1			(9 hours)
Introductory Concepts and definition: Review of basics of Modes of Heat Transfer. Conduction Basic Equations: General form of 3-dimensional heat conduction equation for Cartesian coordinate. Boundary conditions of first, second and third kinds. One dimensional Steady state conduction with and without heat generation: Steady state conduction in slab, cylinder and sphere with engineering applications. Steady state conduction: Overall heat transfer coefficient for a composite medium; thermal contact resistance; critical thickness of insulation. Teaching Learning Process: Chalk and Talk / PPT			
MODULE – 2			(9 hours)
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, Discussion on engineering applications. One dimensional Transient conduction: Conduction in solids with negligible internal temperature gradients (lumped system analysis) Use of transient temperature charts (Heisler's charts) Transient conduction in slab, long cylinder and sphere. Teaching Learning Process: Chalk and Talk / PPT			
MODULE – 3			(9 hours)
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, sphere 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. Teaching Learning Process: Chalk and Talk / PPT			

MODULE – 4	(9 hours)
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; Effect of radiation shield.	
Teaching Learning Process: Chalk and Talk / PPT	
MODULE – 5	(9 hours)
Boiling and Condensation; Pool boiling regimes. Basics of Film and drop wise condensation, Use of correlations for film and drop wise condensation on tubes.	
Heat Exchangers: Classification of heat exchangers; Overall heat transfer coefficient, Fouling, Scaling factors; LMTD and NTU methods of analysis of heat exchangers.	
Teaching Learning Process: Chalk and Talk / PPT	

PRACTICAL COMPONENT OF IPCC

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 Convection
6	Determination of Emissivity of a Surface and Determination of Stefan Boltzmann Constant.
7	Performance of Heat exchanger.
8	Experiment on Transient Conduction Heat Transfer
9	Use of CFD for demonstrating heat transfer mechanism considering practical applications, Minimum two exercises

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Determine temperature distribution in steady state heat conduction.
CO2	Analyse the finned surface performance.
CO3	Analyse the heat transfer free and forced convection phenomenon
CO4	Analyse the radiation Heat transfer.
CO5	Design of heat exchangers using LMTD, NTU methods and analyse the boiling and condensation.



Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE- IA Tests (A)	20	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 20 marks.
Continuous and Comprehensive Evaluation (B)	10	-	Any one Assessment methods as per 24RNBE4.2 scaled to 10 marks.
Total CIE Theory (A+B)	30	12	Marks of Tests and Assignments awarded for a maximum of 30.
CIE Practical	12	-	Marks awarded for Weekly Conduction of Experiments and Submission of Laboratory records, scaled to 12 marks.
CIE Practical Test	8	-	Average of marks of Two tests, each conducted for 100 marks covering all experiments, scaled to 8.
Total CIE Practical (C)	20	8	Marks of Experiments, Record and Test awarded for a maximum of 20 marks.
CIE: Theory + Practical (A + B + C)	50	20	CIE Evaluation is done for a maximum of 50 marks.
SEE (D)	50	18	SEE is a theory exam, conducted for 100 marks and scaled down to 50 marks. Exam duration shall before 3 hours.
CIE+SEE (A+B+C+D)	100	40	Final marks shall be the sum of marks scored in Components A, B, C and D

- The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included in their respective modules only.

Suggested Learning Resources:

Text Books

Principals of heat transfer Frank Kreith, Raj M. Manglik, Mark S. Bohn Cengage learning Seventh Edition 2011.

1. Heat transfer, a practical approach Yunus A. Cengel Tata Mc Graw Hill Fifth edition (2019)

Reference Books

1. Heat Transfer A Basic Approach M. Necati Ozisik McGraw Hill, New York 2005
2. Heat Transfer Holman, J. P. Tata McGraw Hill, New York 10th Edition (2010)

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=rxTK_SvSmvs&list=PL1gyM10tgL1hK9666oGndGIWDQdpQzkY9
- https://www.kochheattransfer.com/products/twisted-tube-bundletechnology?gad=1&gclid=Cj0KCQjwmtGjBhDhARIsAEqfDEdG22TY7OHa8PBzHX1Yo_DKQcheV46aZxtD RvDIhCe1Gfpr5obDMLoaArSXEALw_wcB
- <https://www.hightempfurnaces.com/>

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

- Organize a visit to automobile service station and write a report for cooling systems in automobile.
- Apply knowledge of plane wall transient conduction to determine the temperature distribution throughout the pizza as a function of time.

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B.E. (Mechanical Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VI			
COURSE TITLE	MACHINE DESIGN-II		
COURSE CODE	BME602	CIE MARKS	50
L : T : P : S	3 : 2 : 0 : 0	SEE MARKS	50
CREDITS	04	EXAM HOURS	03
TOTAL HOURS OF PEDAGOGY	45 hours	Total Marks	100
COURSE LEARNING OBJECTIVES: The purpose of the course is to facilitate the learner to: ➤ Understand various elements involved in a mechanical system ➤ Analyse various forces acting on the elements of mechanical system and design them using appropriate techniques, codes, and standards ➤ Select transmission elements like gears, belts, pulleys, bearings from the manufacturers' catalogue ➤ Design a mechanical system integrating machine elements ➤ Produce assembly and working drawings of various mechanical systems involving machine elements like clutches and brakes.			
MODULE – 1			9 Hours
SPRINGS: Types of springs, spring materials, stresses in helical coil springs of circular and non-circular cross sections. Tension and compression springs, concentric springs; springs under fluctuating loads. Leaf Springs: Stresses in leaf springs, equalized stresses, and nipping of leaf springs.			
BELTS: Materials of construction of flat and V belts, power rating of belts, concept of slip and creep, initial tension, effect of centrifugal tension, maximum power condition. Selection of flat and V belts-length & cross section from manufacturers' catalogue. Construction and application of timing belts.			
<i>Teaching Learning Process: Chalk and Talk</i>			
MODULE – 2			9 Hours
GEAR DRIVES: Classification of gears, materials for gears, standard systems of gear tooth, lubrication of gears, and gear tooth failure modes.			
SPUR GEARS: Definitions, stresses in gear tooth, Lewis's equation and form factor, design for strength, dynamic load and wear.			
HELICAL GEARS: Definitions, transverse and normal module, formative number of teeth, design based on strength, dynamic load and wear.			
<i>Teaching Learning Process: Chalk and Talk</i>			
MODULE – 3			9 Hours
BEVEL GEARS: Definitions, formative number of teeth, design based on strength, dynamic load and wear.			
WORM GEARS: Definitions, types of worm and worm gears, and materials for worm and worm wheel. Design based on strength, dynamic, wear loads and efficiency of worm gear drives.			
<i>Teaching Learning Process: Chalk and Talk</i>			

MODULE – 4	9 Hours
DESIGN OF CLUTCHES: Necessity of a clutch in an automobile, types of clutches, friction materials and its properties. Design of single plate and multi-plate clutches based on uniform pressure and uniform wear theories. DESIGN OF BRAKES: Different types of brakes, Concept of self-energizing and self-locking of brakes. Practical examples, Design of band brakes, block brakes and internal expanding brakes. <i>Teaching Learning Process: Chalk and Talk</i>	
MODULE – 5	9 Hours
LUBRICATION FUNDAMENTALS: Lubricants and their properties, types of lubricants, bearing materials and their properties, mechanisms of lubrication such as boundary, mixed and hydrodynamic lubrication, basic bearing terminology, Petroff's equation, and numerical problems on bearing pressure, surface velocity, coefficient of friction and heat generated. HYDRODYNAMIC BEARINGS: Hydrodynamic lubrication, pressure development in oil film, Reynold's equation (concept), bearing modulus (Sommerfeld number), coefficient of friction from bearing characteristic curves, minimum oil film thickness, heat generated and heat dissipated, hydrodynamic journal and thrust bearing design, and numerical problems on hydrodynamic journal and thrust bearing design. <i>Teaching Learning Process: Chalk and Talk</i>	

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Apply design principles for the selection of materials, design and analysis of mechanical systems involving springs and belts.
CO2	Apply engineering principles to design spur and helical gears, incorporating strength, dynamic loading and wear.
CO3	Apply engineering principles to design worm and worm wheel and bevel gears, incorporating strength, dynamic loading and wear.
CO4	Apply engineering knowledge and principles for the selection of clutches and brakes to meet engineering design.
CO5	Apply design concepts hydrodynamic bearings for different applications and select bearings for different applications using the manufacturers' catalogue.

2, 3 and 4-Credit Theory Courses			
Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.

Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
- The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE. - If any courses of 3 credits are of Integrated Course type, for such courses the method suggested for 4 credits IPCC shall be followed.			

Suggested Learning Resources:

Text Books:

- Shigley's Mechanical Engineering Design Richard G. Budynas, and J. Keith Nisbett McGraw-Hill Education 10th Edition, 2015
- Fundamentals of Machine Component Design Juvinall R.C, and Marshek K.M John Wiley & Sons Third Edition 2007 Wiley student edition
- Design of Machine Elements V. B. Bhandari Tata McGraw Hill 4th Ed 2016

Reference Books:

- Machine Design- an integrated approach Robert L. Norton Pearson Education 2nd edition
- Design and Machine Elements Spotts M.F., Shoup T.E Pearson Education 8th edition, 2006
- Machine design Hall, Holowenko, Laughlin (Schaum's Outline Series adapted by S.K.Somani Tata McGraw Hill Publishing Company Ltd Special Indian Edition, 2008
- Elements of Machine Design H.G.Patil, S.C.Pilli, R.R.Malagi, M.S.Patil IK International First edition, 2019
- Hand book of Mechanical Design G. M. Maithra and L.V.Prasad Tata McGraw Hill 2nd edition, 2004

Design Data Hand Books:

- Design Data Hand Book, K.Lingaiah, McGraw Hill, 2nd edition, 2003
- Design Data Hand Book, K.Mahadevan and Balaveera Reddy, CBS publication
- Design Data Hand Book, H.G.Patil, I.K.International Publisher, 2010
- PSG Design Data Hand Book, PSG College of technology, Coimbatore

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

- Term Projects
- Course seminar



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PROFESSIONAL ELECTIVE COURSES-II

ESTD : 2001

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B.E. (Mechanical Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VI			
Course Title:	COMPUTER INTEGRATED MANUFACTURING		
Course Code:	BME613A	CIE MARKS	50
L : T : P + (SL)	3 : 0 : 0 + (45 Hours/Sem)	SEE MARKS	50
Credits:	03	EXAM HOURS	03
Total Hours of Pedagogy	45 hours	Total Marks	100
COURSE LEARNING OBJECTIVES: The purpose of the course is to facilitate the learner to: ➤ To impart knowledge of CIM and Automation and different concepts of automation and to make students to understand the Computer Applications in Design and Manufacturing [CAD / CAM] leading to Computer integrated systems. ➤ Enable them to perform various transformations of entities on display devices. ➤ To expose students to automated flow lines, assembly lines, Line Balancing Techniques and Flexible Manufacturing Systems. ➤ To expose students to computer aided process planning, material requirement planning, capacity planning etc. ➤ To expose the students to CNC Machine Tools, CNC part programming, and industrial robots. ➤ To introduce the students to concepts of Internet of Things, and Industry 4.0 leading to Smart Factory			
MODULE – 1			9 Hours
Introduction to CIM and Automation: Automation in Production Systems, automated manufacturing systems- types of automation, reasons for automating, Computer Integrated Manufacturing, computerized elements of a CIM system, CAD/CAM and CIM. Mathematical models and matrices: production rate, production capacity, utilization and availability, manufacturing lead time, work-inprocess, numerical problems.			
Automated Production Lines and Assembly Systems: Fundamentals, system configurations, applications, automated flow lines, buffer storage, control of production line, analysis of transfer lines, analysis of flow lines without storage, partial automation, analysis of automated flow lines with storage buffer, fundamentals of automated assembly systems.			
<i>Teaching Learning Process: Chalk and Talk / PPT</i>			
MODULE – 2			9 Hours
CAD and Computer Graphics Software: The design process, applications of computers in design, software configuration, functions of graphics package, constructing the geometry. Transformations: 2D transformations, translation, rotation and scaling, homogeneous transformation matrix, concatenation, numerical problems on transformations.			
Computerized Manufacture Planning and Control System: Computer Aided Process Planning, Retrieval and Generative Systems, benefits of CAPP, Production Planning and Control Systems, typical activities of PPC System, computer integrated production management system, Material Requirement Planning, inputs to MRP system, working of MRP, outputs and benefits, Capacity Planning, Computer Aided Quality Control, Shop floor control			
<i>Teaching Learning Process: Chalk and Talk / PPT</i>			

MODULE – 3	9 Hours
Flexible Manufacturing Systems: Fundamentals of Group Technology and Flexible Manufacturing Systems, types of FMS, FMS components, Material handling and storage system, applications, benefits, computer control systems, FMS planning and design issues. Automated Storage and Retrieval Systems, AS/RS and Automatic parts identification systems and data capture. Line Balancing: Line balancing algorithms, methods of line balancing, numerical problems on largest candidate rule, Kilbridge and Wester method, and Ranked Positional Weights method. <i>Teaching Learning Process: Chalk and Talk / PPT</i>	
MODULE – 4	9 Hours
Computer Numerical Control: Introduction, components of CNC, CNC programming, manual part programming, G Codes, M Codes, programming of simple components in turning, drilling and milling systems, programming with canned cycles. Cutter radius compensations. High Volume Production System: Introduction Automated flow line symbols, objectives, Work part transport-continuous, Intermittent, synchronous, Pallet fixtures, Transfer Mechanism-Linear-Walking beam, roller chain drive, Rotary-rack and pinion, Ratchet & Pawl, Geneva wheel, Buffer storage, control functions-sequence, safety, Quality, Automation for machining operation. Automated Guided Vehicle System: Introduction Vehicle guidance and routing system. <i>Teaching Learning Process: Chalk and Talk / PPT</i>	
MODULE – 5	9 Hours
Future of Automated Factory: Industry 4.0, functions, applications and benefits. Components of Industry 4.0, Internet of Things (IOT), IOT applications in manufacturing, Big-Data and Cloud Computing for IOT, IOT for smart manufacturing, influence of IOT on predictive maintenance, industrial automation, supply chain optimization, supply-chain & logistics, cyber-physical manufacturing systems. Robot Technology: Robot anatomy, joints and links, common robot configurations, robot control systems, accuracy and repeatability, end effectors, sensors in robotics. Robot programming methods: on-line and off-line methods. Robot industrial applications: Material handling, processing and assembly and inspection <i>Teaching Learning Process: Chalk and Talk / PPT / Field Visits</i>	

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Able to define Automation, CIM, CAD, CAM and explain the differences between these concepts.
CO2	Explain the basics of automated manufacturing industries through mathematical models and analyze the automated flow lines to reduce down time and enhance productivity.
CO3	Understand the concept of Flexible Manufacturing system and Line balancing.
CO4	Understand the concept of high Volume production system and explain the use of different computer applications in manufacturing, and able to prepare part programs for simple jobs on CNC machine tools.

CO5	Visualize and appreciate the modern trends in Manufacturing Industry 4.0 and applications of Internet of Things leading to Smart Manufacturing and concept of robot programming methods.
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2, 3 and 4-Credit Theory Courses			
Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
- The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE. If any courses of 3 credits are of Integrated Course type, for such courses the method suggested for 4 credits IPCC shall be followed.			

Suggested Learning Resources:

Text Books

- Automation, Production Systems and Computer-Integrated Manufacturing, Mikell P Groover, Pearson Learning. 4 th Edition, 2015.
- CAD / CAM Principles and Applications, P N Rao Tata McGraw-Hill 3 rd Edition, 2015
- CAD/CAM/CIM, Dr. P. Radhakrishnan, New Age International Publishers, New Delhi, 3 rd edition

Reference Books

- CAD/CAM” Ibrahim Zeid Tata McGraw Hill.
- Principles of Computer Integrated Manufacturing, S.Kant Vajpayee , Prentice Hall of India, New Delhi. 1999
- Computer Automation in Manufacturing Boucher, T. O., Chapman & Hall London, UK, 1996.

4. Introduction to Robotics: Mechanics And Control Craig, J. J. Addison-Wesley Publishing Company 2 nd Ed 1989.
5. Internet of Things (IoT): Digitize or Die: Transform your organization. Embrace the digital evolution. Rise above the competition Nicolas Windpassinger Amazon.
6. Internet of Things: A Hands-on Approach" ArshdeepBahga and Vijay Madiseti Universities Press

Web links and Video Lectures (e-Resources):

1. <https://nptel.ac.in/courses/105101087>

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

1. Case studies
2. Quiz
3. Topic Seminar presentation
4. Assignments



ESTD : 2001

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B.E. (Mechanical Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VI			
Course Title:	ADDITIVE MANUFACTURING		
Course Code:	BME613B	CIE MARKS	50
L : T : P + (SL)	3 : 0 : 0 + (45 Hours/Sem)	SEE MARKS	50
Credits:	03	EXAM HOURS	03
Total Hours of Pedagogy	45 hours	Total Marks	100
COURSE LEARNING OBJECTIVES: The purpose of the course is to facilitate the learner to: ➤ To know the principal methods, areas of usage, possibilities and limitations of the Additive Manufacturing technologies. ➤ To be familiar with the characteristics of the different materials those are used in Additive Manufacturing. ➤ To know the principles of polymerization and powder metallurgy process, extrusion based system printing processes, sheet lamination processes, beam deposition processes, direct write technologies Direct Digital Manufacturing. ➤ To get exposed to process selection, software issues and post processing.			
MODULE – 1			9 Hours
Introduction and basic principles: Need for Additive Manufacturing, Generic AM process, stereo lithography or 3dprinting, rapid prototyping, the benefits of AM, distinction between AM and CNC machining, other related technologies reverse engineering technology.			
Development of Additive Manufacturing Technology: Introduction, computers, computer aided design technology, other associated technologies, the use of layers, classification of AM processes, metals systems, hybrid systems, milestones in AM development. Additive Manufacturing Process chain: Introduction, the eight steps in additive manufacture, variations from one AM machine to another, metal systems, maintenance of equipment, materials handling issues, design for AM, and application areas.			
<i>Teaching Learning Process: Chalk and Talk / PPT</i>			
MODULE – 2			9 Hours
Photo polymerization processes: Stereo lithography (SL), Materials, SL resin curing process, Micro Stereo lithography, Process Benefits and Drawbacks, Applications of Photo polymerization Processes.			
Powder bed fusion processes: Introduction, Selective laser Sintering (SLS), Materials, Powder fusion mechanism, SLS Metal and ceramic part creation, Electron Beam melting (EBM), Process Benefits and Drawbacks, Applications of Powder Bed Fusion Processes. Extrusion-based systems: Fused Deposition Modelling (FDM), Principles, Materials, Plotting and path control, Bio Extrusion, Process Benefits and Drawbacks, Applications of Extrusion-Based Processes.			
<i>Teaching Learning Process: Chalk and Talk / PPT</i>			
MODULE – 3			9 Hours
Printing Processes: Evolution of printing as an additive manufacturing process, research achievements in printing deposition, technical challenges of printing, printing process modelling, material modification methods, three dimensional printing, advantages of binder printing			
Sheet Lamination Processes: Materials, Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC), Gluing, Thermal bonding, LOM and UC applications.			

Beam Deposition Processes: introduction, general beam deposition process, description material delivery, BD systems, process parameters, typical materials and microstructure, processing–structure–properties relationships, BD benefits and drawbacks. Direct Write Technologies: Background, ink –based DW, laser transfer, DW thermals pray, DW beam deposition, DW liquid phase direct deposition. Teaching Learning Process: Chalk and Talk / PPT		
MODULE – 4		9 Hours
Guidelines for	Process	Selection: Introduction, selection methods for apart, challenges of selection, example system for preliminary selection, production planning and control. Software issues for Additive Manufacturing: Introduction, preparation of cad models – the STL file, problems with STL files, STL file manipulation.
Post Processing: Support material removal, surface texture improvements, preparation for use as a pattern, property enhancements using nonthermal techniques and thermal techniques. Teaching Learning Process: Chalk and Talk / PPT		
MODULE – 5		9 Hours
The use of multiple materials in additive manufacturing: Introduction, multiple material approaches, discrete multiple material processes, porous multiple material processes, blended multiple material processes, commercial applications using multiple materials, future directions. AM Applications: Examples for Aerospace, defence, automobile, Biomedical and general engineering industries. Direct digital manufacturing: Align Technology, Siemens and Phonak, DDM drivers, manufacturing vs. prototyping, lifecycle costing, future of direct digital manufacturing. Teaching Learning Process: Chalk and Talk / PPT / Field Visits		

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Demonstrate the knowledge of the broad range of AM processes, devices, capabilities and materials that are available.
CO2	Demonstrate the knowledge of the broad range of AM processes that are available for SL, SLS, EBM and FDM processes.
CO3	Demonstrate the knowledge of the broad range of AM processes that are available for LOM, BD and DW processes.
CO4	Describe the various software tools, processes and techniques that enable advanced/additive manufacturing.
CO5	Apply the concepts of additive manufacturing to design and create components that satisfy product development/prototyping requirements, using advanced/additive manufacturing devices and processes.

2, 3 and 4-Credit Theory Courses			
Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details

CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
- The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE. - If any courses of 3 credits are of Integrated Course type, for such courses the method suggested for 4 credits IPCC shall be followed.			

Suggested Learning Resources:

Text Books

- Additive Manufacturing Technologies Rapid Prototyping to Direct Digital Manufacturing I. Gibson I D. W. Rosen I B. Stucker Springer New York Heidelberg Dordrecht, London ISBN: 978 1 441911193 eISBN: 978 14419 11209 DOI 10.1007/978 14419 11209
- “Rapid Prototyping: Principles & Applications Chua Chee Kai, Leong Kah Fai World Scientific 2003
- Rapid Prototyping: Theory & Practice Ali K. Kamrani, Springer 2006 Emand Abouel Nasr,

Reference Books

- Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling” D.T. Pham, S.S. Dimov, Springer 2001
- Rapid Prototyping: Principles and Applications in Manufacturing Rafiq Nooran John Wiley & Sons 2006
- Additive Manufacturing Technology Hari Prasad, A.V. Suresh Cengage 2019 7. Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing Andreas Gebhardt

Web links and Video Lectures (e-Resources):

- VTU, E- learning

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

- Case studies
- Quiz
- Topic Seminar presentation
- Assignments

B.E. (Mechanical Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VI			
COURSE TITLE	ROBOTICS AND AI		
COURSE CODE	BME613C	CIE MARKS	50
L : T : P + (SL)	3 : 0 : 0 + (45 Hours/Sem)	SEE MARKS	50
CREDITS	3	EXAM HOURS	3
TOTAL HOURS OF PEDAGOGY	45 hours theory	Total Marks	100
COURSE LEARNING OBJECTIVES: The purpose of the course is to facilitate the learner to: ➤ Develop foundational knowledge of robotics, robot components, control systems, and sensing technologies. ➤ Interpret robot anatomy, configurations, degrees of freedom, and workspace analysis for industrial applications. ➤ Explain and apply fundamental concepts of Artificial Intelligence and Machine Learning relevant to robotic systems. ➤ Analyse sensor characteristics, signal conditioning circuits, and data acquisition systems for robotic integration ➤ Apply robotics knowledge to multidisciplinary real-world applications including industrial automation, medical, agricultural, and autonomous systems.			
MODULE – 1			9 Hours
Introduction To Robotics: Introduction to Robotics and Automation, laws of robot, brief history of robotics, basic components of robot, robot specifications, classification of robots, robot control systems, end effectors, sensors in robotics, Fundamentals of robotic sensors, including classification and working of internal and external sensors such as vision sensors, proximity sensors, light sensors, range sensors, infrared sensors, and force and torque sensors. Teaching Learning Process: Chalk and Talk/PPT/Field Visits/Videos			
MODULE – 2			9 Hours
Robot Anatomy: Anatomy of a Robot, Robot configurations: polar, cylindrical, Cartesian, and jointed arm configurations, Robot links and joints, Degrees of freedom: types of movements, vertical, radial and rotational traverse, roll, pitch and yaw, Work volume/envelope. Industrial robot applications, robot accuracy and repeatability, various generations of robots, degrees of freedom – Asimov's laws of robotics. Teaching Learning Process: Chalk and Talk/PPT/Field Visits/Videos			
MODULE – 3			9 Hours
Introduction to Artificial Intelligence and Machine Learning: Feature engineering, neural networks, supervised learning algorithms including Bayes classifier, decision trees, k-nearest neighbors, support vector machines, and logistic regression. Fundamentals of reinforcement learning: Deep learning architectures including deep feed forward neural networks, hyperparameter optimization, convolutional neural networks, recurrent neural networks, transformers, and deep generative models. Teaching Learning Process: Chalk and Talk/PPT/Field Visits/Videos			
MODULE – 4			9 Hours
Sensors, actuators, and signal conditioning including energy transformation principles, sensor performance characteristics, amplification, filtering, multiplexing, conversion techniques, Wheatstone bridge, and operational amplifier circuits. Data acquisition systems including single and multi-channel acquisition, data logging, DAQ interfacing, and sensor integration techniques. Teaching Learning Process: Chalk and Talk/PPT/Field Visits/Videos			

MODULE – 5	9 Hours
Robotics Applications: Material Handling: Pick and place, palletizing and depalletizing, machining loading and unloading, welding & assembly, Medical, agricultural and space applications, unmanned vehicles: ground, Ariel and underwater applications, robotic for computer integrated manufacturing. Types of robots: Manipulator, Legged robot, wheeled robot, aerial robots, Industrial robots, Humanoids, Robots, Autonomous robots, and Swarm robots Teaching Learning Process: Chalk and Talk/PPT/Field Visits/Videos	

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Explain fundamental robotics concepts, components, control systems, and sensor working principles.
CO2	Analyze robot anatomy, configurations, degrees of freedom, and industrial applications.
CO3	Apply AI and machine learning techniques for basic robotic decision-making.
CO4	Apply sensor characteristics, signal conditioning, and DAQ systems in robotics.
CO5	Explain and apply robotics principles in multidisciplinary real-world applications.

2, 3 and 4-Credit Theory Courses			
Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
- The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE. - If any courses of 3 credits are of Integrated Course type, for such courses the method suggested for 4 credits IPCC shall be followed.			

Suggested Learning Resources:

Text Books:

1. Industrial Robotics: Technology, Programming, and Applications, Mikell P. Groover, Tata McGraw Hill International Editions
2. Robotics: An Introduction, D.A. Malcolm, Delmar Cengage Learning, 2nd Edition
3. Introduction to Robotics, Saeed B Niku, Wiley India Publications, 3rd Edition, 2020.
4. Machine Learning, S. Sridhar, M. Vijayalakshmi, Oxford Higher Educations (Free online resource)

Reference Books:

1. Mechanism Design for Robotics, Edited by Marco Ceccarelli, Marco Ceccarelli, Alessandro Gasparetto. <https://doi.org/10.3390/books978-3-03921-059-6>
2. Dynamics and Control of Robotic Systems, Andrew J. Kurdila, Pinhas Ben-Tzvi, Wiley Publications
3. Foundations of Robotics & Automation, (Theory & Practice), A. B. Bhattacharya, Debasish Roy, Khanna Book Publishing Co. PVT. Ltd., New Delhi

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

1. Organize industrial visits to robotics industries followed by submission of a detailed report.
2. Undertake a mini-project in robotics to gain hands-on practical experience.



ESTD : 2001

An Institute with a Difference



B.E. (Mechanical Engineering)			
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)			
SEMESTER –VI			
Course Title:	BASICS OF CFD		
Course Code:	BME613D	CIE MARKS	50
L : T : P: S	3:0:0:0	SEE MARKS	50
Credits:	03	EXAM HOURS	03
Total Hours of Pedagogy	45 hours Theory	Total Marks	100
COURSE LEARNING OBJECTIVES: The purpose of the course is to facilitate the learner to learn:			
➤ Study the basic definition, ASHRAE Nomenclature for refrigerating systems ➤ Understand the working principles and applications of different types of refrigeration systems ➤ Study the working of air conditioning systems and their applications. ➤ Identify the performance parameters and their relations of an air conditioning system			
MODULE – 1		(9 hours)	
Introduction to CFD and Governing Equations: Need of CFD as tool, role in R&D, continuum, material or substantial derivative or total derivative, gradient, divergence and curl operators, Linearity, Principle of Superposition. Derivation of Navier-Stokes equations in control volume (integral form) and partial differential form, Euler equations (governing inviscid equations). Mathematical classification of PDE (Hyperbolic, Parabolic, Elliptic). Method of characteristics, Introduction to Riemann Problem and Solution Techniques. <i>Teaching Learning Process: Chalk and Talk / PPT</i>			
MODULE – 2		(9 hours)	
One-dimensional Euler's equation: Conservative, Non-conservative form and primitive variable forms of Governing equations. Flux Jacobian Is there a systematic way to diagonalize 'A'. Eigen values and Eigenvectors of Flux Jacobian. Decoupling of Governing equations , introduction of characteristic variables. Relation between the two non-conservative forms. Conditions for genuinely nonlinear characteristics of the flux Jacobian. <i>Teaching Learning Process: Chalk and Talk / PPT</i>			
MODULE – 3		(9 hours)	
Representation of Functions on Computer: Need for representation of functions, Box Function, Hat Function, and Representation of sinx using hat functions: Aliasing, high frequency, low frequency. Representation error as a global error. Derivatives of hat functions, Haar functions, Machine Epsilon. Using Taylor series for representation of Derivatives. <i>Teaching Learning Process: Chalk and Talk / PPT</i>			
MODULE – 4		(9 hours)	
Finite difference method – Applied to Linear Convection equation, Laplace Equations, Convection Diffusion equations, Burgers equations, modified equations. Explicit methods and Implicit methods – as applied to applied to linear convection equation,			

Laplace equations , convection-diffusion equation ° FTCS, FTFS, FTBS, CTCS ° Jacobi Method, Gauss-Siedel, Successive Over Relaxation Method, TDMA • Von Naumann stability (linear stability) analysis. Upwind Method in Finite Difference method. Teaching Learning Process: Chalk and Talk / PPT	
MODULE – 5	(9 hours)
Finite volume method Finite volume method. Finding the flux at interface. Central schemes - Lax-Friedrichs Method, Lax-Wendroff Method, Two-Step Lax-Wendroff Method and Mac Cormack Method Upwind Method in Finite Volume methods - Flux Splitting Method Steger and Warming, vanLeer, Roe's Method and finding Roe's Averages. Teaching Learning Process: Chalk and Talk / PPT	

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Understand mathematical characteristics of partial differential equations.
CO2	Explain how to classify and computationally solve Euler and Navier-Stokes equations.
CO3	Make use of the concepts like accuracy, stability, consistency of numerical methods for the governing equations.
CO4	Identify and implement numerical techniques for space and time integration of partial differential equations.
CO5	Conduct numerical experiments and carry out data analysis.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Average of Two Internal Assessment Tests each of 50 marks, scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.

Suggested Learning Resources:

Textbooks

1. Computational Fluid Dynamics T.j.chung Cambridge University, Press 2nd Edition (2010)
2. Computational fluid dynamics and heat transfer Ghoshdastidar Cengage learning 2017

Reference Books

1. Numerical Computation of Internal and External Flows: The Fundamentals of Computational Fluid Dynamics – Vol 1 & Vol 2 Charles Hirsch Butterworth- Heinemann 2007
2. Numerical Heat Transfer and Fluid Flow SuhasPatankar Taylor and Francis Publisher.

Web links and Video Lectures (e-Resources):

- <https://nptel.ac.in/courses/103106119>
- <https://nptel.ac.in/courses/112105045>

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

Real-Life Observation/ Group Discussion/ Role Play/ Problem-Based Learning



ESTD : 2001

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OPEN ELECTIVE COURSES

ESTD : 2001

An Institute with a Difference

B.E. (Mechanical Engineering)			
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)			
SEMESTER – VI			
Course Title:	ENERGY AND ENVIRONMENT		
Course Code:	BME654A	CIE MARKS	50
L : T : P	3:0:0	SEE MARKS	50
Credits:	3	EXAM HOURS	3
Total hours of Pedagogy	45 hours Theory	TOTAL MARKS	100
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> ➤ To understand the fundamentals of energy sources, energy use, energy efficiency, and resulting environmental implications of various energy supplies. ➤ To introduce various aspects of environmental pollution and its control. ➤ To understand the causes and remedies related to social issues like global warming, ozone layer depletion, climate change etc. ➤ To introduce various acts related to prevention and control of pollution of water and air, forest protection act, wild life protection act etc.			
MODULE – 1		(9 hours)	
BASIC INTRODUCTION TO ENERGY: Energy and power, forms of energy, primary energy sources, energy flows, world energy production and consumption, Key energy trends in India: Demand, Electricity, Access to modern energy, Energy production and trade, Factors affecting India’s energy development: Economy and demographics Policy and institutional framework, Energy prices and affordability, Social and environmental aspects, Investment. <i>Teaching Learning Process: Chalk and Talk / PPT</i>			
MODULE – 2		(9 hours)	
ENERGY STORAGE SYSTEMS: Thermal energy storage methods, Energy saving, Thermal energy storage systems Energy Management: Principles of Energy Management, Energy demand estimation, Energy pricing Energy Audit: Purpose, Methodology with respect to process Industries. <i>Teaching Learning Process: Chalk and Talk / PPT</i>			
MODULE – 3		(9 hours)	
ENVIRONMENT: Introduction, Multidisciplinary nature of environmental studies- Definition, scope and importance, Need for public awareness. Global Environmental Concerns: Ground water depletion/recharging, Climate Change; Acid Rain; Ozone Depletion. ECOSYSTEM: Concept, Energy flow, Structure and function of an ecosystem. Food chains, food webs and ecological pyramids, Forest ecosystem, Grassland ecosystem, Desert ecosystem and Aquatic ecosystems, Ecological succession. <i>Teaching Learning Process: Chalk and Talk / PPT</i>			

MODULE – 4	(9 hours)
ENVIRONMENTAL POLLUTION: Definition, Cause, effects and control measures of - Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution and nuclear hazards. WASTE MANAGEMENT & PUBLIC HEALTH ASPECTS: Bio-medical Wastes; Solid waste; Hazardous wastes; E-wastes; Industrial and Municipal Sludge. <i>Teaching Learning Process: Chalk and Talk / PPT</i>	
MODULE – 5	(9 hours)
SOCIAL ISSUES AND THE ENVIRONMENT: Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies. Wasteland reclamation, Consumerism and waste products, Environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation. Sustainability: 17 Sustainable Development Goals (SDG)- history, targets, implementation, capacity development. <i>Teaching Learning Process: Chalk and Talk / PPT</i>	

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Understand energy scenario, energy sources and their utilization.
CO2	Understand various methods of energy storage, energy management and economic analysis.
CO3	Analyse the awareness about environment and eco system.
CO4	Understand the environment pollution along with waste management & public health aspects
CO5	Understand the social issues and the environmental effects.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Average of Two Internal Assessment Tests each of 50 marks, scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration

			shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
- The minimum marks to be secured in CIE is 20 out of allotted 50 marks to appear for SEE, with minimum 40 % scored in every component of CIE. - If any courses of 3 credits are of Integrated Course type, for such courses the method suggested for 4 credits IPCC shall be followed.			
Suggested Learning Resources: Text Books - Energy Management Audit & Conservation- for Module 2 by Barun Kumar De, Vrinda Publication, 2nd Edition, 2010. - Energy Management, Murphy, W. R, Elsevier, 2007 Reference Books - Energy Management Principles, Smith, C. B, Pergamum, Reprints (2016) - Environmental studies, Benny Joseph, Tata McGraw Hill, 3rd edition 2016 Web links and Video Lectures (e-Resources): https://nptel.ac.in/domains/discipline/103?course=103_3 https://nptel.ac.in/courses/109101171			
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning: Real-Life Observation/ Group Discussion/ Role Play/ Problem-Based Learning			

ESTD : 2001

An Institute with a Difference

B.E. (Mechanical Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VI			
Course Title:	RENEWABLE ENERGY POWER PLANTS		
Course Code:	BME654B	CIE MARKS	50
L : T : P	3:0:0	SEE MARKS	50
Credits:	3	EXAM HOURS	3
Total hours of Pedagogy	45 hours Theory	TOTAL MARKS	100
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> ➤ To introduce the concepts and principles of solar energy, its radiation, collection, storage and application. ➤ To understand application aspects of Wind, Biomass, Geothermal, hydroelectric and Ocean energy. ➤ To examine energy sources and systems, including fossil fuels and nuclear energy, and then focus on other forms of alternate energy sources.			
MODULE – 1			(9 hours)
Introduction: Energy sources (including fossil fuels and nuclear energy), India's production and reserves of commercial energy sources, need for non-conventional energy sources, energy alternatives, Indian and global energy scenario. Solar Radiation & Measurement: Extra-Terrestrial radiation, the spectral distribution of extra-terrestrial radiation, solar constant, solar radiation at the earth's surface, beam, diffuse and global radiation, and solar radiation data. Pyrometer, shading ring Pyrheliometer, sunshine recorder, schematic diagrams, principle of working, actinometer and bolometer.			
MODULE – 2			(9 hours)
Solar Radiation Geometry: Flux on a plane surface, latitude, declination angle, surface azimuth angle, hour angle, zenith angle, solar altitude angle, expressions for the angle between the incident beam and the normal to a plane surface (No derivation) local apparent time, apparent motion of sun, day length, numerical problems. Solar Thermal Systems: Flat plate collector, Evacuated Tubular Collector, Solar air collector, Solar concentrator, Solar distillation, Solar cooker, Thermal energy storage systems, Solar Pond, Solar Chimney (Tower). Solar Photovoltaic Systems: Introduction, Solar cell Fundamentals, Characteristics and classification, Solar cell: Module, panel and array construction			
MODULE – 3			(9 hours)
Wind Energy: Properties of wind, availability of wind energy in India, wind velocity and power from wind; major problems associated with wind power, wind machines; Types of wind machines and their characteristics, horizontal and vertical axis windmills, elementary design principles; coefficient of performance of a windmill rotor, design aspects, numerical examples. Energy from Biomass: Energy plantation, biogas production from organic wastes by anaerobic fermentation, description of bio-gas plants, transportation of biogas, problems associated with bio-gas			

production, application of biogas, application of biogas in engines, cogeneration plant, advantages & disadvantages.	
MODULE – 4	(9 hours)
Hydroelectric plants: Advantages & disadvantages of waterpower, Hydrographs and flow duration curves- numerical, Storage and pondage, General layout of hydel power plants- components such as Penstock, surge tanks, spill way and draft tube and their applications, pumped storage plants, Detailed classification of hydroelectric plants. Tidal Power: Tides and waves as energy suppliers and their mechanics, fundamental characteristics of tidal power, harnessing tidal energy, limitations of tidal energy. Ocean Thermal Energy Conversion: Principle of working, Rankine cycle, OTEC power stations in the world, problems associated with OTEC, case studies.	
MODULE – 5	(9 hours)
Geothermal energy: Introduction, Principle of working, types of geothermal stations with schematic diagram Estimates of Geothermal Power, Nature of geothermal fields, Geothermal resources, Hydrothermal, Resources Geo pressured resources, Hot dry rock resources of petro-thermal systems, Magma Resources-Interconnection of geothermal fossil systems, Advantages, and disadvantages of geothermal energy over other energy forms, Geothermal stations in the world. Hydrogen Energy: Properties of Hydrogen with respect to its utilization as a renewable form of energy, sources of hydrogen, production of hydrogen, electrolysis of water, thermal decomposition of water, thermos Chemical production bio-chemical production.	

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Explain the various types of energy sources, including fossil fuels, nuclear energy, and renewable energy sources, and their importance in the global and Indian energy scenario.
CO2	Evaluate solar radiation data and analyze the performance of different solar thermal and photovoltaic systems using principles of solar radiation geometry.
CO3	Design basic renewable energy systems, including wind turbines, biogas plants, and hydroelectric power systems, considering their design principles and operational characteristics.
CO4	Assess the efficiency, advantages, and disadvantages of various renewable energy technologies such tidal, OTEC energy systems.
CO5	Develop innovative solutions for integrating multiple renewable energy sources to enhance sustainability and energy security, considering environmental, economic, and technical factors of hydrogen energy.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Average of Two Internal Assessment Tests each of 50 marks, scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
- The minimum marks to be secured in CIE is 20 out of allotted 50 marks to appear for SEE, with minimum 40 % scored in every component of CIE. - If any courses of 3 credits are of Integrated Course type, for such courses the method suggested for 4 credits IPCC shall be followed.			
Suggested Learning Resources: Text Books - Solar Energy Principles, Thermal Collection & Storage, S.P.Sukhatme: Tata McGraw Hill Pub., New Delhi. - Non-Conventional Energy Sources, G.D.Rai, New Delhi. - Renewable Energy, power for a sustainable future, Godfrey Boyle, 3rd Edition (2012) - The Generation of electricity by wind, E.W.Golding. - Non-Conventional Energy Resources by B.H. Khan, Tata McGraw Hill Pub., Reprints/ updated versions (2018). Reference Books: - Fundamentals of Renewable Energy Resources by G.N.Tiwari, M.K.Ghosal, Narosa Pub., 2007. - Non-Conventional Energy Resources by B.H. Khan, Tata McGraw Hill Pub., 2018. - Non-Conventional Energy Resources by Shobh Nath Singh, Pearson India., 2016 - Environmental Justice in India: The National Green Tribunal, By Gitanjali Nain Gill, Routledge (2016). - Ref: The Oxford Handbook of Comparative Environmental Law, edited by Emma Lees, Jorge E. ViOuales, Oxford University Press (2019). Web links and Video Lectures (e-Resources): https://www.youtube.com/watch?v=iZyzvDj6Y3c&list=PLwdnzlV3ogoXUifhvYB65ILJCZ740_fAk&index=2			

- https://www.youtube.com/watch?v=Og4LEc7SpdQ&list=PLwdnzlV3ogoXUifhvYB65ILJCZ740_fAk&index=3
- https://www.youtube.com/watch?v=L3AEXdvtikk&list=PLwdnzlV3ogoXUifhvYB65ILJCZ740_fAk&index=19
- https://www.youtube.com/watch?v=TUu40kDqcEc&list=PLwdnzlV3ogoXUifhvYB65ILJCZ740_fAk&index=24
- https://www.youtube.com/watch?v=k7LX0a67V8A&list=PLwdnzlV3ogoXUifhvYB65ILJCZ740_fAk&index=37

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning:
Real-Life Observation/ Group Discussion/ Role Play/ Problem-Based Learning



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B.E. (Mechanical Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VI			
COURSE TITLE	AUTOMOTIVE ENGINEERING		
COURSE CODE	BME654C	CIE MARKS	50
L : T : P : S	3 : 0 : 0 : 0	SEE MARKS	50
CREDITS	03	EXAM HOURS	03
TOTAL HOURS OF PEDAGOGY	45 hours	Total Marks	100
COURSE LEARNING OBJECTIVES: The student will be able: ➤ To know layout and arrangement of principal parts of an automobile. ➤ To understand the working of transmission and brake systems. ➤ To comprehend operation and working of steering and suspension systems. ➤ To know the Injection system and its advancements. ➤ To know the automobile emissions and its effects on environment.			
MODULE – 1			9 Hours
Engine Components and It's Principle Parts: Spark Ignition (SI) & Compression Ignition (CI) engines, cylinder – arrangements and their relatives merits, Liners, Piston, connecting rod, crankshaft, valves, valve actuating mechanisms, Types of combustion chambers for S.I.Engine and C.I.Engines, methods of a Swirl generation, engine positioning. Concept of HCCI engines, Hybrid engines, Twin spark engine, Electric car.			
Cooling And Lubrication: Cooling requirements, Types of cooling- Thermo siphon system, Forced circulation water cooling system, Water pump, Radiator, Significance of lubrication, Splash and Forced feed system.			
<i>Teaching Learning Process: Chalk and Talk</i>			
MODULE – 2			9 Hours
Transmission Systems: Clutch-types and construction, gear boxes- manual and automatic, gear shift mechanisms, Over drive, transfer box, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints. Differential and rear axle, Hotchkiss Drive.			
Brakes: Types of brakes, mechanical compressed air, vacuum and hydraulic braking systems, construction and working of master and wheel cylinder, brake shoe arrangements, Disk brakes, drum brakes, Antilock – Braking systems, purpose and operation of antilock-braking system, ABS Hydraulic Unit.			
<i>Teaching Learning Process: Chalk and Talk</i>			
MODULE – 3			9 Hours
Steering and Suspension Systems: Steering geometry and types of steering gear box-Power Steering, Types of Front Axle, Suspension, Torsion bar suspension systems, leaf spring, coil spring, independent suspension for front wheel and rear wheel, Air suspension system.			
Ignition System: Battery Ignition system, Magneto Ignition system, electronic Ignition system.			
<i>Teaching Learning Process: Chalk and Talk</i>			

MODULE – 4	9 Hours
Superchargers and Turbochargers: Naturally aspirated engines, Forced Induction, Types of superchargers, Turbocharger construction and operation, Intercooler, Turbocharger lag. Fuels, Fuel Supply Systems For SI And CI Engines: Conventional fuels, Alternative fuels, Normal and Abnormal combustion, Cetane and Octane numbers, Fuel mixture requirements for SI engines, Types of carburetors, C.D. & C.C. carburetors, Multi point and Single point fuel injection systems, fuel transfer pumps, Fuel filters, fuel injection pumps and injectors. Electronic Injection system, Common Rail Direct Injection System. <i>Teaching Learning Process: Chalk and Talk</i>	
MODULE – 5	9 Hours
Automotive Emission Control Systems: Different air pollutants, formation of photochemical smog and causes. Automotive emission controls, Controlling crankcase emissions, Controlling evaporative emissions, Cleaning the exhaust gas, Controlling the air-fuel mixture, Controlling the combustion process, Exhaust gas recirculation, Treating the exhaust gas, Air-injection system, Air-aspirator system, Catalytic converter. Emission Standards: Euro I, II, III and IV norms, Bharat Stage II, III, IV norms. Motor Vehicle Act. <i>Teaching Learning Process: Chalk and Talk</i>	

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Explain the construction, working principles, components, cooling and lubrication systems of SI and CI engines and describe modern engine concepts.
CO2	Describe and analyze the construction and working of transmission systems, drive mechanisms, and braking systems including ABS.
CO3	Explain the principles, construction, and operation of steering, suspension, and ignition systems used in automobiles.
CO4	Describe the working of supercharging and turbocharging systems and analyze fuel types and fuel supply systems for SI and CI engines.
CO5	Explain automotive emission formation, control techniques, and emission standards in accordance with environmental regulations.

2, 3 and 4-Credit Theory Courses			
Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.

Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
- The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE. - If any courses of 3 credits are of Integrated Course type, for such courses the method suggested for 4 credits IPCC shall be followed.			

Suggested Learning Resources:

Text Books:

4. Automobile engineering Vol I and II Kirpal Singh Standard Publishers 12th Edition 2011.
5. Automotive Mechanics S. Srinivasan Tata McGraw Hill 2003 2 nd Edition

Reference Books:

6. Automotive Mechanics, William H Crouse & Donald L Anglin, Tata McGraw Hill Publishing Company 10th Edition 2007
7. Automotive Mechanics: Principles and Practices, Joseph Heitner, D Van Nostrand Company, Inc
8. Automobile Engineering, R. B. Gupta, Satya Prakashan, 4 thedition 1984.
9. Fundamentals of Automobile Engineering, K.K.Ramalingam, Scitech Publications (India) Pvt. Ltd

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

3. Term Projects
4. Course seminar



B.E. (Mechanical Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VI			
COURSE TITLE	PROJECT MANAGEMENT		
COURSE CODE	BME654D	CIE MARKS	50
L : T : P : S	3 : 0 : 0 : 0	SEE MARKS	50
CREDITS	03	EXAM HOURS	03
TOTAL HOURS OF PEDAGOGY	45 hours	Total Marks	100
COURSE LEARNING OBJECTIVES: The purpose of the course is to facilitate the learner to: ➤ To understand how to break down a complex project into manageable segments and use of effective project management tools and techniques to arrive at solution and ensure that the project meets its deliverables and is completed within budget and on schedule. ➤ To impart knowledge on various components, phases, and attributes of a project. ➤ To prepare students to plan, develop, lead, manage, and successfully implement and deliver projects within their chosen practice area			
MODULE – 1			9 Hours
Introduction: Definition of project, characteristics of projects, types of projects, scalability of project tools, project roles. PMBOK (10 knowledge areas) Project life cycle, Constraints and Assumptions in Projects, methods of selecting projects, financial mode & scoring models to select projects Teaching Learning Process: Chalk and Talk/PPT			
MODULE – 2			9 Hours
Planning Projects: Defining the project scope, Project scope checklist, Work Breakdown Structure (WBS), Integrating WBS with organization, coding the WBS for the information system. Scheduling Projects: Purpose of a project schedule, how project schedules are limited and created, develop project schedules, uncertainty in project schedules, Gantt chart Teaching Learning Process: Chalk and Talk/PPT			
MODULE – 3			9 Hours
Resourcing Projects: Importance of Resource Planning Abilities needed when resourcing projects, estimate resource needs, creating staffing management plan, Budgeting Projects: Cost planning, cost estimating, cost budgeting, establishing cost control. Project Risk Planning: Project Risk Planning: Planning, identifying, analysing, and responding to project risks. Project Quality Planning: Development of quality concepts, project quality management plan, project quality tools, PMI and key contributions of PMI Teaching Learning Process: Chalk and Talk/PPT			
MODULE – 4			9 Hours
Performing Projects: Project supply chain management: - Plan purchasing and acquisitions, plan contracting, contract types, project partnering and collaborations, Project Progress and Results: Project Balanced Scorecard Approach, issues faced in performing projects, Managing Project Deliverables. Terminate project early, secure customer feedback and approval, knowledge management, perform administrative and contract closure. Two case studies Teaching Learning Process: Chalk and Talk/PPT			

MODULE – 5	9 Hours
Network Analysis: Introduction, network construction - rules, Fulkerson's rule for numbering the events, AON and AOA diagrams; Critical path method (CPM) to find the expected completion time of a project, floats; PERT for finding expected duration of an activity and project, determining the probability of completing a project, predicting the completion time of project. simple numericals Teaching Learning Process: Chalk and Talk/PPT	

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Understand the selection, prioritization and initiation of individual projects and strategic role of project management
CO2	Understand the work breakdown structure by integrating it with organization
CO3	Understand the scheduling and uncertainty in projects. Understand risk management planning
CO4	Understand the activities like purchasing, acquisitions, contracting, partnering and collaborations related to performing projects.
CO5	Draw the network diagram to calculate the duration of the project and reduce it using crashing.

2, 3 and 4-Credit Theory Courses			
Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
- The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE. - If any courses of 3 credits are of Integrated Course type, for such courses the method suggested for 4 credits IPCC shall be followed.			



Suggested Learning Resources:

Text Books:

1. Project Management Timothy J. Kloppenborg Cengage Learning Edition 2023
2. Project Management - A systems approach to planning scheduling and controlling Harold Kerzner Wiley, Edition 2025
3. Project Management S Choudhury McGraw Hill Education (India) Pvt. Ltd., New Delhi: 2016

Reference Books:

1. Project Management – A Moder Joseph J. Moder and Cecil R. Phillips Van Nostrand Reinhold, New York :1983
2. Project Management Bhavesh M. Patel Vikas Publishing House 3rd Edition, 2024

Web links and Video Lectures (e-Resources):

1. <https://www.coursera.org/articles/project-management-basics-video>
2. <https://www.udemy.com/course/project-management-fundamentals-guide/>

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

3. Term Projects
4. Course seminar



ESTD : 2001

An Institute with a Difference

B.E. (Mechanical Engineering)			
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)			
SEMESTER – VI			
Course Title:	COMPUTER AIDED MODELLING AND ANALYSIS LAB		
Course Code:	BMEL616	CIE MARKS	50
L : T : P + (SL)	0 : 2 : 2 : 0	SEE MARKS	50
Credits:	02	EXAM HOURS	3
Total hours of Pedagogy	15 sessions	TOTAL MARKS	100
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i>			
- To acquire basic understanding of Modeling 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 learn to apply the basic principles to carry out dynamic analysis to know the natural frequencies of different kind of beams.			
Sl No	Experiments		
PART A			
1.	Study of a FEA package and modelling and stress analysis of: a. Bars of constant cross section area, tapered cross section area and stepped bar b. Trusses – (Minimum 2 exercises of different types) c. Beams – Simply supported, cantilever, beams with point load, UDL, beams with varying load etc. (Minimum 6 exercises) Stress analysis of a rectangular plate with a circular hole.		
PART B			
2.	Thermal Analysis – 1D & 2D problem with conduction and convection boundary conditions (Minimum 4 exercises of different types).		
3.	Dynamic Analysis to find: a. Natural frequency of beam with fixed – fixed end condition b. Response of beam with fixed – fixed end conditions subjected to forcing function Response of Bar subjected to forcing functions		
PART C (only for demo)			
4.	a. Demonstrate the use of graphics standards (IGES, STEP etc.) to import the model from modeler to solver. b. Demonstrate one example of contact analysis to learn the procedure to carry out contact analysis. Demonstrate at least two different types of examples to model and analyze bars or plates made from composite material.		

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Use the modern tools to formulate the problem, create geometry, discretize, apply boundary conditions to solve problems of bars, truss, beams, and plate to find stresses with different-loading conditions.
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CO2	Demonstrate the ability to obtain deflection of beams subjected to point, uniformly distributed and varying loads and use the available results to draw shear force and bending moment diagrams.
CO3	Analyze and solve 1D and 2D heat transfer conduction and convection problems with different boundary conditions.
CO4	Carry out dynamic analysis and finding natural frequencies of beams and bars for various boundary conditions and also carry out dynamic analysis with forcing functions.
CO5	Carry out the stress analysis of plates and 2D brackets for various boundary condition.

2-Credit Lab Course			
Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE Practical (A)	30	-	Marks awarded for Weekly Conduction of Experiments and Submission of Laboratory records, scaled to 30 marks.
CIE Practical Test (B)	20	-	Average of marks of Two tests, each conducted for 100 marks covering all experiments, scaled to 20.
Total CIE Practical (A+B)	50	20	Sum of Marks of Experiments, Record and Test shall be CIE marks awarded for a maximum of 50.
SEE (C)	50	20	SEE is a lab exam, conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

SUGGESTED LEARNING RESOURCES:

1. Erik G. Thompson, Introduction to the Finite Element Method: Theory, Programming and Applications, John Wiley
2. <https://online-learning.tudelft.nl/courses/linear-modeling-fem/>



ABILITY ENHANCEMENT/SKILL ENHANCEMENT(AEC/SEC) COURSES

An Institute with a Difference

B.E. (Mechanical Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VI			
Course Title:	Basics of MATLAB		
Course Code:	BME657A	CIE MARKS	50
L : T : P + (SL)	0 : 0 : 2	SEE MARKS	50
Credits:	1	EXAM HOURS	3
Total hours of Pedagogy	15 sessions	TOTAL MARKS	100
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> • To know about fundamentals of MATLAB tool. • To provide an overview to program curve fitting & solve Linear and Nonlinear Equations. • To understand the concept and importance of Fourier transforms. • To gain knowledge about MATLAB Simulink & solve engineering problems.			
Sln0	Experiments		
1	Introduction to MATLAB Programming: Basics of MATLAB Programming, array operations in MATLAB, loops and execution of control, working with files: Scripts and functions, plotting and programming output, examples.		
2	Numerical Methods and their applications: Curve Fitting: Straight line fit, Polynomial fit.		
3	Numerical Integration and Differentiation: Trapezoidal method, Simpson method.		
4	Linear and Nonlinear Equations: Eigen values, Eigen vectors, Solution of linear algebraic equations using Gauss Elimination, Solution of nonlinear equation in single variable Newton-Raphson method.		
5	Ordinary Differential Equations: Introduction to ODE's, Euler's method, second order Runge Kutta method, MATLAB ode45 algorithm in single variable and multivariable		
6	Application of MATLAB to analyse problems in basic engineering mechanics, mechanical vibrations, control system, statistics and dynamics of different circuits.		
7	MATLAB Simulink: Introduction to MATLAB Simulink, Simulink libraries, development of basic models		

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Implement loops, branching, control instruction and functions in MATLAB programming environment.
CO2	Programming for curve fitting, numerical differentiation and integration, solution of linear equations in MATLAB and solve engineering problems.
CO3	Understand implementation of ODE using ode 45 and execute Solutions of nonlinear equations in MATLAB.
CO4	Simulate MATLAB Simulink examples.

1-Credit Lab Course			
Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE Practical (A)	30	-	Marks awarded for Weekly Conduction of Experiments and Submission of Laboratory records, scaled to 30 marks.
CIE Practical Test (B)	20	-	Average of marks of Two tests, each conducted for 100 marks covering all experiments, scaled to 20.
Total CIE Practical (A+B)	50	20	Sum of Marks of Experiments, Record and Test shall be CIE marks awarded for a maximum of 50.
SEE (C)	50	20	SEE is a lab exam, conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

SUGGESTED LEARNING RESOURCES:

1.MATLAB-An Introduction with Applications-Amos Gilat,John Wiley & Sons,Inc

An Institute with a Difference

B.E. (Mechanical Engineering)			
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)			
SEMESTER – VI			
Course Title:	Introduction to Machine Learning for Mechanical Engineers		
Course Code:	BMEL657B	CIE MARKS	50
L : T : P + (SL)	0 : 0 : 2	SEE MARKS	50
Credits:	1	EXAM HOURS	3
Total hours of Pedagogy	15 sessions	TOTAL MARKS	100
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i>			
- Introduce basic concepts of Machine Learning for engineering applications. - Help mechanical engineering students understand data-driven problem solving. - Expose students to simple and commonly used learning models. - Relate machine learning concepts to mechanical engineering systems.			
Slno	Experiments		
1.	Demonstrate the setup of Python Machine Learning environment using Anaconda/Jupyter Notebook and illustrate the usage of NumPy, Pandas, Matplotlib, and Scikit-learn libraries with suitable examples.		
2.	Demonstrate data handling and preprocessing techniques using Pandas: loading datasets, handling missing values, feature selection, basic statistical analysis, data visualization using Matplotlib.		
3.	Implement Simple Linear Regression using Scikit-learn to predict continuous values and evaluate the model using appropriate performance metrics.		
4.	Implement Multiple Linear Regression using real-world datasets and analyze the impact of multiple independent variables on prediction accuracy.		
5.	Implement Polynomial Regression to model non-linear relationships and compare the results with Linear Regression.		
6.	Implement Logistic Regression for binary classification problems and evaluate the model using accuracy, confusion matrix, precision, and recall.		
7.	Implement supervised learning models using: Decision Tree Classifier, k-Nearest Neighbors (kNN) and compare their performance on a given dataset.		
8.	Implement Unsupervised Learning using K-Means Clustering to group unlabelled data and visualize the clusters using appropriate plots.		
9.	Demonstrate model evaluation and validation techniques using: Train–Test split, Cross-Validation, Comparison of multiple machine learning models.		
10.	Develop an end-to-end Machine Learning mini-project involving data preprocessing, feature engineering, model training, evaluation, and interpretation of results using a real-world dataset.		
COURSE OUTCOMES:			
After successfully completing the course, the student will be able to:			
CO1	Explain basic concepts of machine learning and their relevance to mechanical engineering.		
CO2	Prepare and preprocess engineering data for machine learning applications.		
CO3	Apply regression techniques for prediction in mechanical systems.		
CO4	Apply classification algorithms for engineering problem solving.		
CO5	Apply clustering techniques and evaluate machine learning models.		

1-Credit Lab Course			
Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE Practical (A)	30	-	Marks awarded for Weekly Conduction of Experiments and Submission of Laboratory records, scaled to 30 marks.
CIE Practical Test (B)	20	-	Average of marks of Two tests, each conducted for 100 marks covering all experiments, scaled to 20.
Total CIE Practical (A+B)	50	20	Sum of Marks of Experiments, Record and Test shall be CIE marks awarded for a maximum of 50.
SEE (C)	50	20	SEE is a lab exam, conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

SUGGESTED LEARNING RESOURCES:

Suggested Learning Resources:

Text Books

- S. Sridhar and M. Vijayalakshmi, Machine Learning, Oxford University Press, 2021.
- M. N. Murty and Ananthanarayana V. S., Machine Learning: Theory and Practice, Universities Press (India) Pvt. Ltd., 2024.

Reference Books:

- Ethem Alpaydin, Introduction to Machine Learning, 3rd Edition, MIT Press, 2014.
- Tom M. Mitchell, Machine Learning, McGraw-Hill Education, International Edition.
- Aurélien Géron, Hands-On Machine Learning with Scikit-Learn and TensorFlow, O'Reilly Media.
- Trevor Hastie, Robert Tibshirani, and Jerome Friedman, The Elements of Statistical Learning, Springer.

Web links and Video Lectures (e-Resources):

- https://www.drssridhar.com/?page_id=1053
- <https://www.universitiespress.com/resources?id=9789393330697>
- https://onlinecourses.nptel.ac.in/noc23_cs18/preview
- <https://www.geeksforgeeks.org/machine-learning/>
- https://www.w3schools.com/python/python_ml_getting_started.asp
- https://www.tutorialspoint.com/machine_learning/index.h

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

Course project by taking suitable machine learning-based real-world application problem.

B.E. (Mechanical Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VI			
Course Title:	Introduction to Cloud-Based CRM Platform lab		
Course Code:	BMEL657C	CIE MARKS	50
L : T : P + (SL)	0 : 0 : 2	SEE MARKS	50
Credits:	1	EXAM HOURS	3
Total hours of Pedagogy	15 sessions	TOTAL MARKS	100
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> - Introduce the fundamentals of cloud computing and cloud-based CRM platforms. - Familiarize with the architecture and features of CRM systems. - Develop hands-on skills in configuring and customizing a cloud-based CRM platform. - Enable creation and management of data models, workflows, and automation tools in CRM. - Enhance understanding of business processes and their integration with CRM solutions.			
Slno	Experiments		
1.	Create a free Salesforce Developer Org		
2.	Trailhead Playground Management: Create a Trailhead Playground, Get Your Trailhead Playground Username and Password, Install Apps and Packages in Your Trailhead Playground Reference: Create a Trailhead Playground Salesforce Trailhead		
3.	Salesforce Platform Basics: Get introduced to the platform, navigate use cases, and build custom functionality; Unlock Business Success with Salesforce Data Platform, Discover Use Cases for the Platform, Understand the Salesforce Architecture, Navigate Setup, Power Up with AppExchange. Reference: Salesforce Platform Basics Salesforce Trailhead		
4.	Data Modeling: Give your data structure with objects, fields, and relationships; Optimize Customer Data with Standard and Custom Objects, Create Object Relationships, Work with Schema Builder Reference: Data Modeling Salesforce Trailhead		
5.	Data Management: Learn how to import and export data in Salesforce; Import Data, Export Data. Reference: Data Management Salesforce Trailhead		
6.	Lightning Experience Customization Level 1: Customize the Lightning Experience user interface without writing any code; Set Up Your Org, Create and Customize Lightning Apps, Create and Customize List Views, Reference: Lightning Experience Customization Salesforce Trailhead		
7.	Lightning Experience Customization Level 2: Customize the Lightning Experience user interface without writing any code; Customize Record Highlights with Compact Layouts, Customize Record Page Components and Fields, Create Custom Buttons and Links, Empower Your Users with Quick Actions. Reference: Lightning Experience Customization Salesforce Trailhead		
8.	User Engagement: Create in-app guidance to help users get the most value out of your Salesforce app; Get Started with User Engagement, Promote Feature Adoption and Discovery, Create Prompts in Lightning Experience, Enable Users to Learn in the Flow of Work, Design a User Engagement Journey. Reference: User Engagement Salesforce Trailhead		
9.	Reports & Dashboards for Lightning Experience: Visualize key business metrics in real-time using Lightning Experience; Get to Know Lightning Reports and Dashboards, Create Reports		



	with the Report Builder, Filter Your Report, Format Your Report, Visualize Your Data with the Lightning Dashboard Builder. Reference: Reports & Dashboards for Lightning Experience Salesforce Trailhead
10.	Advanced Exercises (Not for CIE/SEE Evaluation) Become an Agentblazer Champion 2026: Learn and apply core Artificial Intelligence concepts using Salesforce Trailhead; Get Started with AI Basics, Understand Generative AI, NLP, and Large Language Models, Explore Salesforce AI and Data Foundations, Learn Prompt Engineering and Prompt Builder, Understand Ethical AI and Einstein Trust Layer, Explore Autonomous Agents, Get Introduced to Agentforce, Build and Customize AI Agents using Agentforce Builder, Implement Service and Employee Agents through Hands-on Practice. Reference: Become an Agentblazer Champion 2026 Salesforce Trailhead

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Understand the basic concepts of cloud computing and CRM platforms.
CO2	Demonstrate the ability to navigate and use a cloud-based CRM environment.
CO3	Configure and customize CRM applications to meet business requirements.
CO4	Design and manage data, reports, and dashboards in CRM systems.
CO5	Implement automation tools such as workflows and validation rules in CRM.

1-Credit Lab Course			
Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE Practical (A)	30	-	Marks awarded for Weekly Conduction of Experiments and Submission of Laboratory records, scaled to 30 marks.
CIE Practical Test (B)	20	-	Average of marks of Two tests, each conducted for 100 marks covering all experiments, scaled to 20.
Total CIE Practical (A+B)	50	20	Sum of Marks of Experiments, Record and Test shall be CIE marks awarded for a maximum of 50.
SEE (C)	50	20	SEE is a lab exam, conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in

			Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

SUGGESTED LEARNING RESOURCES:

Books

- "Salesforce for Beginners: A Step-by-Step Guide to Creating, Managing, and Automating Sales and Marketing Processes" by Sharif Shaalan, www.packt.com.
- "Salesforce.com For Dummies" by Tom Wong, Liz Kao, and Matt Kaufman, For Dummies
- "Salesforce Essentials for Administrators" by Maria Nordin, Packt Publishing
- "Salesforce Handbook" by Wes Nolte and Jeff Douglas, Lulu.com
- "Mastering Salesforce CRM Administration" by Rakesh Gupta, Packt Publishing

Web links and Video Lectures (e-Resources):

- https://trailhead.salesforce.com/content/learn/modules/starting_force_com?trail_id=force_com_admin_beginner
- https://trailhead.salesforce.com/content/learn/modules/data_modeling?trail_id=force_com_admin_beginner
- https://trailhead.salesforce.com/content/learn/modules/lex_implementation_data_management?trail_id=force_com_admin_beginner
- https://trailhead.salesforce.com/content/learn/modules/lex_customization?trail_id=force_com_admin_beginner
- https://trailhead.salesforce.com/content/learn/modules/user-engagement?trail_id=force_com_admin_beginner
- https://trailhead.salesforce.com/content/learn/modules/lex_implementation_reports_dashboards?trail_id=force_com_admin_beginner

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

- Walkthrough session on setting up a Salesforce Developer Org.
- Demonstration on creating a Trailhead Playground.
- Case study analysis or scenario-based exercise.

B.E. (Mechanical Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VI			
Course Title:	INTERNET OF THINGS LAB		
Course Code:	BMEL657D	CIE MARKS	50
L : T : P + (SL)	0:0:2:0	SEE MARKS	50
Credits:	1	EXAM HOURS	3
Total hours of Pedagogy	15 sessions	TOTAL MARKS	100
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> - Understand the design, characteristics and technologies of Internet of Things - Interpret the impact and challenges posed by IoT networks leading to new architectural models. - Compare and contrast the deployment of smart objects and the technologies to connect them to network. - Appraise the role of IoT protocols for efficient network communication - Illustrate different sensor technologies for sensing real world entities and identify the applications of IoT in Industry			
Sl No	Experiments		
1	Interfacing Light Emitting Diode(LED)- Blinking LED and Controlling the Light Emitting Diode (LED) with a push button		
2	Controlling the LED blink rate with the potentiometer interfacing with Arduino.		
3	Interfacing Light Dependent Resistor (LDR) and LED, displaying automatic night lamp		
4	Interfacing Temperature Sensor (LM35) and/or humidity sensor (e.g.DHT11).		
5	Interfacing Liquid Crystal Display (LCD) – display data generated by sensor on LCD.		
6	Interfacing Air Quality Sensor-pollution (e.g. MQ135) – display data on LCD switch on LED when data sensed is higher than specified value.		
7	Interfacing Relay module to demonstrate Bluetooth based home automation application. (using Bluetooth and relay).		
8	Interfacing Bluetooth module (e.g. HC05)- receiving data from mobile phone on Arduino and display on LCD		
9	Potentiometer and IR Sensor Interfacing With Arduino		
10	Controlling Two Actuators Using Arduino		
11	Iot Based Air Pollution Control System		
12	TDs Sensor Interfacing With Arduino		
13	Actuator Controlling by Mobile Using Arduino		
14	Detection of the light using photo resistor		
15	Interfacing of the Active Buzzer with Arduino		
16	Interfacing Servo Motor with the Arduino		
17	Interfacing of the Relay with Arduino		
18	Building Intrusion Detection System with Arduino and Ultrasonic sensor		

19	Directional Control of the DC motor using Arduino
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COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Choose the sensors and actuators for an IoT application
CO2	Select protocols for a specific IoT application
CO3	Utilize the cloud platform and APIs for IoT application
CO4	Experiment with embedded boards for creating IoT prototypes
CO5	Design a solution for a given IoT application

1-Credit Lab Course			
Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE Practical (A)	30	-	Marks awarded for Weekly Conduction of Experiments and Submission of Laboratory records, scaled to 30 marks.
CIE Practical Test (B)	20	-	Average of marks of Two tests, each conducted for 100 marks covering all experiments, scaled to 20.
Total CIE Practical (A+B)	50	20	Sum of Marks of Experiments, Record and Test shall be CIE marks awarded for a maximum of 50.
SEE (C)	50	20	SEE is a lab exam, conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

SUGGESTED LEARNING RESOURCES:

Text book:

- Internet of Things (IoT) — *Surya Durbha & Jyoti Joglekar*

2. Programming the Internet of Things: An Introduction to Building Integrated, Device-to-Cloud IoT Solutions — *Andy King (O'Reilly)*
3. Enabling the Internet of Things: Fundamentals, Design and Applications — *Muhammad Azhar Iqbal et al.*
4. Internet of Things from Scratch — *Renaldi Gondosubroto*

Web links and video lectures (e-resources):

MOOC Practical IoT with Raspberry Pi – a full YouTube playlist on hands-on IoT using Raspberry Pi:

- https://www.youtube.com/playlist?list=PL8bSwVy8_IcO1kFUjq-9rU12u2JYU0u3H

IoT / Arduino / Raspberry Pi Projects – IoT project playlist with sensor and cloud demos:

- <https://www.youtube.com/playlist?list=PLCH9hVc2IAZZ8ncN8E0HtnvFwgbOiolP>

IoT Lab – Raspberry Pi & NodeMCU Experiments – a practical lab demo video:

- <https://www.youtube.com/watch?v=UhH0NbPTY-M>



ESTD : 2001

An Institute with a Difference

B.E. (Common to All Branches)			
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)			
SEMESTER – VI			
Course Title:	Indian Knowledge Systems		
Course Code:	BIKS608	CIE MARKS	100
(L :T : P) + SL	(1:0:0) + (15 hrs/semester)	SEE MARKS	-
Credits:	1	EXAM HOURS	3
COURSE LEARNING OBJECTIVES:			
<i>The purpose of the course is</i>			
1. To facilitate the students with the concepts of Indian traditional knowledge and to make them understand the Importance of roots of knowledge system. 2. To make the students understand the traditional knowledge and analyze it and apply it to their day-to-day life.			
Module-1		5 hrs	
Introduction to Indian Knowledge Systems (IKS): Overview, Importance of ancient knowledge, The IKS corpus, Vedic Corpus, Philosophical systems, Character scope and importance, traditional knowledge vis-a-vis indigenous knowledge, traditional knowledge vs. western knowledge.			
Module-2		5 hrs	
Fundamental concepts for science and technology: Linguistics, Numbers and measurements- Mathematics, Chemistry, Physics, Art, Astronomy, Astrology, Crafts and Trade in India and Engineering and Technology.			
Module-3		5 hrs	
Traditional Knowledge in Professional Domain: Town planning and architecture, Construction, Health, wellness and Psychology-Medicine, Agriculture, Governance and Public administration.			

COURSE OUTCOMES: *After successfully completing the course, the student will be able to:*

CO1	Provide an overview of the concept of the Indian Knowledge System and its
CO2	Appreciate the need for and importance of protecting traditional knowledge.
CO3	Recognize the relevance of Traditional knowledge in different domains.
CO4	Establish the significance of Indian Knowledge systems in the contemporary world.

ASSESSMENT DETAILS (CIE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	40	--	Each test will be conducted for 25 Marks adding upto 50 marks. Final test marks will be reduced to 40 Marks
Experimental Learning (B)	40	---	Case Study-based Teaching-Learning. Video-based Seminar (4-5 minutes per student on a relevant IKS topic)
Quiz(C)	20	---	Each quiz is evaluated for 10 marks adding up to 20 Marks.
Total CIE (A+B+C)	100	40	CIE Evaluation is done for a maximum of 100 marks

Suggested Learning Resources:

Text Book:

1. Introduction to Indian Knowledge System- concepts and applications, B Mahadevan, Vinayak Rajat Bhat, Nagendra Pavana R N, 2022, PHI Learning Private Ltd, ISBN-978-93- 91818-21-0M. M. Mano, Digital Logic and Computer Design. PHI Learning, 2008. ISBN: 978-81-203-0417-84.

Reference Books:

2. Traditional Knowledge System in India, Amit Jha, 2009, Atlantic Publishers and Distributors (P) Ltd., ISBN-13: 978-8126912230
3. Knowledge Traditions and Practices of India, Kapil Kapoor, Avadesh Kumar Singh, Vol. 1, 2005, DK Print World (P) Ltd., ISBN 81-246-0334

Suggested Web Links:

1. <https://www.youtube.com/watch?v=LZP1StpYEPM>
2. <http://nptel.ac.in/courses/121106003/>
3. <http://www.iitkgp.ac.in/departments/KS;jsessionid=C5042785F727F6EB46CBF432D7683B63> (Centre of Excellence for Indian Knowledge System, IIT Kharagpur)
4. https://www.wipo.int/pressroom/en/briefs/tk_ip.html
5. https://unctad.org/system/files/official-document/ditcted10_en.pdf
6. http://nbaindia.org/uploaded/docs/traditionalknowledge_190707.pdf
7. https://unfoundation.org/what-we-do/issues/sustainable-development-goals/?gclid=EAIaIQobChMIInp-Jtb_p8gIVTeN3Ch27LAmPEAAAYASAAEgIm1vD_BwE

B.E. (Common to All Branches) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VI			
Course Title:	NSS-National Service Scheme		
Course Code:	BNSK659	CIE MARKS	100
L : T : P:	0:0:0:30	SEE MARKS	0
Credits:	0	EXAM HOURS	-
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> 1. Identify the needs and problems of the community and involve the problem-solving. 2. Develop among them a sense of social & civic responsibility & utilize their knowledge in finding practical solutions to individual and community problems. 3. Develop competence required for group-living and sharing of responsibilities & gain skills in mobilising community participation to acquire leadership qualities and democratic attitudes.			
Module-1			
Contribution to national-level initiatives of the Government of India, such as Digital India, Skill India, Swachh Bharat, Atmanirbhar Bharat, Make in India, the Mudra Scheme, and other skill development programs.			
Module-2			
Spreading public awareness through rural outreach programs. (minimum 5 programs).			
Module-3			
Innovative approaches to assist in the marketing of rural produce			
Module-4			
Creating awareness on rainwater harvesting in Urban areas.			
Module-5			
Creating awareness on digital payment frauds to locals.			

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Identify and analyze community needs and actively participate in solving social issues through NSS activities.
CO2	Demonstrate social and civic responsibility by engaging in national initiatives and rural outreach programs.
CO3	Develop leadership qualities, teamwork skills, and the ability to mobilize community participation effectively.
CO4	Apply innovative approaches to address real-world problems such as rural development, environmental sustainability, and digital awareness.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
Evaluation based on Reports (A)	100	-	5 modules Reports, 5 modules X 10 M each = 50 M
Total CIE Theory (A)	100	40	
SEE (B)	-	-	-
CIE+SEE (A+B)	100	40	Final marks shall be the sum of marks scored in Components A, B
- The minimum marks to be secured in CIE is 40 out of allotted 50 marks with minimum 40 % scored in every component of CIE. - No SEE for this subject			

Suggested Learning Resources:

Reference Books:

- 1) NSS Course Manual, Published by NSS Cell, VTU Belagavi.
- 2) Government of Karnataka, NSS cell, activities reports and its manual.
- 3) Government of India, NSS cell, Activities reports and its manual.

Web links:

- 1) <https://nss.gov.in/>
- 2) <https://pledge.mygov.in/>

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B.E. (Mechanical Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VI			
Course Title:	Physical Education		
Course Code:	BPEK659	CIE MARKS	100
L: T: P: S	0:0:1: 0	SEE MARKS	---
Credits:	---	EXAM HOURS	---
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> - Understand the fundamental concepts of Physical Education, games and sports skills, Health, Nutrition and Fitness - Familiarization of health-related Exercises, Sports for overall growth and development - Participate in the competition at regional/state / national / international levels. - Create consciousness among the students on Health, Fitness and Wellness in developing and maintaining a healthy lifestyle.			
Module-1: Title: Athletics - Track Events - Relays			3 HOURS
Relays Relay Race: Starting, Baton Holding/Carrying, Baton Exchange in between zone, and Finishing			
Module-2: Title: Athletics - Triple Jumps			3 HOURS
Triple Jump E) Approach Run F) Take-off G) Step, H) Flight in the Hop I) Jump and Landing			
Module-3: Title: Athletics - Throws			3 HOURS
Javelin Throw E) Grip F) Carry and Recovery (3/5 Impulse stride). G) Release			
Module-4: Title: CRICKET			3 HOURS
A. Fundamental skills - Batting - Forward Defense Stroke, Backward Defense Stroke, Off Drive, On - Drive, Straight Drive, Cover Drive, Square Cut. - Bowling -Out-swing, In-swing, Off Break, Leg Break and Googly. - Fielding: Catching - The High Catch, The Skim Catch, The Close Catch and throwing at the stumps from different angles. Long Barrier and Throw, Short Throw, Long Throw, Throwing on the Turn. - Wicket Keeping B. Rules and their interpretation and duties of the officials			

Module-5: Title: BASEBALL	3 HOURS
C. Fundamental skills 1. Player Stances – walking, extending walking, L stance, cat stance 2. Grip – standard grip, choke grip 3. Batting – swing and bunt. Pitching 4. Baseball: slider, fast pitch, curve ball, drop ball, rise ball, change up, knuckle ball, screw ball, D. Rules and their interpretation and duties of the officials	

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Demonstrate the techniques of relay races , including starting, baton holding, exchange within the zone, and finishing, along with basic skills of javelin throw.
CO2	Apply the fundamental techniques of triple jump , including approach run, take-off, hop, step, jump, flight, and landing.
CO3	Develop and perform javelin throw techniques , including grip, carry, impulse stride, release, and recovery with proper coordination.
CO4	Exhibit fundamental skills of cricket , including batting, bowling, fielding, wicket keeping, and understand rules and duties of officials.
CO5	Demonstrate basic skills and techniques in baseball , including player stances, grip, batting, pitching, and understand rules and officiating.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	60	---	Sum of Two Internal Assessment Tests (MCQs) each conducted for 30 marks.
Project (B)	40	---	-----
Total CIE (A+B)	100	40	CIE Evaluation is done for a maximum of 100 marks
The minimum marks to be secured in CIE is 40 (40%) out of 100 marks allotted to Pass.			

Textbooks:-

1. Health and Physical Education by V.K. Sharma

2. Introduction to Physical Education, Fitness, and Sport by Daryl Siedentop
3. Physical Education Activities, Sports and Games: The Origin and Background, Rules of Play, Teaching Hints and Fundamentals by Louis E. Means

Reference Books: -

1. Saraswati Health and Physical Education Textbook
2. Foundations of Physical Education, Exercise Science and Sport by Deborah A. Wuest



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B.E. (Common to all Branches) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VI			
Course Title:	Yoga		
Course Code:	BYOK659	CIE MARKS	100
L: T: P: S	0:0:1:0	SEE MARKS	---
Credits:	---	EXAM HOURS	---
COURSE LEARNING OBJECTIVES: <i>The purpose of the course is to facilitate the learner to:</i> 1. Physical, Mental & spiritual Objectives of Yoga 2. Explain the meaning of Yoga. 3. Discuss the importance of the Yoga and its scope. 4. Describe the aims and objectives of Yoga. 5. Clarify the misconceptions on Yoga			
Module-1: Title: Suryanamaskara			3 HOURS
Suryanamaskara - Revision of practice 12 count 8 rounds a) Suryanamaskar prayer. b) Meaning, need & Importance c) Benefits of Suryanamaskara			
Module-2: Title: Asanas			3 HOURS
Need & importance of different Asana, Asana its meaning by name, technique, precautionary measures and benefits of each asana. Sitting: 1. Bakasana 2. Hanumanasana 3. Yogamudra in Vajrasana Standing: 1. Vatayanasana 2. Garudasana			
Module-3: Title: Asanas			3 HOURS
Need, importance of Asana. Different types, Asana by name, technique, precautionary measures and benefits of each asana Prone line 1. Bhujangasana 2. Shalabh asana Supine line 1. Utthita dvipadasana, 2. Ardha halasana Balancing 1. Sheershasana			
Module-4: Title: Pranayama			3 HOURS
Kapalabhati - Revision of Kapalabhati practice 80 strokes/min 3 rounds			
Module-5: Title: Pranayama			3 HOURS

Pranayam 1. Bhastrika
2. Bhramari

Meaning, Need, importance of Pranayama. Different types. Meaning by name, technique, precautionary measures and benefits of each Pranayama

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Explain the meaning, objectives, scope, and importance of Yoga, including its physical, mental, and spiritual benefits and misconceptions.
CO2	Demonstrate Suryanamaskara (12 counts, 8 rounds) with correct technique, prayer, and understanding of its need and benefits.
CO3	Perform sitting and standing Asanas (Bakasana, Hanumanasana, Yogamudra in Vajrasana, Vatayanasana, Garudasana) with proper technique, precautions, and
CO4	Execute prone, supine, and balancing Asanas (Bhujangasana, Shalabhasana, Utthita Dvipadasana, Ardha Halasana, Sheershasana) with correct body alignment and
CO5	Practice Pranayama techniques (Kapalabhati, Bhastrika, Bhramari) with proper method, breathing control, and understanding of their importance and health

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	60	---	Sum of Two Internal Assessment Tests (MCQs) each conducted for 30 marks.
Project (B)	40	---	-----
Total CIE (A+B)	100	40	CIE Evaluation is done for a maximum of 100 marks
The minimum marks to be secured in CIE is 40 (40%) out of 100 marks allotted to Pass.			

Suggested Learning Resources:

Textbooks

1. The Yoga Sutras of Patanjali – Sri Swami Satchidananda.
2. Light on Yoga — B.K.S Iyengar.

Reference Books: -

1. The Heart of Yoga — T.K.V Desikachar.
2. Asana Pranayama Mudra Bandha by Swami Satyananda Saraswati.



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CORE COURSES VII-SEM

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B.E. (Mechanical Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VII			
COURSE TITLE	FINITE ELEMENT METHODS		
COURSE CODE	BME701	CIE MARKS	50
L : T : P : S	3 : 2 : 0 : 0	SEE MARKS	50
CREDITS	4	EXAM HOURS	3
TOTAL HOURS OF PEDAGOGY	45 Hours Theory	Total Marks	100
COURSE LEARNING OBJECTIVES: The purpose of the course is to facilitate the learner to: ➤ Understand the fundamental principles of Finite Element Method and elasticity for engineering analysis. ➤ Apply numerical methods and energy principles in formulating simple finite element models. ➤ Develop finite element formulations for one-dimensional structural elements. ➤ Analyse structural and thermal problems using appropriate finite element procedures. ➤ Interpret dynamic and heat transfer behaviour of engineering systems using FEM concepts.			
MODULE – 1			9 Hours
Introduction to FEM: Introduction to FEM, engineering applications, advantages, General steps, Element types, Convergence criteria, Coordinate systems, commercial packages- pre-processor, solver and post processor. Principles of Elasticity: Strain- displacement relations, Stress- strain relations for 1D, 2D, and 3D cases, Plain stress and Plain strain conditions, differential equations of equilibrium for 2D. Introduction to Numerical Methods, Potential energy method, Rayleigh-Ritz method - applied to simple problems on axially loaded members, cantilever, simply supported beams, with point loads and distributed loads.			
BTL: Remember, Understand, Apply (L1, L2, L3) Teaching Learning Process: Chalk and Talk			
MODULE – 2			9 Hours
One Dimensional Element: Formulation of a linear bar element, Shape Functions- Polynomial, The Potential Energy Approach, derivation of stiffness matrix, Properties of stiffness matrix, Assembly of Global Stiffness Matrix and Load Vector, Boundary conditions- elimination method and penalty method . Numerical Problems on straight and stepped bars. (Problems with 2 elements only)			
BTL: Remember, Understand, Apply (L1, L2, L3) Teaching Learning Process: Chalk and Talk			
MODULE – 3			9 Hours
Trusses and Beams: Formulation plane trusses element, Stiffness matrix for a derivation for a truss element, Numerical Problems on point load, Formulation beam element, derivation of Hermite shape functions, Stiffness matrix for a beam using Euler-Bernoulli beam theory and load vector, Numerical Problems on beams carrying concentrated, UDL and couples. (Problems with 2 elements only).			
BTL: Remember, Understand, Apply (L1, L2, L3) Teaching Learning Process: Chalk and Talk			

MODULE – 4	9 Hours
Two-dimensional Element: Formulation of triangular and quadrilateral elements. Displacement models and shape functions for linear and higher order elements, Lagrangian and serendipity elements, Iso parametric – sub parametric – super parametric elements, Introduction to axisymmetric– triangular elements. Convergence criteria, pascal triangle. <i>BTL: Remember, Understand, Apply (L1, L2, L3)</i> <i>Teaching Learning Process: Chalk and Talk</i>	
MODULE – 5	9 Hours
Dynamic considerations: Formulation for point mass and distributed masses, Consistent mass matrices for 1-D bar element, computation of eigen values and eigen vectors. Numerical Problems on straight and stepped bars. Heat Transfer Problems: Steady state heat transfer, 1D heat conduction governing equation, boundary conditions, Numerical problems on composite wall, 1D heat transfer in thin fins. <i>BTL: Remember, Understand, Apply (L1, L2, L3)</i> <i>Teaching Learning Process: Chalk and Talk</i>	

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Explain the fundamentals of FEM, elasticity relations, and energy-based numerical methods for simple structural problems.
CO2	Formulate and solve one-dimensional bar problems using stiffness matrix approach and boundary conditions.
CO3	Apply finite element formulation to analyze plane trusses and beam elements under various loading conditions.
CO4	Explain the formulation and characteristics of two-dimensional finite elements and isoparametric concepts.
CO5	Analyze basic dynamic and steady-state heat transfer problems using finite element formulation.

2, 3 and 4-Credit Theory Courses			
Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.

Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
- The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE. - If any courses of 3 credits are of Integrated Course type, for such courses the method suggested for 4 credits IPCC shall be followed.			

Suggested Learning Resources:

Text Books:

1. Logan, D. L., A first course in the finite element method, 6th Edition, Cengage Learning, 2016.
2. Rao, S. S., Finite element method in engineering, 5th Edition, Pergaman Int. Library of Science, 2010.
3. Chandrupatla T. R., Finite Elements in engineering, 2nd Edition, PHI, 2013.
4. O. C. Zienkiewicz and Y.K. Cheung, The Finite Element Method in Structural and Soil Mechanics, McGraw Hill, London

Reference Books:

1. J.N.Reddy, "Finite Element Method"- McGraw -Hill International Edition. Bathe K. J. Finite Elements Procedures, PHI.
2. Cook R. D., et al. "Concepts and Application of Finite Elements Analysis"- 4th Edition, Wiley & Sons, 2003.
3. C.S.Krishnamoorthy, Finite Element Analysis, Tata McGraw-Hill David V. Hutton, Fundamentals of Finite Element Analysis, McGraw Hill
4. D. Maity, Computer Analysis of Framed Structures, I.K. International Pvt. Ltd. New Delhi
5. Erik G. Thompson, Introduction to the Finite Element Method: Theory, Programming and Applications, John Wiley

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

1. <https://www.edx.org/course/hands-introduction-engineering-cornellx-engr2000x>
2. <http://nptel.ac.in/courses/112104115/>
3. <https://www.coursetalk.com/providers/mit/courses/finite-element-analysis-of-solids-and-fluids-i>
4. <https://online-learning.tudelft.nl/courses/linear-modeling-fem/>

B.E. (Mechanical Engineering) Outcome Based Education (OBE) and Choice Based Credit System(CBCS) SEMESTER – VII			
Course Title:	HYDRAULICS AND PNEUMATICS (IPCC)		
Course Code:	BME702	CIE MARKS	50
L : T : P + (SL)	3 : 0 : 2 (45 Hours/Sem)	SEE MARKS	50
Credits:	04	EXAM HOURS	03
Total Hours of Pedagogy	45 hours Theory+ 10 to 12 Lab slots	Total Marks	100
COURSE LEARNING OBJECTIVES: ➤ To provide an insight into the capabilities and applications of hydraulic and pneumatic fluid power. ➤ To understand concepts and relationships surrounding force, pressure, energy and power in fluid power systems. ➤ To examine concepts centering on sources of hydraulic power, rotary and linear actuators, distribution systems, hydraulic flow in pipes, and control components in fluid power systems. ➤ Exposure to build and interpret hydraulic and pneumatic circuits related to industrial applications. ➤ To familiarize with logic controls and trouble shooting			
MODULE – 1			9Hours
Introduction to fluid power systems Fluid power system: components, advantages and applications. Transmission of power at static and dynamic states, Pascal's law and its applications. Fluids for hydraulic system: types, properties, and selection. Additives, effect of temperature and pressure on hydraulic fluid. Seals, sealing materials, compatibility of seal with fluids. Fluid conditioning through filters, strainers; sources of contamination and contamination control; heat exchangers. Teaching Learning Process: Chalk and Talk / PPT / Field Visits/videos			
MODULE – 2			9Hours
Pumps and Actuators Pumps: Classification of pumps, pumping theory of positive displacement pumps, construction and working of Gear pumps, Vane pumps, Piston pumps, fixed and variable displacement pumps, Pump performance characteristics, pump selection factors, problems on pumps. Actuators: Classification cylinder and hydraulic motors, Hydraulic cylinders, single and double acting cylinder, mounting arrangements, cushioning, special types of cylinders, problems on cylinders. Construction and working of rotary actuators such as gear, vane, piston motors, and Hydraulic Motor. Theoretical torque, power, flow rate, and hydraulic motor performance; numerical problems. Symbolic representation of hydraulic actuators (cylinders and motors). Accumulators: Types, selection/applications of accumulators Teaching Learning Process: Chalk and Talk / PPT / Field Visits/videos			

MODULE – 3	9Hours
Components and Hydraulic Circuit Design Components: Classification of control valves, Directional Control Valves symbolic representation, constructional features of poppet, sliding spool, shuttle valve, and check valves. Pressure control valves types, direct operated types and pilot operated types. Flow Control Valves compensated and non-compensated FCV, needle valve, temperature compensated, pressure compensated, pressure and temperature compensated FCV, symbolic representation. Hydraulic Circuit Design: Control of single and Double acting hydraulic cylinder, regenerative circuit, pump unloading circuit, double pump hydraulic system, counterbalance valve application, hydraulic cylinder sequencing circuits, cylinder synchronizing circuit. using different methods, hydraulic circuit for force multiplication; speed control of hydraulic cylinder metering in, metering out. Hydraulic circuit examples with accumulator.	
Teaching Learning Process: Chalk and Talk / PPT / Field Visits/videos	
MODULE – 4	9Hours
Pneumatic Power Systems Introduction to Pneumatic systems: Pneumatic power system, advantages, limitations, applications, Choice of working medium. Characteristics of compressed air and air compressors. Structure of pneumatic control System, fluid conditioners, dryers and FRL unit. Pneumatic Actuators: Linear cylinder – types of cylinders, working, end position cushioning, seals, mounting arrangements, and applications. Rotary cylinders types, construction and application, symbols. Pneumatic Control Valves: DCV such as poppet, spool, suspended seat type slide valve, pressure control valves, flow control valves, types and construction, use of memory valve, Quick exhaust valve, time delay valve.	
MODULE – 5	9Hours
Pneumatic Control Circuits Simple Pneumatic Control: Direct and indirect actuation pneumatic cylinders, speed control of cylinders supply air throttling and exhaust air throttling. Signal Processing Elements: Use of Logic gates OR and AND gates in pneumatic applications. Practical examples involving the use of logic gates. PLC -based hydraulic and pneumatic system ,ladder diagram Multi Cylinder Application: Coordinated and sequential motion control, motion and control diagrams. Signal elimination methods, Cascading method principle, <u>Practical application examples (up to two cylinders) using cascading method (using reversing valves).</u>	
Teaching Learning Process: Chalk and Talk / PPT / Field Visits/videos	
PRACTICAL COMPONENT OF IPCC (May cover all / major modules)	
Experiments 1. a] Study of Construction and working Hydraulic pumps and Pneumatic b] Study of Hydraulic and Pneumatic valves. c] Study of solenoid valves, limit switches. Pressure, flow control valve 2. Basic hydraulic circuit for the working of double acting cylinder and a hydraulic motor	

3. Basic pneumatic circuit for the working of single and double acting cylinder.
4. Speed control circuits. Different Metering methods Inlet & outlet flow control (meter in & meter out circuit)
5. Circuits for the Use of different direction control valves and valve actuation in single and double acting cylinder, and multi actuation circuit.
6. Hydraulic Counterbalancing circuit
7. Hydraulic or Pneumatic Regenerative circuit.
8. Hydraulic or Pneumatic Sequencing circuit.

Demo experiments for CIE:

9. Circuit with cam operated pilot valves operating a pilot operated 4way direction control Valve or proximity/ limit switches, solenoid operated 4way direction control valve for Auto reversing circuit.
10. Study of hydraulics and Pneumatics circuit, based on the industrial application. (At least one in each)

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Identify and analyse the functional requirements of a fluid power transmission system for a given application.
CO2	Understand the operation, application, and maintenance of common fluid power components such as pumps, actuators and accumulators.
CO3	Design an appropriate hydraulic or pneumatic circuit or combination circuit like electro hydraulics, electro pneumatics for a given application.
CO4	Explain the pneumatic working media, applications and components of pneumatic system.
CO5	Develop a comprehensive circuit diagram by integrating the components selected for the given application using signal processing element.

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE- IA Tests (A)	20	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 20 marks.
Continuous and Comprehensive Evaluation (B)	10	-	Any one Assessment methods as per 24RNBE4.2 scaled to 10 marks.
Total CIE Theory (A+B)	30	12	Marks of Tests and Assignments awarded for a maximum of 30.
CIE Practical	12	-	Marks awarded for Weekly Conduction of Experiments and Submission of

			Laboratory records, scaled to 12 marks.
CIE Practical Test	8	-	Average of marks of Two tests, each conducted for 100 marks covering all experiments, scaled to 8.
Total CIE Practical (C)	20	8	Marks of Experiments, Record and Test awarded for a maximum of 20 marks.
CIE: Theory + Practical (A + B + C)	50	20	CIE Evaluation is done for a maximum of 50 marks.
SEE (D)	50	18	SEE is a theory exam, conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE+SEE (A+B+C+D)	100	40	Final marks shall be the sum of marks scored in Components A, B, C and D
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included in their respective modules only.			

SUGGESTED LEARNING RESOURCES:

Test Books

1. Anthony Esposito, "Fluid Power with applications", Pearson edition, Seventh edition 2014
2. Majumdar S.R., "Oil Hydraulics", Tala McGraw Hill, 2002.
3. Majumdar S.R., "Pneumatic systems Principles and Maintenance", Tata McGrawHill, New Delhi, 2005

Reference Books

1. John Pippenger, Tyler Hicks, "Industrial Hydraulics", McGraw Hill International Edition, 1980.
2. Andrew Par, Hydraulics and pneumatics, Jaico Publishing House, 2005.
3. FESTO, Fundamentals of Pneumatics, Vol I, II and III.
4. Herbert E. Merritt, "Hydraulic Control Systems", John Wiley and Sons, Inc.
5. Thomson, Introduction to Fluid power, Prentice Hall, 2004.
6. John Watton, "Fundamentals of fluid power control", Cambridge University press, 2012.

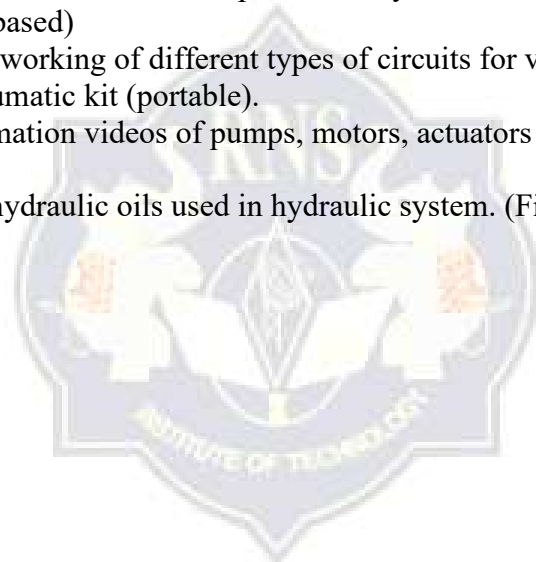
WEB LINKS AND VIDEO LECTURES (E-RESOURCES):

1. <https://nptel.ac.in/courses/112105047/>
2. <https://www.youtube.com/watch?v=8xd7cWvMrvE>
3. <https://nptel.ac.in/courses/105103096/>

4. <https://nptel.ac.in/courses/112105047/37>

ACTIVITY BASED LEARNING (SUGGESTED ACTIVITIES IN CLASS)/ PRACTICAL BASED LEARNING

1. Basic laws of hydraulics and Power in hydraulic system used in fluid power system.
2. Prepare working models of hydraulic crane using waste injections used by doctors. (Laboratory based)
3. Prepare report of agriculture equipment's working on hydraulics and pneumatics (Field based)
4. Collect technical specifications of pumps and motors and actuators. (Internet based)
5. Prepare visit report to observe use of pneumatic system used in automobile, Medical and agriculture (Field based)
6. Constructions and working of different types of circuits for various applications using hydraulic and pneumatic kit (portable).
7. Collections of animation videos of pumps, motors, actuators and Filters.(Software based)
8. Market survey of hydraulic oils used in hydraulic system. (Field based)



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B.E. (Mechanical Engineering) Outcome Based Education(OBE) and Choice Based Credit System(CBCS) SEMESTER – VII			
Course Title:	Control Engineering		
Course Code:	BME703	CIE MARKS	50
L : T : P + (SL)	3 : 0 : 0 + (45 Hours/Sem)	SEE MARKS	50
Credits:	03	EXAM HOURS	03
Total Hours of Pedagogy	45 hours	Total Marks	100
COURSE LEARNING OBJECTIVES: The purpose of the course is to facilitate the learner to: ➤ 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.			
MODULE – 1			9 Hours
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. <i>Teaching Learning Process: Chalk and Talk / PPT</i>			
MODULE – 2			9 Hours
Block Diagram Representation: Transfer Functions definition, block representation of systems elements, reduction of block diagrams. Signal Flow Graphs: Transfer function using Mason's gain formula. <i>Teaching Learning Process: Chalk and Talk / PPT / Video</i>			
MODULE – 3			9 Hours
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. <i>Teaching Learning Process: Chalk and Talk / PPT</i>			
MODULE – 4			9 Hours
System stability: Routh's stability Criterion. Root Locus Plots: Definition of root loci, General rules for constructing root loci, Analysis using root locus plots. <i>Teaching Learning Process: Chalk and Talk / PPT</i>			
MODULE – 5			9 Hours
Frequency Response Analysis: Polar plots, Nyquist stability criterion. Bode Plots- Determination of phase margin and gain margin using Bode plot. <i>Teaching Learning Process: Chalk and Talk / PPT</i>			

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Explain the control system and its types, control actions and develop system governing equations for physical models (Mechanical, Electrical Systems)
CO2	Apply block diagram & signal flow representations to obtain transfer function of control systems.
CO3	Analysis on the response of control system for standard test signals.
CO4	Analyze the stability of transfer functions in complex domain and frequency domain.
CO5	Analyse a linear feedback control system for stability using bode plot technique in complex domain.

2, 3 and 4-Credit Theory Courses			
Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
- The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE. - If any courses of 3 credits are of Integrated Course type, for such courses the method suggested for 4 credits IPCC shall be followed.			

Suggested Learning Resources:

Text Books

1. Modern Control Engineering, Katsuhiko Ogatta, Pearson Education, Fifth edition. 2010.
2. Modern Control Systems, Richard.C. Dorf and Robert. H. Bishop, Addison Wesley, Thirteenth Edition. 2017.

Reference Books

1. Control Systems Principles and Design, M.Gopal, Fourth Edition, TMH. 2014.
2. Automatic Control Systems, Benjamin C. Kuo, Farid Golnaraghi, McGraw Hill Education, Tenth Edition. 2017.

Web links and Video Lectures (e-Resources):

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

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

1. Case studies
2. Quiz
3. Topic Seminar presentation
4. Assignments



ESTD : 2001

An Institute with a Difference



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Department of Mechanical Engineering (ME)
Autonomous Scheme (Effective from Academic Year 2024 – 25)

PROFESSIONAL ELECTIVE COURSES

ESTD : 2001

An Institute with a Difference

B.E. (Mechanical Engineering) Outcome Based Education(OBE) and Choice Based Credit System(CBCS) SEMESTER – VII			
Course Title:	TRIBOLOGY		
Course Code:	BME714A	CIE MARKS	50
L : T : P + (SL)	3 : 0 : 0 + (45 Hours/Sem)	SEE MARKS	50
Credits:	03	EXAM HOURS	03
Total Hours of Pedagogy	45 hours	Total Marks	100
COURSE LEARNING OBJECTIVES: The purpose of the course is to facilitate the learner to: ➤ To educate the students on the importance of friction, the related theories/laws of sliding and rolling friction and the effect of viscosity of lubricants. ➤ To expose the students to the consequences of wear, wear mechanisms, wear theories and analysis of wear problems. ➤ To make the students understand the principles of lubrication, lubrication regimes, theories of hydrodynamic and the advanced lubrication techniques. ➤ To expose the students to the factors influencing the selection of bearing materials for different sliding applications. ➤ To introduce the concepts of surface engineering and its importance in tribology.			
MODULE – 1			9 Hours
Introduction to tribology: Historical background, practical importance, and subsequent use in the field. Lubricants: Types and specific field of applications. Properties of lubricants, viscosity, its measurement, effect of temperature and pressure on viscosity, lubrication types, standard grades of lubricants, and selection of lubricants. Teaching Learning Process: Chalk and Talk / PPT			
MODULE – 2			9 Hours
Friction: friction theories, measurement methods, friction of metals and non-metals. Wear: Classification and mechanisms of wear, delamination theory, debris analysis, testing methods and standards. Teaching Learning Process: Chalk and Talk / PPT / Video			
MODULE – 3			9 Hours
Hydrodynamic journal bearings: Friction forces and power loss in a lightly loaded journal bearing, Petroff's equation, mechanism of pressure development in an oil film, and Reynold's equation in 2D. Introduction to idealized journal bearing: load carrying capacity, condition for equilibrium, Sommerfeld's number and its significance; partial bearings, end leakages in journal bearing, numerical examples. Teaching Learning Process: Chalk and Talk / PPT			
MODULE – 4			9 Hours
Plane slider bearings with fixed/pivoted shoe: Pressure distribution, Load carrying capacity, coefficient of friction, frictional resistance in a fixed/pivoted shoe bearing, center of pressure, numerical examples.			

Hydrostatic Lubrication: Introduction to hydrostatic lubrication, hydrostatic step bearings, load carrying capacity and oil flow through the hydrostatic step bearing, numerical examples. Introduction to Hydrostatic journal bearings. Teaching Learning Process: Chalk and Talk / PPT
MODULE – 5
Bearing Materials: Commonly used bearings materials, and properties of typical bearing materials. Advantages and disadvantages of bearing materials. Introduction to Surface engineering: Concept and scope of surface engineering. Surface modification – transformation hardening, surface melting, thermo chemical processes. Surface Coating – plating, fusion processes, vapor phase processes. Selection of coating for wear and corrosion resistance. Teaching Learning Process: Chalk and Talk / PPT
9 Hours

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Understand the fundamentals of tribology and associated parameters.
CO2	Apply concepts of tribology for the performance analysis and design of components experiencing relative motion.
CO3	Analyse the requirements and design hydrodynamic journal and plane slider bearings for a given application
CO4	Select proper bearing materials and lubricants for a given tribological application.
CO5	Apply the principles of surface engineering for different applications of tribology

2, 3 and 4-Credit Theory Courses			
Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.

- The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.
- **If any courses of 3 credits are of Integrated Course type, for such courses the method suggested for 4 credits IPCC shall be followed.**

Suggested Learning Resources:

Text Books

1. Introduction to Tribology B. Bhushan John Wiley & Sons, Inc., 2013.
2. Engineering Tribology Prasanta Sahoo PHI Learning Private Ltd, New Delhi 2011
3. Engineering Tribology J. A. Williams Oxford Univ. Press 2008

Reference Books

1. Introduction to Tribology in bearings B. C. Majumdar Wheeler Publishing 2010.
2. Engineering Tribology G. W. Stachowiak and A. W. Batchelor Butterworth-Heinemann 2014.
3. Friction and Wear of Materials Ernest Rabinowicz John Wiley & Sons 2021

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

1. Case studies
2. Quiz
3. Topic Seminar presentation
4. Assignments

ESTD : 2001

An Institute with a Difference

B.E. (Mechanical Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER –VII			
Course Title:	POWER PLANT ENGINEERING		
Course Code:	BME714B	CIE MARKS	50
L : T : P: S	3:0:0:0	SEE MARKS	50
Credits:	03	EXAM HOURS	03
Total Hours of Pedagogy	45 hours Theory	Total Marks	100
COURSE LEARNING OBJECTIVES: The purpose of the course is to facilitate the learner to learn: ➤ Basic knowledge of Different types of Power Plants, site selection criteria of each one of them. ➤ Understanding of Thermal Power Plant Operation, turbine governing, different types of high-pressure boilers including supercritical and supercharged boilers, Fluidized bed combustion systems. ➤ Design of chimney in thermal power plants, knowledge of cooling tower operation, numerical on surface condenser design. ➤ Basic knowledge of Different types of Nuclear power plants including Pressurized water reactor, Boiling water reactor, gas cooled reactor, liquid metal fast breeder reactor. ➤ Understanding of Power Plant Economics, Energy Storage including compressed air energy and pumped hydro etc. ➤ Discussing environmental and safety aspects of power plant operation			
MODULE – 1			(9 hours)
INTRODUCTION TO THE SOURCES OF ENERGY – Resources and Development of Power in India. Steam Power Plant: Plant Layout, Working of different Circuits, Fuel and handling equipments, types of coals, coal handling, choice of handling equipment, coal storage, Ash handling systems. COMBUSTION PROCESS: Properties of coal – overfeed and underfeed fuel beds, traveling grate stokers, spreader stokers, retort stokers, pulverized fuel burning system and its components, combustion needs and draught system, cyclone furnace, design and construction, Dust collectors, cooling towers and heat rejection. Corrosion and feed water treatment. <i>Teaching Learning Process: Chalk and Talk / PPT</i>			
MODULE – 2			(9 hours)
INTERNAL COMBUSTION ENGINE PLANT: Diesel Power Plant-Introduction – IC Engines, types, construction– Plant layout with auxiliaries – fuel supply system, air starting equipment, lubrication and cooling system – super charging. GAS TURBINE PLANT: Introduction – classification - construction – Layout with auxiliaries – Principles of working of closed and open cycle gas turbines. Combined Cycle Power Plants and comparison. <i>Teaching Learning Process: Chalk and Talk / PPT</i>			
MODULE – 3			(9 hours)
HYDRO ELECTRIC POWER PLANT: Water power – Hydrological cycle / flow measurement – drainage area characteristics – Hydrographs – storage and Pondage – classification of dams and spill ways.			

HYDRO PROJECTS AND PLANT: Classification – Typical layouts – plant auxiliaries – plant operation pumped storage plants <i>Teaching Learning Process: Chalk and Talk / PPT</i>	
MODULE – 4	(9 hours)
NUCLEAR POWER STATION: Nuclear fuel – breeding and fertile materials – Nuclear reactor – reactor operation. TYPES OF REACTORS: Pressurized water reactor, Boiling water reactor , sodium-graphite reactor, fast Breeder Reactor, Homogeneous Reactor, Gas cooled Reactor, Radiation hazards and shielding – radioactive waste disposal. <i>Teaching Learning Process: Chalk and Talk / PPT</i>	
MODULE – 5	(9 hours)
Power Plant Economics and Environmental Considerations: Capital cost, investment of fixed charges, operating costs, general arrangement of power distribution, Load curves, load duration curve. Definitions of connected load , Maximum demand, demand factor, average load, load factor, diversity factor– related exercises. Effluents from power plants and Impact on environment – pollutants and pollution standards – Methods of Pollution control. <i>Teaching Learning Process: Chalk and Talk / PPT</i>	

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Get the basics of Power Plants.
CO2	The idea about the power generation by renewable and non-renewable energy resources.
CO3	know about the different types of cycles and natural resources used in power plants and their applications.
CO4	Idea of Power Plant Economics and Environmental Considerations

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Average of Two Internal Assessment Tests each of 50 marks, scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.

Suggested Learning Resources:

Text Books

1. Power Plant Engineering – P.C.Sharma / S.K.Kataria Pub
2. A Course in Power Plant Engineering: / Arora and S. Domkundwar.
3. A Text Book of Power Plant Engineering / Rajput / Laxmi Publications

Reference Books

1. Power plant Engineering/ Ramalingam/ Sciotech Publishers
2. An Introduction to Power Plant Technology / G.D. Rai.

Web links and Video Lectures (e-Resources):

1. <http://nptel.ac.in/courses/108105058/8>
2. <http://nptel.ac.in/courses/108105058/9>
3. <http://nptel.ac.in/courses/108105058/10>

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

Real-Life Observation/ Group Discussion/ Role Play/ Problem-Based Learning



ESTD : 2001

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B.E. (Mechanical Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VII			
COURSE TITLE	ENTREPRENEURSHIP & DEVELOPMENT		
COURSE CODE	BME714C	CIE MARKS	50
L : T : P : S	3 : 0 : 0 : 0	SEE MARKS	50
CREDITS	03	EXAM HOURS	03
TOTAL HOURS OF PEDAGOGY	45 hours	Total Marks	100
COURSE LEARNING OBJECTIVES: The purpose of the course is to facilitate the learner to: ➤ To enable the students to understand the concept of Entrepreneur and Entrepreneurship and relevant roles ➤ To enable the students to learn creativity and entrepreneurial plan including Project Feasibility and Project Appraisal ➤ To enable the students to understand corporate entrepreneurship and issues related to corporate entrepreneurship ➤ To enable the students to understand Family and Non-Family Entrepreneur & Women entrepreneurs and women entrepreneurs in India ➤ To enable the students to understand International Entrepreneurship Opportunities and Case studies on Indian Start ups			
MODULE – 1			9 Hours
Entrepreneurship: Definition of Entrepreneur, Functions of an Entrepreneur, Entrepreneurial motivation and Barriers, Classification of Entrepreneurship, concept of Entrepreneurship, Development of entrepreneurship; Concept of entrepreneur, Manager and Intrapreneur (differences in their roles, responsibilities and Career Opportunities) Teaching Learning Process: Chalk and Talk/PPT			
MODULE – 2			9 Hours
Creativity and Entrepreneurial Plan: The business plan as an entrepreneurial tool, Contents of a business plan, Idea Generation, Screening and Project Identification, Creative Performance, Feasibility Analysis: Economic, Marketing, Financial and Technical; Project Planning: Evaluation, Monitoring and Control segmentation. Creative Problem Solving: Heuristics, Brainstorming, Syntectic's, Value Analysis, Innovation Teaching Learning Process: Chalk and Talk/PPT			
MODULE – 3			9 Hours
Corporate entrepreneurship: Introduction, Need for corporate entrepreneurship, Flavors of corporate entrepreneurship, corporate venturing, Intrapreneurship, organizational transformation, Industry rule bending, domain of corporate entrepreneurship, conditions favorable for corporate entrepreneurship, benefits of corporate entrepreneurship, issues related to corporate entrepreneurship Teaching Learning Process: Chalk and Talk/PPT			
MODULE – 4			9 Hours
Family and Non-Family Entrepreneur & Women entrepreneurs: Role of Professionals, Professionalism vs family entrepreneurs, Role of Woman entrepreneur, Factors influencing women entrepreneur, Challenges for women entrepreneurs, Growth and development of women entrepreneurs in India			

Teaching Learning Process: Chalk and Talk/PPT	
MODULE – 5	9 Hours
International Entrepreneurship Opportunities: The nature of international entrepreneurship, Importance of international business to the firm, International versus domestic entrepreneurship, Institutional support for new ventures: Supporting Organizations; Incentives and facilities; Financial Institutions and Small-scale Industries, Govt. Policies for SSIs. Case studies on Indian Start ups Teaching Learning Process: Chalk and Talk/PPT	

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Understand the concept of Entrepreneur and Entrepreneurship and relevant roles
CO2	learn creativity and entrepreneurial plan including Project Feasibility and Project Appraisal
CO3	Understand Corporate entrepreneurship and issues related to corporate entrepreneurship
CO4	Understand Family and Non-Family Entrepreneur & Women entrepreneurs and women entrepreneurs in India
CO5	Understand International Entrepreneurship Opportunities and Case studies on Indian Start ups

2, 3 and 4-Credit Theory Courses			
Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE.			

- If any courses of 3 credits are of Integrated Course type, for such courses the method suggested for 4 credits IPCC shall be followed.

Suggested Learning Resources:

Text Books:

1. Dynamics of Entrepreneurship Development, Vasant Desai Himalaya Publishing House, 6th Edition, 2021
2. Entrepreneurship, New Venture Creation, David H. Holt, Prentice Hall India / Pearson Education, Edition, 2020
3. Entrepreneurial Development, S.S. Khanka, S. Chand & Company Ltd., New Delhi, 5th Edition, 2026
4. Innovation and Entrepreneurship, Peter F. Drucker, Butterworth-Heinemann, Edition, 2014

Reference Books:

1. Entrepreneurship – Theory, Process and Practice, Donald F. Kuratko, Cengage Learning, 10th Edition, 2021
2. 02 Entrepreneurship, Rajeev Roy, Oxford University Press, 3rd Edition, 2020
3. 03 Entrepreneurship Theory at Crossroads: Paradigms and Praxis, Mathew J. Manimala, Dreamtech Press, 2nd Edition, 2005
4. 04 Entrepreneurship, Hisrich R. D., Peters M. P., Tata McGraw-Hill, 10th Edition, 2017

Web links and Video Lectures (eResources):

1. https://onlinecourses.nptel.ac.in/noc24_mg93/preview?
2. https://onlinecourses.nptel.ac.in/noc24_mg93/preview?

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

1. Term Projects
2. Course seminar



B.E. (Mechanical Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VII			
COURSE TITLE	TOTAL QUALITY MANAGEMENT		
COURSE CODE	BME714D	CIE MARKS	50
L : T : P : S	3 : 0 : 0 : 0	SEE MARKS	50
CREDITS	03	EXAM HOURS	03
TOTAL HOURS OF PEDAGOGY	45 hours	Total Marks	100
COURSE LEARNING OBJECTIVES: The purpose of the course is to facilitate the learner to: ➤ Understand various approaches to TQM ➤ Understand the characteristics of quality leader and his role. ➤ Develop feedback and suggestion systems for quality management. ➤ Enhance the knowledge in Tools and Techniques of quality management			
MODULE – 1			9 Hours
Principles and Practice: Definition, basic approach, gurus of TQM, TQM Framework, awareness, defining quality, historical review, obstacles, benefits of TQM. Quality Management Systems: Introduction, benefits of ISO registration, ISO 9000 series of standards, ISO 9001 requirements. Teaching Learning Process: Chalk and Talk / PPT			
MODULE – 2			9 Hours
Leadership: Definition, characteristics of quality leaders, leadership concept, characteristics of effective people, ethics, the Deming philosophy, Role of TQM leaders, implementation, core values, concepts and framework, strategic planning communication, decision making, Teaching Learning Process: Chalk and Talk / PPT			
MODULE – 3			9 Hours
Customer Satisfaction and Customer Involvement: Customer Satisfaction: customer and customer perception of quality, feedback, using customer complaints, service quality, translating needs into requirements, customer retention, case studies Employee Involvement – Motivation, employee surveys, empowerment, teams, suggestion system, recognition and reward, gain sharing, performance appraisal, unions and employee involvement, case studies. Teaching Learning Process: Chalk and Talk/PPT			
MODULE – 4			9 Hours
Continuous Process Improvement: The Juran trilogy, improvement strategies, types of problems, the PDSA Cycle, problem-solving methods, Kaizen, reengineering, six sigma, case studies. Statistical Process Control: Pareto diagram, process flow diagram, cause and effect diagram, check sheets, histograms, statistical fundamentals, Control charts, state of control, out of control process, control charts for variables, control charts for attributes, scatter diagrams, case studies. Teaching Learning Process: Chalk and Talk/PPT			
MODULE – 5			9 Hours
Total Productive Maintenance (TPM): Definition, Types of Maintenance, Steps in introduction of TPM in an organization, Pillars of TPM – 5S, Jishu Hozen, Quality Maintenance, Planned			

Maintenance. Quality by Design (QbD): Definition, Key components of QbD, Role of QbD in Pharmaceutical Industry, Benefits and Challenges of QbD. Environmental Management Systems (EMS): Definition, Basic EMS, EMS under ISO 14001, Costs and Benefits of EMS

Teaching Learning Process: Chalk and Talk/PPT

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Explain the various approaches of TQM
CO2	Infer the customer perception of quality
CO3	Analyze customer needs and perceptions to design feedback systems.
CO4	Apply statistical tools for continuous improvement of systems
CO5	Tools and technique for effective implementation of TQM.

2, 3 and 4-Credit Theory Courses			
Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
- The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE. - If any courses of 3 credits are of Integrated Course type, for such courses the method suggested for 4 credits IPCC shall be followed.			

Suggested Learning Resources:

Text Books:

1. Total Quality Management, Dale H. Besterfield, Pearson Education India, 5th Edition, 2019
2. Total Quality Management for Engineers, M. Zairi, Woodhead Publishing, Edition, 1991
3. Managing for Quality and Performance Excellence, James R. Evans and William M. Lindsay, Cengage Learning, 12th Edition, 2025
4. Four Revolutions in Management, Shoji Shiba, Alan Graham, David Walden, Productivity Press:1993

Reference Books:

1. Organizational Excellence through TQM, H. Lal, New Age Publications, Latest Edition, 2008
2. Engineering Optimization: Methods and Applications, A. Ravindran, K. M. Ragsdell, Wiley India Private Limited, 2nd Edition, 2006
3. Introduction to Operations Research – Concepts and Cases, F.S. Hillier, G.J. Lieberman, Tata McGraw Hill, 10th Edition, 2021

Web links and Video Lectures (e-Resources):

1. https://onlinecourses-archive.nptel.ac.in/noc18_mg39/
2. https://onlinecourses.nptel.ac.in/noc20_mg34/preview

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

1. Term Projects
2. Course seminar

ESTD : 2001

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Department of Mechanical Engineering (ME)
Autonomous Scheme (Effective from Academic Year 2024 – 25)

OPEN ELECTIVE COURSE



ESTD : 2001

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B.E. (Mechanical Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VII			
COURSE TITLE	OPERATIONS RESEARCH		
COURSE CODE	BME755A	CIE MARKS	50
L : T : P : S	3 : 0 : 0 : 0	SEE MARKS	50
CREDITS	03	EXAM HOURS	03
TOTAL HOURS OF PEDAGOGY	45 hours	Total Marks	100
COURSE LEARNING OBJECTIVES: The purpose of the course is to facilitate the learner to: ➤ Understand the meaning, definitions, scope, need, phases and techniques of operations research. ➤ Summarize the optimal solutions to linear programming problems by graphical method, Simplex method. ➤ Develop the optimum solutions for transportation, Assignment and travelling salesman problems. ➤ Explore and Construct network diagrams and determine critical path, floats for deterministic and PERT networks including crashing of Networks ➤ Compare minimum processing times for sequencing of n jobs-2 machines, n jobs-3 machines, n jobs-m machines and 2 jobs-n machines using Johnson's algorithm			
MODULE – 1			9 Hours
INTRODUCTION: Evolution of OR, Definitions of OR, Scope of OR, Applications of OR, Phases in OR study. Characteristics and limitations of OR. FORMULATION: Linear Programming Problem (LPP), Generalized LPP- Formulation of problems as L.P.P. Solutions to LPP by graphical method (Two Variables) Teaching Learning Process: Chalk and Talk/PPT			
MODULE – 2			9 Hours
LPP: Simplex method, Canonical and Standard form of LP problem, slack, surplus and artificial Variables, Solutions to LPP by Simplex method, Degeneracy in LPP. Concept of Duality, writing Dual of given LPP. Solutions to L.P.P by Dual Simplex Method. Teaching Learning Process: Chalk and Talk/PPT			
MODULE – 3			9 Hours
TRANSPORTATION PROBLEM: Formulation of transportation problem, types, initial basic feasible solution using North-West Corner rule, Vogel's Approximation method. Optimality in Transportation problem by Modified Distribution (MODI) method. ASSIGNMENT PROBLEM- Formulation, Solutions to assignment problems by Hungarian method, unbalanced, Maximization assignment problems. Travelling Salesman Problem (TSP). Teaching Learning Process: Chalk and Talk/PPT			
MODULE – 4			9 Hours
NETWORK ANALYSIS: Introduction, Construction of networks, Fulkerson's rule for numbering the			

nodes, AON and AOA diagrams; Critical path method to find the expected completion time of a project, determination of floats in networks, PERT networks, determining the probability of completing a project, predicting the completion time of project; Cost analysis in networks.
QUEUING THEORY: Queuing systems and their characteristics, Pure-birth and Pure-death models (only equations), Kendall & Lee's notation of Queuing, empirical queuing models – Numerical on M/M/1 and M/M/C Queuing models. Teaching Learning Process: Chalk and Talk/PPT
MODULE – 5 9 Hours GAME THEORY: Definition, Pure Strategy problems, Saddle point, Max-Min and Min-Max criteria, Principle of Dominance, Solution of games with Saddle point. Mixed Strategy problems. Solution of 2xn and mx2 games by graphical method. SEQUENCING: Basic assumptions, Johnson's algorithm, sequencing 'n' jobs on single machine using priority rules, sequencing using Johnson's rule-'n' jobs on 2 machines, 'n' jobs on 3 machines, 'n' jobs on 'm' machines. Sequencing of 2 jobs on 'm' machines using graphical method. Teaching Learning Process: Chalk and Talk/PPT

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Understand the meaning, definitions, scope, need, phases and techniques of operations research.
CO2	Summarize the optimal solutions to linear programming problems by graphical method, Simplex method.
CO3	Develop the optimum solutions for transportation, Assignment and travelling salesman problems.
CO4	Explore and Construct network diagrams and determine critical path, floats for deterministic and PERT networks including crashing of Networks
CO5	Compare minimum processing times for sequencing of n jobs-2 machines, n jobs-3 machines, n jobs-m machines and 2 jobs-n machines using Johnson's algorithm

2, 3 and 4-Credit Theory Courses			
Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.

Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
- The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE. - If any courses of 3 credits are of Integrated Course type, for such courses the method suggested for 4 credits IPCC shall be followed.			

Suggested Learning Resources:

Text Books:

- Operations Research, P. K. Gupta and D. S. Hira, S. Chand and Company LTD. Publications, New Delhi – 2022
- Operations Research, An Introduction, Eleventh Edition, Hamdy A. Taha, Pearson Education, 2022

Reference Books:

- Operations Research, Theory and Applications, Sixth Edition, J K Sharma, Trinity Press, Laxmi Publications Pvt. Ltd., New Delhi – 2024
- Operations Research, Third Edition, R. Panneerselvam, PHI Learning Pvt. Ltd., New Delhi – 2023
- Operations Research, Second Edition, A M Natarajan and P Balasubramani, Pearson Education, New Delhi – 2014
- Introduction to Operations Research, Twelfth Edition, Hillier and Lieberman, McGraw Hill, New York – 2024

Web links and video lectures (E-Resources):

- <https://elearn.nptel.ac.in/shop/nptel/operations-research/>
- <https://www.digimat.in/nptel/courses/video/112106134/112106134.html>

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

- Term Projects
- Course seminar

B.E. (Mechanical Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VII			
COURSE TITLE	MECHATRONICS & MICROPROCESSOR		
COURSE CODE	BME755B	CIE MARKS	50
L : T : P : S	3 : 2 : 0 : 0	SEE MARKS	50
CREDITS	03	EXAM HOURS	03
TOTAL HOURS OF PEDAGOGY	45 hours	Total Marks	100
COURSE LEARNING OBJECTIVES: The purpose of the course is to facilitate the learner to: ➤ Understand the fundamentals of mechatronics systems, including components, design process, measurement systems, and various types of control systems with real-world applications. ➤ Analyse the working principles and applications of transducers and sensors, and evaluate their role in engineering measurement and automation systems. ➤ Comprehend signal conditioning techniques and electro-mechanical drives, including data acquisition systems, SCADA, motors, and control methods such as PWM. ➤ Explain the architecture and functioning of microprocessors and microcontrollers, particularly the Intel 8085, and differentiate their roles in control and automation. ➤ Develop and apply PLC programming and mechatronics concepts in industrial applications such as CNC machines, automation systems, and modern mechatronics design processes.			
MODULE – 1			9 Hours
INTRODUCTION: Evolution of OR, Definitions of OR, Scope of OR, Applications of OR, Phases in OR Scope and elements of mechatronics, mechatronics design process, measurement system, requirements and types of control systems, feedback principle, Basic elements of feedback control systems, Classification of control system. Examples of Mechatronics Systems such as Automatic Car Park system, Engine management system, Antilock braking system (ABS) control, Automatic washing machine.			
TRANSDUCERS AND SENSORS: Definition and classification of transducers, Difference between transducer and sensor, Definition and classification of sensors, Principle of working and applications of light sensors, Potentiometers, LVDT, Capacitance sensors, force and pressure sensors, Strain gauges, temperature sensors, proximity switches and Hall Effect sensors.			
<i>Teaching Learning Process: Chalk and Talk/PPT</i>			
MODULE – 2			9 Hours
SIGNAL CONDITIONING: Introduction – Hardware – Digital I/O, Analog to digital conversions, resolution, Filtering Noise using passive components – Registers, capacitors, amplifying signals using OP amps. Digital Signal Processing – Digital to Analog conversion, Low pass, high pass, notch filtering. Data acquisition systems (DAQS), data loggers, Supervisory control and data acquisition (SCADA), Communication methods.			
ELECTRO MECHANICAL DRIVES: Relays and Solenoids – Stepper Motors – DC brushed motors – DC brushless motors – DC servo motors – 4-quadrant servo drives, PWM's – Pulse Width Modulation.			
<i>Teaching Learning Process: Chalk and Talk/PPT</i>			

MODULE – 3	9 Hours
MICROPROCESSOR & MICROCONTROLLERS: Introduction, Microprocessor systems, Basic elements of control systems, Microcontrollers, Difference between Microprocessor and Microcontrollers. Microprocessor Architecture: Microprocessor architecture and terminology-CPU, memory and address, I/O and Peripheral devices, ALU, Instruction and Program, Assembler, Data Registers, Program Counter, Flags, Fetch cycle, write cycle, state, bus interrupts. Intel's 8085A Microprocessor.	
<i>Teaching Learning Process: Chalk and Talk/PPT</i>	
MODULE – 4	9 Hours
PROGRAMMABLE LOGIC CONTROLLER: Introduction to PLCs, Basic structure of PLC, Principle of operation, input and output processing, PLC programming language, ladder diagram, ladder diagrams circuits, timer counters, internal relays, master control, jump control, shift registers, data handling, and manipulations, analogue input and output, selection of PLC for application.	
APPLICATION OF PLC CONTROL: Extending and retracting a pneumatic piston using latches, control of two pneumatic pistons, control of process motor, control of vibrating machine, control of process tank, control of conveyer motor etc.	
<i>Teaching Learning Process: Chalk and Talk/PPT</i>	
MODULE – 5	9 Hours
MECHATRONICS IN COMPUTER NUMERICAL CONTROL (CNC) MACHINES: Design of modern CNC machines - Machine Elements: Different types of guide ways, Linear Motion guideways. Bearings: anti-friction bearings, hydrostatic bearing and hydrodynamic bearing. Re-circulating ball screws. Typical elements of open and closed loop control systems. Adaptive controllers for machine tools.	
MECHATRONICS DESIGN PROCESS: Stages of design process – Traditional and Mechatronics design concepts – Case studies of Mechatronics systems – Pick and place Robot – Automatic car park barrier.	
<i>Teaching Learning Process: Chalk and Talk/PPT</i>	

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Illustrate various components of Mechatronics systems.
CO2	Assess various control systems used in automation.
CO3	Design and conduct experiments to evaluate the performance of a mechatronics system or component with respect to specifications, as well as to analyse and interpret data.
CO4	Apply the principles of Mechatronics design to product design.
CO5	Function effectively as members of multidisciplinary teams.

2, 3 and 4-Credit Theory Courses			
Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
- The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE. - If any courses of 3 credits are of Integrated Course type, for such courses the method suggested for 4 credits IPCC shall be followed.			

Suggested Learning Resources: Text Books: 1. Mechatronics-Principles Concepts and Applications Nitaigour Premchand Mahalik Tata McGraw Hill 1st Edition, 2003 2. Mechatronics–Electronic Control Systems in Mechanical and Electrical Engineering, W.Bolton Pearson Education 1stEdition, 2005 Reference Books: 1. Mechatronics HMT Ltd Tata Mc Graw Hill 1st Edition, 2000 ISBN:978007 4636435 2. Mechatronics: Integrated Mechanical Electronic Systems K.P. Ramachandran, G.K. Vijayaraghavan, M.S. Balasundaram. Wiley India Pvt. Ltd. New Delhi 2008 3. Introduction to Mechatronics and Measurement Systems David G. Aldatore, Michael B. Histan McGraw-Hill Inc USA 2003 4. Introduction to Robotics: Analysis, Systems, Applications. Saeed B. Niku, Person Education 2006 5. Mechatronics System Design Devdas Shetty, Richard A. kolk Cengage publishers. second edition
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning 1. Assignment 2. Quiz 3. Seminar

B.E. (Mechanical Engineering)			
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)			
SEMESTER –VII			
Course Title:	SOLAR ENERGY & AUTONOMOUS VEHICLES		
Course Code:	BME755C	CIE MARKS	50
L : T : P: S	3:0:0:0	SEE MARKS	50
Credits:	03	EXAM HOURS	03
Total Hours of Pedagogy	45 hours Theory	Total Marks	100
COURSE LEARNING OBJECTIVES: The purpose of the course is to facilitate the learner to learn:			
➤ To understand the fundamentals of solar radiation and solar energy conversion systems. ➤ To analyze design, performance, and applications of solar thermal and photovoltaic systems. ➤ To study energy storage and integration of solar systems with smart grids and EVs. ➤ To introduce fundamentals of autonomous vehicle technologies and intelligent transportation systems. ➤ To understand sensors, perception, control systems, and AI techniques used in autonomous vehicles.			
MODULE – 1		(9 hours)	
INTRODUCTION: Energy scenario – Global and Indian perspective, Solar radiation fundamentals, Solar constant and solar spectrum, Extraterrestrial and terrestrial solar radiation Solar angles (Declination, Hour angle, Zenith angle, Tilt factor). Measurement of solar radiation, Solar resource assessment in India. Teaching Learning Process: Chalk and Talk / PPT			
MODULE – 2		(9 hours)	
SOLAR THERMAL COLLECTORS: Classification, Flat plate collectors – Construction & working. Concentrating collectors – Parabolic trough, dish collectors, Solar water heating systems, Solar dryers and solar cookers, SOLAR THERMAL POWER PLANTS: Basic concepts, Performance analysis of solar collectors Teaching Learning Process: Chalk and Talk / PPT			
MODULE – 3		(9 hours)	
Photovoltaic effect, Solar cell materials (Si, thin film, emerging technologies), I–V characteristics of solar cells, PV modules and arrays Maximum Power Point Tracking (MPPT), Energy storage systems (Batteries, BMS), Grid-connected and standalone PV systems, Solar PV applications in EV charging Teaching Learning Process: Chalk and Talk / PPT			
MODULE – 4		(9 hours)	
Evolution of autonomous vehicles, Levels of automation (SAE levels), Architecture of autonomous vehicles, Advanced Driver Assistance Systems (ADAS), Sensors: LiDAR, RADAR, Ultrasonic, Cameras, Vehicle communication (V2V, V2I), Ethical and safety considerations			

MODULE – 5	(9 hours)
Sensor fusion techniques, Localization and mapping (SLAM basics), Object detection and lane detection, Path planning algorithms, Motion control strategies, AI and Machine Learning in autonomous vehicles , Case studies of autonomous vehicle platforms. Teaching Learning Process: Chalk and Talk / PPT	

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Explain solar radiation fundamentals and assess solar energy potential.
CO2	Analyze and evaluate performance of solar thermal systems.
CO3	Design and interpret solar photovoltaic systems with storage solutions.
CO4	Describe architecture, sensors, and communication systems in autonomous vehicles.
CO5	Apply perception, planning, and control concepts in autonomous vehicle systems.

ASSESSMENT DETAILS (Both CIE and SEE)

Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Average of Two Internal Assessment Tests each of 50 marks, scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.

Suggested Learning Resources:

Text Books

1. G.D. Rai, *Non-Conventional Energy Sources*, Khanna Publishers.
2. S.P. Sukhatme & J.K. Nayak, *Solar Energy: Principles of Thermal Collection and Storage*, Tata McGraw Hill.

Reference Books

1. Chetan Singh Solanki, *Solar Photovoltaics – Fundamentals, Technologies and Applications*, PHI.
2. S. Sumathi, L. Ashok Kumar & Surekha P., *Solar PV and Wind Energy Conversion Systems*, Springer.

Web links and Video Lectures (e-Resources):



- <https://www.nptelprep.in/courses/115103123/materials>
- <https://www.nptelprep.in/courses/103103206/materials>

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

Real-Life Observation/ Group Discussion/ Role Play/ Problem-Based Learning



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B.E. (Mechanical Engineering) Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VII			
Course Title:	NON TRADITIONAL MACHINING		
Course Code:	BME755D	CIE MARKS	50
L : T : P + (SL)	3 : 0 : 0 + (45 Hours/Sem)	SEE MARKS	50
Credits:	03	EXAM HOURS	03
Total Hours of Pedagogy	45 hours	Total Marks	100
COURSE LEARNING OBJECTIVES: The purpose of the course is to facilitate the learner to: ➤ To learn various concepts related to modern machining processes & their applications. ➤ To appreciate the differences between conventional and non-conventional machining processes ➤ To acquire a functional understanding of non-traditional manufacturing equipment. ➤ To know about various process parameters and their influence on performance and their applications ➤ To impart knowledge on various types of energy involved in non-traditional machining processes.			
MODULE – 1			9 Hours
Introduction to Non-traditional machining: Introduction to Non-traditional machining, Need for Non-traditional machining process, Comparison between traditional and non-traditional machining, general classification Non-traditional machining processes, classification based on nature of energy employed in machining,			
Selection of non-traditional machining processes, Specific advantages, limitations and applications of non-traditional machining processes.			
<i>Teaching Learning Process: Chalk and Talk / PPT</i>			
MODULE – 2			9 Hours
Ultrasonic Machining (USM): Introduction, Equipment and material process, Effect of process parameters: Effect of amplitude and frequency, Effect of abrasive grain diameter, effect of slurry, tool & work material. Process characteristics: Material removal rate, tool wear, accuracy, surface finish, applications, advantages & limitations of USM.			
Abrasive Jet Machining (AJM): Introduction, Equipment and process of material removal, process variables: carrier gas, type of abrasive, work material, stand-off distance (SOD). Process characteristics- Material removal rate, Nozzle wear, accuracy & surface finish. Applications, advantages & limitations of AJM. Water Jet Machining (WJM): Introduction, Equipment and process of material removal, process variables and process characteristics.			
<i>Teaching Learning Process: Chalk and Talk / PPT</i>			
MODULE – 3			9 Hours
ELECTROCHEMICAL MACHINING (ECM): Introduction, Principle of electro chemical machining, ECM equipment, elements of ECM operation, Chemistry of ECM. ECM Process characteristics: Material removal rate, accuracy, surface finish. Process parameters: Current density, Tool feed rate, Gap between tool & work piece, velocity of electrolyte flow, type of electrolyte, its concentration temperature, and choice of electrolytes. ECM Tooling: ECM tooling technique & example, Tool & insulation materials. Applications ECM			

CHEMICAL MACHINING (CHM): Elements of the process, Resists (maskants), Etchants. Types of chemical machining process-chemical blanking process, chemical milling process. Process characteristics of CHM: material removal rate, accuracy, surface finish, advantages, limitations and applications of chemical machining process. <i>Teaching Learning Process: Chalk and Talk / PPT</i>	
MODULE – 4	9 Hours
ELECTRICAL DISCHARGE MACHINING (EDM): Introduction, mechanism of metal removal, EDM equipment: spark erosion generator (relaxation type), dielectric medium-its functions & desirable properties, electrode feed control system. EDM process parameters: Spark frequency, current & spark gap, surface finish, Heat Affected Zone. Advantages, limitations & applications of EDM. PLASMA ARC MACHINING (PAM): Introduction, non-thermal generation of plasma, equipment mechanism of metal removal, Plasma torch, process parameters, process characteristics. Safety precautions. Safety precautions, applications, advantages and limitations. <i>Teaching Learning Process: Chalk and Talk / PPT</i>	
MODULE – 5	9 Hours
LASER BEAM MACHINING (LBM): Introduction, generation of LASER, Equipment and mechanism of metal removal, LBM parameters and characteristics, Applications, Advantages & limitations. ELECTRON BEAM MACHINING (EBM): Introduction, Principle, equipment and mechanism of metal removal, applications, advantages and limitations. <i>Teaching Learning Process: Chalk and Talk / PPT / Field Visits</i>	

COURSE OUTCOMES:

After successfully completing the course, the student will be able to:

CO1	Describe non-traditional machining process and compare with Traditional machining process. Recognize the need for Non-traditional machining process
CO2	Describe the constructional features, performance parameters, process characteristics, applications, advantages, and limitations of USM, AJM and WJM.
CO3	Characterize the need of Chemical and electro-chemical machining process along with the constructional features, process parameters, process characteristics, applications, advantages, and limitations.
CO4	Illustrate the constructional feature of the equipment, process parameters, process characteristics, applications, advantages and limitations EDM & PAM
CO5	Understand the LBM equipment, LBM parameters, and characteristics and EBM equipment, mechanism of metal removal, applications, advantages and limitations LBM & EBM.

2, 3 and 4-Credit Theory Courses			
Assessment Type	Maximum Marks	Minimum Passing Marks	Evaluation Details
CIE – IA Tests (A)	30	-	Two tests each of 50 marks shall be conducted. Average of Two Internal Assessment Tests shall be scaled down to 30 marks.
Continuous and Comprehensive Evaluation (B)	20	-	Any two Assessment methods as per 24RNBE4.2 (*if it is project based, one assignment shall be given), scaled to 20 marks.
Total CIE (A+B)	50	20	CIE Evaluation is done for a maximum of 50 marks
SEE (C)	50	18	SEE is a theory exam conducted for 100 marks and scaled down to 50 marks. Exam duration shall be for 3 hours.
CIE + SEE (A+B+C)	100	40	Final marks shall be the sum of marks scored in Components A, B and C.
- The minimum marks to be secured in CIE is 20 (40%) out of allotted 50 marks to appear for SEE. - If any courses of 3 credits are of Integrated Course type, for such courses the method suggested for 4 credits IPCC shall be followed.			

Suggested Learning Resources:

Text Books

1. Modern Machining Process by P.C Pandey and H S Shah, McGraw Hill Education India Pvt. Ltd. 2000
2. Wellar, E.J. "Non-Traditional Machining Processes", Society of Manufacturing Engineers Publications, 2nd Edition, Michigan, 1984.
3. Non Traditional Manufacturing Processes, by Gary F Benedict, Taylor & Francis

Reference Books

1. Production technology, HMT, McGraw Hill Education India Pvt. Ltd. 2001
2. New Technology, Dr. Amitabha Bhattacharyya, The Institute of Engineers (India), 2000
3. Modern Machining process, Aditya, 2002.
4. Non-Conventional Machining, P.K.Mishra, The Institution of Engineers (India) Test book series, Narosa Publishing House – 2005.
5. Metals Handbook: Machining Volume 16, Joseph R. Davis (Editor), American Society of Metals (ASM)
6. Gary F. Benedict, —Nontraditional manufacturing processesl, Marcel Dekker, Inc. 1987

Web links and Video Lectures (e-Resources):

1. <https://nptel.ac.in/courses/112105127>
2. Non-traditional machining: https://www.youtube.com/watch?v=jhM01_mwygg
3. Ultrasonic machining: https://www.youtube.com/watch?v=E4VZ_rFqpG4
4. Abrasive Jet Machining: <https://www.youtube.com/watch?v=FYOsugdD274>
5. Water Jet Machining: <https://www.youtube.com/watch?v=3yV-uJHla58>
6. Chemical Machining: <https://www.youtube.com/watch?v=KfJ85mjpWx4>
7. Electro Chemical Machining: <https://www.youtube.com/watch?v=fOc65syJvDM>
8. Plasma Arc Machining: <https://www.youtube.com/watch?v=kvIBEOliOGw&t=454s>
9. Laser Beam Machining: <https://www.youtube.com/watch?v=mgaukC25Hqk>
10. Electron Beam Machining: <https://www.youtube.com/watch?v=pkikv0RHWTa>

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

1. Case studies
2. Quiz
3. Topic Seminar presentation
4. Assignments



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CORE COURSES- VIII SEM

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B.E. (Mechanical Engineering)

Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER – VIII

SL NO	COURSE	COURSE CODE	COURSE TITLE
1	PCC	BME811X	Professional Elective (Provide List-Online)
2	OEC	BME852X	Open Elective (Provide List-Online)
3	INT	BME803	Internship (Industry/Research)- Minimum 14 Week
4	PCC	BME811X	Professional Elective (Provide List) (Online)

PROFESSIONAL ELECTIVE COURSE

SL NO	COURSE	COURSE CODE	COURSE TITLE
1	PEC	BME811A	Quality Design & Control (Available in NPTEL)
2	PEC	BME811B	Modelling & Analytics for Supply Chain Management (Available in NPTEL)
3	PEC	BME811C	Machinery Fault Diagnosis and Signal Processing (Available in NPTEL)
4	PEC	BME811D	Strategies for Sustainable Design (Available in NPTEL)

OPEN ELECTIVE COURSE

SL NO	COURSE	COURSE CODE	COURSE TITLE
1	OEC	BME852A	Fundamentals of Automotive systems (Available in NPTEL)
2	OEC	BME852B	Computer Integrated Manufacturing (Available in NPTEL)
3	OEC	BME852C	Product Design and Manufacturing (Available in NPTEL)
4	OEC	BME852D	Business Planning & Project Management (Available in Swayam Portal)



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