Department of Mechanical Engineering

COURSE PLAN 2023-24

III Semester

INSTITUTE VISION

"To be a preferred institution in Engineering Education by achieving excellence in teaching and research and to remain as a source of pride for its commitment to holistic development of individual and society"

INSTITUTE MISSION

"To continuously strive for the overall development of students, educating them in a state-of-the-art-infrastructure, by retaining the best practices, people and inspire them to imbibe real time problem solving skills, leadership qualities, human values and societal commitments, so that they emerge as competent professionals"

DEPARTMENT OF MECHANICAL ENGINEERING

VISION

"To be the centre of excellence in providing education in the field of Mechanical Engineering to produce technically competent and socially responsible engineering graduates"

MISSION

"Educating students to prepare them for professional competencies in the broader areas of the Mechanical Engineering field by inculcating analytical skills, research abilities and encouraging culture of continuous learning for solving real time problems using modern tools"

Program Educational Objectives (PEOs)

The Graduates will be able to

PEO1: Acquire core competence in Applied Science, Mathematics and Mechanical Engineering fundamentals to excel in professional career and higher study

PEO2: Design, demonstrate and analyze the mechanical systems which are useful to society.

PEO3: Maintain professional & ethical values, employability skills, multidisciplinary approach & an ability to realize engineering issues to broader social context by engaging in lifelong learning.

Program Specific Outcomes (PSOs)

PSO1: Able to apply the basic principles of Mechanical Engineering in various practical fields to solve societal problems by engaging themselves in many state/national level projects.

PSO2: Able to analyze and design basic mechanical system using relevant tools and techniques.

PSO3: Able to resolve contemporary issues of industries through industry institute interaction and alumni social networks

Program Outcomes (POs)

PO1: **Engineering knowledge-** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: **Problem analysis-** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3:**Design/development of solutions-** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4:**Conduct investigations of complex problems-** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5:**Modern tool usage-** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6:**The engineer and society-** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7:**Environment and sustainability-** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8:**Ethics-** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9:**Individual and team work-** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10:**Communication-** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: **Project management and finance-** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12:**Life-long learning-** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

CONTENTS

Departmental Resources

Department of Mechanical Engineering was established in the year 1996 and is housed in a total area of **2584.5 Sq. Meters**.

Faculty Position

Sl. No.	Category	No. in position	Average experience
1	Teaching faculty	09	20
2	Technical staff	05	18
3	Helper / Peons	03	14

Major Laboratories

S.N.	Name of the laboratory	Area in Sq. Meters	Amount Invested (Rs.)
1	Basic Workshop Laboratory	170	438593
2	Fluid Mechanics Machinery Laboratory	172	775916.75
3	Energy Conversion Engg. Laboratory	173	1278158.2
4	Machine shop Laboratory	170	1372566.5
5	Foundry & Forging Laboratory	179	321057.11
6	Design Laboratory	73	365861
7	Heat & Mass Transfer Laboratory	148	524576
8	Metallography & Material Testing Laboratory	149	1102945.2
9	Mechanical Measurements & Metrology Laboratory	95	557593.75
10	CIM & Automation/CAMA Laboratory	66	5114658
11	Computer Aided Machine Drawing Laboratory	66	2197382
12	Computer Aided Engg Drawing Laboratory	66	2818657
13	Department/Other	--	2107430
14	Research Centre	73	640747
	Total	**1527**	**19616142**

Teaching Faculty Details

S.N.	Faculty Name	Designation	Qualification	Area of specialization	Teaching Exp (in years)	Contact Nos.
1	Dr. S. C. Kamate	Principal	Ph. D	Thermal(Cogeneration)	32	9480849331
2	Dr. S. N. Topannavar	Assoc. Prof.	Ph. D	Thermal Power Engg.	24	9482440235
3	Prof. K. M. Akkoli	Assoc. Prof.	Ph. D	Thermal Power Engg.	19	9739114856
4	Prof. D. N. Inamdar	Asst. Prof	M Tech.(Ph. D)	Tool Engg	20	9591208980
5	Prof.M.S.Futane	Asst. Prof	M Tech.	Computer Integrated Manufacturing	17	9164105035
6	Prof.S. A. Goudadi	Asst. Prof	M Tech.	Design Engineering	15	9448876682
7	Prof.M.M.Shivashimpi	Asst. Prof	M Tech.(Ph.D)	Thermal Power Engg.	16	9742197173
8	Prof.M.A.Hipparagi	Asst. Prof	M Tech.(Ph.D)	Production Technology	14	7411507405
9	Prof. G. M. Zulapi	Asst. Prof	M Tech.	Product Design & Manufacturing	15	9480213587
10	Prof. P.M.Kokitakar	Asst. Prof	M Tech.	Design Engineering	05	8095048022

REVISED ACADEMIC CALENDAR OF EVENTS-02 (CoE-02) OF III & V SEM FOR THE AY: 2023-24

Ref: 1. VTU CoE Notification No.: VTU/BGM/ACA/2023-24/3252, Dated 30th Sept. 2023
2. VTU CoE Notification No.: VTU/BGM/ACA/2023-24/2668, Dated 25th Aug. 2023
3. VTU Revised CoE Notification No.: VTU/BGM/ACA/2023-24/3681, Dated 20th Oct. 2023

Calendar

October -2023

Sun	Mon	Tue	Wed	Thu	Fri	Sat
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

November -2023

Sun	Mon	Tue	Wed	Thu	Fri	Sat
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

December -2023

Sun	Mon	Tue	Wed	Thu	Fri	Sat
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

January -2024

Sun	Mon	Tue	Wed	Thu	Fri	Sat
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

February -2024

Sun	Mon	Tue	Wed	Thu	Fri	Sat
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29		

March -2024

Sun	Mon	Tue	Wed	Thu	Fri	Sat
31					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

Date	Events & Holidays
28th Sept.2023	GH: Eid-Milad
2nd Oct. 2023	GH: Gandhi Jayanthi
14th Oct.2023	GH: Mahalaya Amavasya
17th Oct. 2023	Fresher's day: A Welcome Function for 1st year students
23rd -24th Oct. 2023	GH: Mahanavami, Ayudhapooja, Vijayadasami
25th Oct to 23rd Nov. 2023	V Sem Innovation/Entrepreneurship/Societal Internship (2021 Scheme)
28th Oct. 2023	Valmiki Jayanti
1st Nov. 2023	GH: Kannada Rajyothsava
14th Nov. 2023	GH: Balipadyami, Deepavali
15th Nov. 2023	Commencement of III Semester Classes
25th Nov. 2023	Commencement of V Semester Classes
30th Nov. 2023	GH: Kanakadasa Jayanti
8th-9th Dec. 2023	International Conference
25th Dec. 2023	GH: Christmas
21st-23rd Dec.2023	1st IA Test for III & V Semesters
23rd Dec. 2023	1st Feedback on Teaching-Learning (III & V Sems.)
27th Dec. 2023	Display of 1st IA Test Marks (III & V Sems.)
12th Jan. 2024	National Youth Day
15th Jan. 2024	GH: Uttarayana Punya Kala Sankrathi (Tentative)
19th -20th Jan. 2024	Lab IA Test-I (III Sem. 2022 Scheme & V Sem. 2021 Scheme)
22nd-24th Jan. 2024	2nd IA Test for III & V Semesters
24th Jan. 2024	2nd Feedback on Teaching-Learning (III & V Sems.)
26th Jan. 2024	Republic Day
29th Jan. 2024	Display of 2nd IA Test Marks (III & V Sems.)
9th -10th Feb. 2024	Lab IA Test-II (III Sem. 2022 Scheme)
15th-17th Feb. 2024	3rd IA Test for III Semester
19th Feb. 2024	Display of 3rd IA Test Marks (III Sem.)
20th Feb. 2024	Last Working Day of the III Semester
21st -29th Feb. 2024	III Semester VTU Practical Examination
04th -23rd March 2024	III Semester VTU Theory Exams (SEE)
1st & 2nd March 2024	Lab IA Test-II (V Sem. 2021 Scheme)
5th -7th March 2024	3rd IA Test for V Sem
9th March 2024	Display of 3rd IA Test Marks
8th March 2024	GH: Mahashivaratri & International Women's Day
9th March 2024	Last Working Day of the V Semester
11th-20th March 2024	V Semester Practical Examination
1st April 2024	Commencement of IV Semester
22nd March-20th April 24	V Semester VTU Theory Exams (SEE)
22nd April 2024	Commencement of VI Semester
29th March 2024	GH: Good Friday

GH: General Holiday, RH: Local Holiday

Dr.S.N.Topannavar
IQAC Coordinator & Dean (Academics)

Dr.S.C.Kamate
Principal

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VTU Scheme of Teaching and Examination

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
B.E. in Mechanical Engineering
Scheme of Teaching and Examinations2022
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
(Effective from the academic year 2023-24)

III SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching Hours /Week				Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	SDA	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1	PCC	BME301	Mechanics of Materials	TD- ME PSB-ME	2	2	0		03	50	50	100	3
2	IPCC	BME302	Manufacturing Process	TD: ME PSB: ME	3	0	2		03	50	50	100	4
3	IPCC	BME303	Material Science and Engineering	TD: ME PSB: ME	3	0	2		03	50	50	100	4
4	PCC	BME304	Basic Thermodynamics	TD: ME PSB: ME	2	2	0		03	50	50	100	3
5	PCCL	BMEL305	Introduction to Modelling and Design for Manufacturing	TD: ME PSB: ME	0	0	2		03	50	50	100	1
6	ESC	BME306x	ESC/ETC/PLC	TD: Respective Dept. PSB: Respective Dept.	3	0	0		03	50	50	100	3
7	UHV	BSCK307	**Social Connect and Responsibility**	Any Department	0	0	2		01	100	---	100	1
8	AEC/ SEC	BME358x	Ability Enhancement Course/Skill Enhancement Course - III		If the course is a Theory				01	50	50	100	1
					1	0	0						
					If a course is a laboratory				02				
					0	0	2						
9	MC	BNSK359	National Service Scheme (NSS)	NSS coordinator	0	0	2			100	---	100	0
		BPEK359	Physical Education (PE) (Sports and Athletics)	Physical Education Director									
		BYOK359	Yoga	Yoga Teacher									
									Total	**550**	**350**	**900**	**20**

Subject Title	MECHANICS OF MATERIALS		
Course Code	BME301	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	2-2-0-0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

FACULTY DETAILS:		
Name: Prof. D.N.Inamdar.	**Designation:** Asst. Professor	**Experience:** 20
No. of times course taught: 11	**Specialization:** Tool Design	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Students should have the knowledge of basic subjects	I/II Sem, High school & PU level Physics basics	Engineering Mechanics, Classical Physics, Trigonometry,

2.0 Course Objectives

Students will be able

1. To provide the basic concepts and principles of strength of materials.
2. To give an ability to calculate stresses and deformations of objects under external loadings.
3. To give an ability to apply the knowledge of strength of materials on engineering applications and design problems.

3.0 Course Outcomes

Having successfully completed this course, the student will be able to understand the,

CO	Course Outcome	Cognitive Level	POs
C302.1	Understand the concepts of stress and strain in simple and compound bars.	L1,L2	PO1, PO2,PO3,PO4
C302.2	Explain the importance of principal stresses and principal planes & analyze cylindrical pressure vessels under various loadings	L1,L2 & L3	PO1, PO2,PO3,PO4
C302.3	Apply the knowledge to understand the load transferring mechanism in beams and stress distribution due to shearing force and bending moment.	L1,L2 & L3	PO1, PO2,PO3,PO4
C302.4	Evaluate stresses induced in different cross-sectional members subjected to shear loads.	L1,L2 & L3	PO1, PO2,PO3,PO4
C302.5	Apply basic equation of simple torsion in designing of circular shafts & Columns	L1,L2 & L3	PO1, PO2,PO3,PO4
Total Hours of instruction		**50**	

4.0 Course Content

Module - 1

Simple stress and strain: Definition/derivation of normal stress, shear stress, and normal strain and shear strain – Stress strain diagram for brittle and ductile materials - Poisson's ratio & volumetric strain – Elastic constants – relationship between elastic constants and Poisson's ratio – Generalised Hook's law – Deformation of simple and compound bars, Resilience, Gradual, sudden, impact and shock loadings – thermal stresses.. **10 hours**

Module- 2

Bi-axial Stress system: Introduction, plane stress, stresses on inclined sections, principal stresses and maximum shear stresses, graphical method - Mohr's circle for plane stress.

Thick and Thin cylinders: Stresses in thin cylinders, Lame's equation for thick cylinders subjected to internal and external pressures, Changes in dimensions of cylinder (diameter, length and volume), simple numerical. **10 hours**

Module- 3

Bending moment and Shear forces in beams: Definition of beam – Types of beams – Concept of shear force and bending moment – S.F and B.M diagrams for cantilever, simply supported and overhanging beams subjected to point loads, uniformly distributed loads, uniformly varying loads and combination of these loads – Point of contra flexure. **05 hours**

Module- 4

Theory of simple bending – Assumptions – Derivation of bending equation - Neutral axis – Determination of bending stresses – section modulus of rectangular and circular sections (Solid and Hollow), I, T and Channel sections – Design of simple beam sections, Shear Stresses: Derivation of formula – Shear stress distribution across various beams sections like rectangular, circular, triangular, I, and T sections. **05 hours**

Module- 5

Torsion of circular shafts: Introduction, pure torsion, assumptions, derivation of torsional equations, polar modulus, torsional rigidity / stiffness of shafts, power transmitted by solid and hollow circular shafts.

Theory of columns – Long column and short column - Euler's formula – Rankine's formula. **10 hours**

5.0 Relevance to future subjects

Sl. No	Semester	Subject	Topics
01	VII/VIII	Project work	Fundamental concepts
02	VII	Dynamics of Machines	Fundamental concepts of vibrations and mechanical systems
03	V/VI	Design of Machine Elements I/II	Design of Keys, Shafts, couplings, Fasteners, Keys and Joints, Rivets, curved beams, springs cylinders.

6.0 Relevance to Real World

SL.No	Real World Mapping
01	Checking for solid body stability & Analysis of Stresses and Strains in machine elements.
02	Design of Boiler, column, Gear, Keys, Beams and Shaft.
03	Determination of Mechanical properties of engineering materials.

7.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
01	NPTEL Tutorial	Topic: concepts of stress and strain, plane stress system, shear force and bending moment diagram, torsion, columns and theories of failures.

8.0 Books Used and Recommended to Students

Sl.No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year

Text Books				
01	Mechanics of Materials	J M Gere, B J Goodno	Cengage	Eighth edition 2013
02	Fundamentals of Strength of Materials	P N Chandramouli	PHI Learning Pvt. Ltd	2013
03	Strength of Materials	R K Rajput	S.Chand and Company Pvt. Ltd	2014
Reference Books				
01	Strength of Materials	R. Subramanian	Oxford	2005
02	Strength of Materials	S. S. Ratan	Tata McGraw Hill	2nd Edition, 2008
03	Mechanics of Materials	S.C.Pilli and N Balasubramanya	Cengage	2019
04	Mechanics of Materials	Ferdinand Beer, Russell Johston, John Dewolf, David Mazurek	McGraw Hill Education (India) Pvt. Ltd	Latest Edition
05	Mechanics of Materials	R C Hibbeler	Pearson	Latest Edition

Additional Study material & e-Books

1. Strength of Materials by R.K.Bansal_pdf drive
2. Strength of Materials by R.K.Rajaput_pdf drive

9.0 Relevant Websites (Reputed Universities and Others) for Notes /Animation / Videos Recommended

Website and Internet Contents References

1) Online Lectures on MOM-18ME32by Prof. D.N.Inamdar,HSIT,Nidasoshi
   Link: https://drive.google.com/drive/folders/1scRLij489y86r4ONDNXZ-RIxt_pfJQoP?usp=sharing
2) Introduction to Strength of materials: https://www.youtube.com/watch?v=GkFgysZC4Vc
3) Solid Mechanics: https://www.youtube.com/watch?v=A1SWKe6ZwVc
4) Advanced strength of Materials: https://www.youtube.com/watch?v=_2d8YsXwm7M
5) Video on Torsion of circular shaft: https://www.youtube.com/watch?v=ICDZ5uLGrI4
6) Video on Bending of beam: https://www.youtube.com/watch?v=asBW0Ojc0bY
7) Video on deriving bending equation: https://www.youtube.com/watch?v=AvCkrU3KaZw
8) GATE: https://www.btechguru.com/GATE--mechanical-engineering--strength-of-materials-video-lecture--23--133.html
9) Theories of Failures: https://nptel.ac.in/courses/105102090/20
10) Columns:
    - https://www.youtube.com/watch?v=hwpGAxa8UoI&list=PL4K9r9dYCOoqADwI0zQXTJ6wy_Dr37Fy2
    - https://www.youtube.com/watch?v=F692spiIyHU&list=PL4K9r9dYCOoqADwI0zQXTJ6wy_Dr37Fy2&index=2
    - https://www.youtube.com/watch?v=DYeRXKa8mKA&list=PL4K9r9dYCOoqADwI0zQXTJ6wy_Dr37Fy2&index=3
    - https://www.youtube.com/watch?v=szApiRoy_wY&list=PL4K9r9dYCOoqADwI0zQXTJ6wy_Dr37Fy2&index=6
11) Strain Energy Theory
    - https://www.youtube.com/watch?v=szApiRoy_wY&list=PL4K9r9dYCOoqADwI0zQXTJ6wy_Dr37Fy2&index=6
    - https://www.youtube.com/watch?v=99_UsxPgDqs
    - https://www.youtube.com/watch?v=sur6mZ_66ak
    - https://www.youtube.com/watch?v=dX8hvaFczY4
    - https://www.youtube.com/watch?v=xf2UoWkIa5w
12) Gate solution with Key answers
    - www.iesacademy.com
    - https://www.iesacademy.com/uploaded_files/download/small-1465029586.pdf
    - https://www.youtube.com/watch?v=LF5GQNDVd7s&list=PLgzsL8klq6DI7pZwzHuLgpeQMLoTIGVgO
13) Stress Strain Theory at a Glance for IES & Gate
    https://www.iesacademy.com/uploaded_files/download/small-1463734449.pdf

14) Previous Question Papers:
https://drive.google.com/file/d/1zdKzCsXBJWToiys54kv6pyXpWY6XMHYA/view

10.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	Elsevier	https://www.journals.elsevier.com
2	Journal of Gears	http://journals.sagepub.com
3	Journal of Manufacturing Science and Engineering	http://manufacturingscience.asmedigitalcollection.asme.org
4	International Journal of Renewable Energy Research (IJRER)	http://www.ijrer.org
5	Magazines	https://www.asminternational.org/news/magazines

11.0 Examination Note

CONTINUOS INTERNAL EVALUATION: 40 Marks
Scheme of Evaluation for Internal Assessment (30 Marks): Internal Assessment test in the same pattern as that of the main examination (Average of all three tests). Questions shall be answered in internal assessment books (blue book).Internal assessment book shall be submitted.
Scheme of Evaluation for Assignments (10 Marks): Assignment on each module is to be submitted and each module carries 10 marks (Average of all five assignments).Assignment book shall be submitted.

SCHEME OF END SEMESTER EXAMINATION:
Two full questions (with a maximum of four sub questions) of twenty mark each to be set from each module. Each question should cover all the contents of the respective module. Students have to answer five full questions choosing one full question from each module. From each module out of two full questions one full question to be answered and each carries 20 Marks. Five full question to be answered 5x20 = 100 Marks. Later final marks are reduced to 60 marks.

12.0 Course Delivery Plan

Module	Lecture No.	Content of Lecturer	% of Portion
Module-1	1	Introduction to **Mechanics of Materials**	20 %
	2	Concepts of stress and strain, Hooke's law and Mechanical Properties of Materials	
	3	Calculation of stresses and deformations in straight bar	
	4	Calculation of stresses and deformations in stepped bar	
	5	Calculation of stresses and deformations in Tapered and composite Sections.	
	6	Stresses due to temperature changes	
	7	Shear stress, shear strain, Poisson's ratio and lateral strain	
	8	Generalized hooks law, Elastic constants	
	9	Relationship between elastic constants	
	10	Problems on elastic constants	
Module-2	11	**Analysis of Stress and Strain**	40 %
	12	Plane stress system	
	13	Components of stresses acting on inclined plane	
	14	Principal stresses and their planes	
	15	Maximum shear stresses, planes and principal angles.	
	16	Problems on stress components calculations	
	17	Mohr's circle method for plane stress analysis	
	18	**Cylinders:** Thin cylinders, Hoop's stress, maximum shear stress	
	19	Circumferential stress and longitudinal stresses	

	20	Thick cylinders and Lami's equation	
Module-3	21	**Shear force and Bending moment diagrams**	**60 %**
	22	Definition of beam, Types of Beam, Loads and End Conditions.	
	23	Relationship between distributed load, Shear force and Bending moment	
	24	Determination of shear force and Bending moment for Cantilever, Simply supported and	
	25	Single and double overhanging beam subjected to point,UDL, UVL, COUPLE & Bracket load	
	26	**Bending stresses in Beam:** Theory of pure bending	
	27	Curvature of beam, longitudinal strains in the beams	
	28	Flexural Formula for beams	
	29	Bending and Shear stress distributions in beams with rectangular, I, T, C cross-sections.	
	30	Problems on Bending and Shear stress distributions in beams	
Module-4	31	**Deflection of Beams:** Relationship between moment, slope and deflection, Moment area method	**80 %**
	32	Macaulay's method. Problems to calculate slope and deflection for determinant beams,	
	33	Beams of uniform strength	
	34	Leaf springs.	
	35	**TORSION:** Torsion of solid circular and hallow shafts	
	36	Torsional Moment of Resistance	
	37	Power transmission of straight and stepped shafts	
	38	Twisting in shaft sections	
	39	Thin tubular and thin walled sections	
	40	Problems on Torsions	
Module-5		**Cylinders:** Thin cylinders, Hoop's stress, maximum shear stress	100%
		Circumferential stress and longitudinal stresses	
		Thick cylinders and Lami's equation	
	41	**Columns :**Buckling and Stability of columns, critical load	
	42	Analysis of columns with pinned ends and other support conditions	
	43	Effective length of columns	
	44	Secant formula	
	45	Problems on columns	
	46	**Strain Energy Theory**	
	47	Strain energy due to axial, shear, bending, torsion and impact load	
	48	Castigliano's theorem I &II	
	49	Load deformation diagram	
	50	Applications on Castigliano's theorem I &II	

13.0 Assignments, Pop Quiz, Mini Project, Seminars

Sl.No.	Title	Outcome expected	Allied study	Week No.	Individual / Group activity	Reference: book/website /Paper
1	Assignment 1: University Questions on stress and strain concepts.	Students study the Topics and prepare the multiple choice questions with answer.	Module-1 of the syllabus	2	Group Activity. Each group should prepare minimum 05 questions expected.	Book 1, 2 of the reference list. Website of the Reference list
2	Assignment 2: University Questions on Analysis of Stress and Strain and Thick	Students study the Topics and identify components of stresses &construct Mohr's	Module-2 of the syllabus	4	Individual Activity.	Book 1, 2 of the reference list. Website of the Reference

	& Thin Cylinders	circle for the given plane stress system. Calculation of stresses developed in thick and thin cylinders				list
3	Assignment 3: University Questions on Shear Forces and Bending Moments	Students study the Topics and draw the SFD &BMD for the beam subjected to external load system	Module-3 of the syllabus	6	Individual Activity & multiple Choice questions and Hobby Project to illustrate the SF &BM.	Book 1, 2 of the reference list. Website of the Reference list
4	Assignment 4: University Questions On Theory of Simple Bending	Students shall study the theory of simple bending, Bending equation for straight beams and evaluation of bending & shear stresses in I & T sections	Module-4of the syllabus	8	Individual Activity.	Book 1, 2 of the reference list. Website of the Reference list
5	Assignment 5: University Questions on Torsion and Columns Failure:	Students shall study the Torsion theory and its equation, evaluation of torsional stresses , moduus of rigidity insolid and hollow circular shafts.Also theory of variety of columns and calcution methods of slenderness ratio and stresses developed in different columns	Module-5 of the syllabus	10	Individual Activity	Book 1, 2 of the reference list. Website of the Reference list

14.0 QUESTION BANK

Module1: Stress and Strain:

1.	Define the stress and Strain.
2.	State Hooke's law and define Poisson's ratio.
3.	Draw Stress-Strain diagram for a ductile material.
4.	Define the following: i) Limit of Proportionality ii) Elastic limit iii) Yield point iv) Ultimate stress v) Breaking stress.
5.	Define i) stress ii) Hook's law iii) Elasticity iv) lateral strain.
6.	Draw Stress-Strain diagram for mild steel with salient features.
7.	Draw Stress-Strain diagram for Aluminum.
8.	Define Nominal stress and True stress
9.	Derive an expression for the elongation of a bar subjected to tensile load
10.	Show that the extension produced due to self weight of a bar of uniform cross section fixed at one end suspended vertically is equal to half the extension produced by a load equal to self weight applied at the free end.
11.	Derive an expression for the extension of a rectangular bar which is having continuously varying cross-section

12. Derive an expression for the extension of a circular bar which is having continuously varying cross section.
13. Derive an expression for the elongation of a bar of uniform cross section due to its self weight
14. The observations were made in a tension test of a mild steel
    i) rod of diameter 10mm
    ii) length 200mm
    iii) Extension under a load of 10kN=0.12mm
    iv) The Maximum load =26kN
    v) Load beyond which stress-strain curve was not proportional=11KN
    vi) Final length at failure =261.5mm, Diameter at failure =5.7mm

    Find the limit of proportionality, Young's modulus, percentage elongation of length and percentage reduction of area at failure.
15. A specimen of steel 25mm in diameter with a gauge length of 200mm is tested to destruction. It has an extension of 0.16mm under a load of 80kN and the load at elastic limit is 160kN. The maximum load is 180kN. The Total extension at fracture is 56mm and diameter at neck is 18mm.Find i) The Stress at elastic limit ii) young's modulus iii) Percentage Elongation iv) Percentage reduction in area and v) Ultimate tensile stress.
16. A stepped bar having circular sections of diameter 1.5D and D are as shown in ***Figure 1*** 1if ρ and E are the density and Young's modulus of elasticity respectively, find the extension of the bar due to own weight.

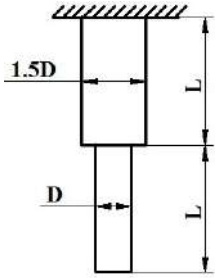
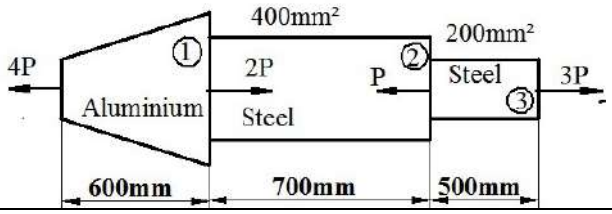


Figure 1

17. A steel wire of 6mm diameter is used for lifting a load 1.5KN at its lower end , the length of the wire being 160 m. Calculate the total elongation of the wire taking $E=2x10^5$ N/mm^2 and unit weight of steel=78kN/m^3
18. A round bar with stepped portion is subjected to the forces as shown in ***Figure 2***. Determine magnitude of force P such that the net deformation in the bar does not exceed 1mm.Young's modulus for steel is 200GPa and that for aluminum is 70GPa. Big end diameter and small end diameter of the tapering bar are 40mm and 12.5mm respectively.



19. A member ABCD is subjected to a pointloads P_1,P_2,P_3 & P_4 as shown in ***Figure 3***. calculate the force P_2 necessary for equibrilium . if P_1 =45KN, P_3 =450KN & P_4= 130KN. Determine stresses in each member also determine the total elongation of the member assuming the E to be 2.1x 0^5N/mm^2.

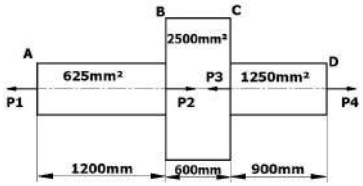


Figure 3

20. For the laboratory tested specimen the following data were obtained,
    i) Diameter of the specimen =25mm

ii) Length of the specimen =300mm
iii) Extension under the load of 15KN=0.045mm
iv) Load at yield point =127.65KN
v) Maximum load =208.60KN
vi) Length of the specimen after failure=375mm
Determine i) Young's modulus ii) Yield point stress iii) Ultimate stress iv) Percentage Elongation v) percentage reduction in area.

21. A stepped bar subjected to an external loading as shown in ***Figure 4***, Calculate the change in the length of the bar. Take E=200Gpa for Steel E=70 GPa for Aluminum and E=100 GPa for Copper (Dec 07/Jan 08)

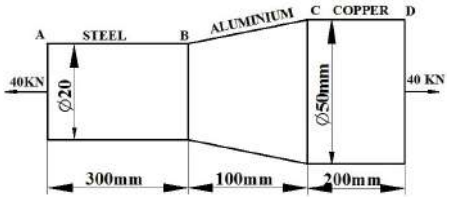


Figure 4

22. A 500 mm long bar has rectangular cross section 20mm x 40mm. This bar is subjected to
    i) 40KN tensile force on 20mm x 40mm faces
    ii) 200KN Compressive forces on20mm x 500 mm faces and
    iii) 300KN tensile force on 40mm x 500mm faces
Find the change in the volume if $E=2x10^5$ N/mm^2 and μ=0.3.

23. Two copper rods and one steel rod together support a load of 200KN as shown in ***Figure 5***. Find the stress in the rod Take E_s=2 x 105 N/mm^2 and E_c=1 x 105N/mm^2.

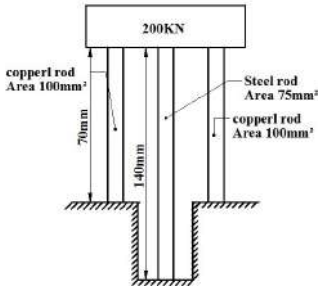


Figure 5

24. A compound bar is made of a central steel plate 60mm wide and 10mm thick to which copper plates 40mm wide and 5mm thick are connected rigidly on each side. The length of the bar at normal temperature is 1 meter. If the temperature is raised by 80˚C, determine the stresses in each metal and change in length. Take Es=200Gpa,Ec=100Gpa, αs=12x10-6/˚C αc=17x10-6/˚C

25. A steel bolt of 16mm diameter passes centrally through a copper tube of internal diameter 20mm and external diameter 30mm. The length of the whole assembly is 500mm. after tight fitting of the assembly; the nut is over tightened by quarter of a turn. What are the stresses introduced in bolt and tube, if pitch of the nut is 2mm.Take E=200kN/mm^2.

26. Define the following i) Volumetric strain, ii) Bulk modulus, iii) Poisson's ratio
    iv) Modulus of rigidity v) Modulus of Elasticity iv) Factor of safety.

27. Establish the relationship between Modulus of elasticity and Modulus of rigidity

28. Establish the relationship between Modulus of elasticity and Bulk modulus

29. state the concept of shear stress and shear strain

30. Define volumetric strain. A bar of uniform rectangular section of area A is subjected to an axial load P. show that the volumetric strain is given by $\varepsilon_v = \frac{P}{AE}\left(1-\frac{2}{m}\right)$,where E is the young's modulus &1/m is the poisson's ratio.

31. The modulus of rigidity of a material is 0.8 x 10^5N/mm^2. When a 6mmx6mm rod of this material was subjected to an axial pull of 3600N,it was found that the lateral dimensions of the rod changed to 5.9991mmx5.9991mm.

Find the poisson's ratio and the modulus of Elasticity.

32. A horizontal rigid bar AB weighing 200KN is hung by three vertical rods, each of 1m length and 500mm^2 cross section as shown in ***Figure 6***. the central rod is of steel and outerrods are copper. If the temperature rise is 40°C, estimate the load carried by each rod and by how much the load will descend.Take E_s=200GN/m^2, E_c=100GN/m^2, α_s=1.2x10^{-5}/°C ,α_c=1.8x10^{-5}/°C.

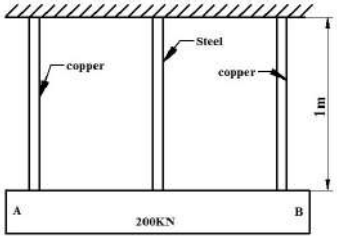


Figure 6

33. A circular rod of 100mm diameter & 500mm long is subjected to a tensile force of 1000kN. Determine Modulus of rigidity,Bulk Moduls and change in volume if poisson's ratio is 0.3 and yuong's modulus E = 2 x 105N/mm2.

34. A compound bar is made of a central steel plate 60mm wide and 10mm thick to which copper plates 40mm wide and 5mm thick are connected rigidly on each side. The length of the bar at normal temperature is 1 meter. If the temperature is raised by 80°C, determine the stresses in each metal and change in length. Take E_s=200GN/m^2,E_c=100GN/m^2 α_s=12x10^{-6}/°C α_c=17x10^{-6}/°C

35. A 12 mm diameter steel rod passes centrally through a copper tube 48 mm external diameter and 36mm internal diameter and 32.50 mm long. The tube is closed at each end by 24mm thick steel plates which are secured by nuts .The nuts are tightened until the copper tube is reduced in length by 0.508mm .The assembly is then raised in temperature by 60°C. Calculate the stresses in the copper and steel before and after raising the temperature, assuming the thickness of the plate remain to be unchanged. Take α_s=1.2x10^{-5}/°C, αc=1.75x10^{-5}/°C, E_s=2.1x10^5 N/mm^2,E_c=1.05x10^5 N/mm^2

36. A steel tube of 25mm external diameter and 18mm internal diameter encloses a copper rod of 15mm diameter. The ends are rigidly fastened to each other. Calculate the stresses in the the rod and the tube when the temperature is raised from 15° to 200°C Take α_{st}=11x10^{-6}/°C, α_{cu}=18x10^{-6}/°C, E_{st}=200 GPa and E_{cu}=100 GPa

37. A steel bar is placed between two copper bars each having the same area and length as the steel bar at 15°C. At this stage they are rigidly connected together at both ends. When the temperature is raised to 315°C, the length of the bars increased by 1.50mm. Determine the original length and the final stresses in the bars. Take E_s=2.1x10^5 N/mm^2, E_c=1x10^5 N/mm^2, α_s=0.000012/°C, α_c=0.0000175/°C

38. A 25 mm diameter steel rod passes concentrically through a bronze tube 400mm long,50mm external diameter and 40mm internal diameter. The end of the steel rod are threaded and provided with nuts andwashers which are adjusted initially so that there is no end play at 20°C.assuming that there is no change in the thickness of the washers, find the stress produced in the steel and bronze when one of the nuts is tightened by giving it one-tength of a turn, the pitch of the rhread being 2.5mm. take E for steel=200KN/mm^2 and E for bronze=100KN/mm^2.

39. A compound bar consist of steel, copper and aluminum bars connected in series is held between two supports as shown in ***Figure 7*** .When the temperature of the compound bar is increased by 50°C, determine stresses induced in each bar. Consider the two cases i) Rigid supports ii) support yield by 0.5mm. Take α_s=12x10^{-6}/°C α_B=19x10^{-6}/°C α_{AL}=22x10^{-6}/°C Es=200 GPa E_B=83 GPa E_{Al}=70 GPa

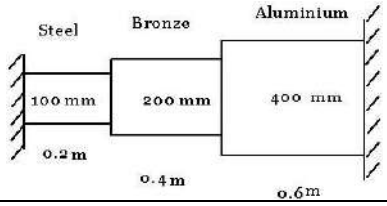


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Figure 7

40. A stepped bar shown in ***Figure 8*** is fixed at its two ends rigidly .The bar is free from stresses when its temperature is 30˚C .When the temperature of the bar is increased to 90˚C determine i) Stresses induced in steel and the copper portions and ii) Displacement in the junction at point C .Take α_c=1.8x10^{-5}/˚C, α_s=1.2x10^{-5}/˚C, Ec=100Gpa E_s=200Gpa.

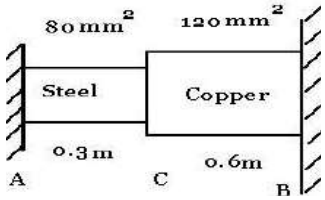

Figure 8

41. A bar of Brass 25mm diameter is enclosed in a steel tube 50mm external diameter. The bar and the tube are both initially 1.5mlong and are rigidly fastened at both ends using 20mm diameter pins .Find the stresses in the two materials when the temperature rises from 30˚C to 100˚C. Take E for Steel =200 kN/mm^2, E for Brass =100KN/mm^2, α for steel =11.6x10^{-6}/˚C, α for brass=18.7x10^{-6}/˚C.

42. A Steel rail is 12.6m long and is laid at tempreture of 24 ˚C. The maximum tempreture expected is 44 ˚C. i) Estimate the minimum gap to be left between two rails so that tempreture stresses do not develop. ii) Calculate ythe thermal stresses developed in the rails ,If a) No expansion joint is provided b) If 2mm gap is provided. Iii) If the stress developed is 20MPa, what is the gap between the rails.

Module 2: Analysis of Stress and Strain and Cylinders:

1. What do you mean by Compound stresses?
2. Define Principal plane and Principal Stress
3. State the sign conventions used in the analysis of stresses
4. What do you understand by maximum shear stress?
5. A rectangular bar is subjected to two direct stresses σ_x and σ_y in two mutually perpendicular directions. Prove that the normal stress(σ_n) & shear stress(τ) on oblique plane which is,

$$\sigma_n = \left(\frac{\sigma_x+\sigma_y}{2}\right) + \left(\frac{\sigma_x-\sigma_y}{2}\right) cos2\theta \text{ \& } \tau = \left(\frac{\sigma_x-\sigma_y}{2}\right) \sin 2\theta.$$

6. Explain procedure for constructing of Mohr's circle, for an element acted upon by two tensile stresses and shear stresses.
7. A point in a strained material is subjected to stresses shown in ***Figure 9***. Using Mohr's circle, determine the normal and tangential stresses across oblique plane.check the answer analytically.

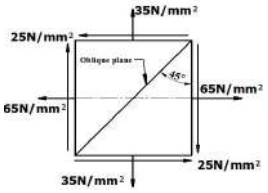

Figure 9

8. The plane element is subjected to stresses as shown in the ***Figure 10***. Determine principal stresses .Maximum shear stresses and their planes. Sketch the plane determined

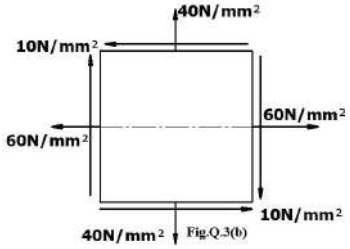

Figure 10

9. The state of the stress in two dimensionally stressed body is shown in ***Figure 11*** .Determine the principal planes, principle stresses ,maximum shear stresses and their planes(June/ July 08)

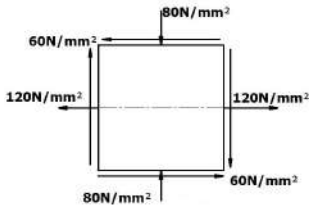

Figure 11

10. Use Mohr's circle, Determine the principal stresses and the planes ,Maximum shear stress and the planes .show the same elements separately

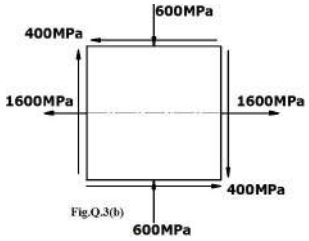

Figure 12

11. A point is strained material is subjected to the stresses as shown in ***Figure 13***. Locate the principal planes and evaluate the principal stresses.

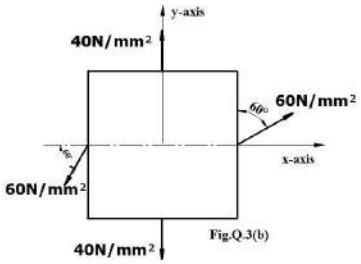

Figure 13

12. The state of stress at a point in strained material is as shown in ***Figure 14***. Determine:
    i) Direction of principle planes
    ii) Magnitude of principle stresses
    iii) Magnitude of the Maximum shear stress and its direction .Indicate all the above by a sketch

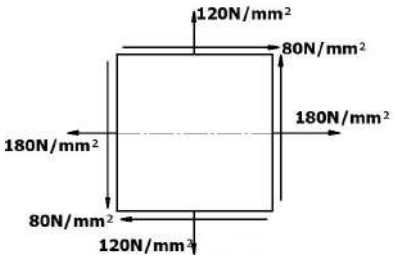

Figure 14

13. The state of stress in two dimensional stressed body is shown in ***Figure*** *15.* Determine principle stresses, principle planes and maximum shear stress .Determine also the normal and tangential stresses on Plane AC .Verify the results by drawing Mohr's circle.

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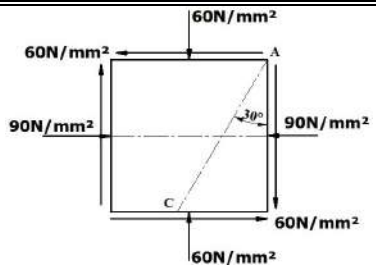


Figure15

14. A point of machine member is subjected to pure shear stress 45Mpa. Determine:
    i) Maximum and minimum stresses induced and orientation of their planes
    ii) ii) stresses on plane whose normal is at an angle of 110˚ with respect to X-axis

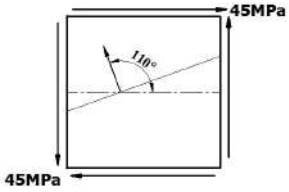


Figure 16

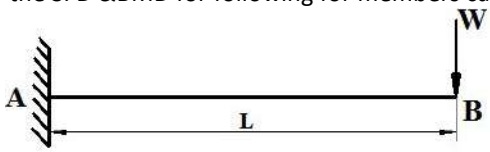
15. What is a thin cylinder and thick cylinder?
16. What do you understand by circumferential and longitudinal stresses?
17. Derive the expressions for the change in the dimensions of a cylinder subjected to internal pressure
18. Derive an expression for strain energy, when member subjected to impact loads.
19. Derive an expression for circumferential stress of a thin cylinder.
20. Define i) strain energy ii) work.
21. Prove that volumetric strain in thin cylinder is given by $\frac{Pd}{4tE}(5-4\mu)$, with usual notations.
22. Calculate the i) change in diameter; ii) change in length and iii) change in volume of a thin cylinder shell 1000mm diameter, 10mm thick and 5m long when subjected to internal pressure of 3N/mm^2. Take the value of **E = 2 x 10^5 N/mm^2** and **1/m= 0.3.**
23. A pressure vessel with outer and inner diameters of 400mm and 320mm respectively is subjected to an external pressure of 80MPa. Determine the circumferential stress induced at the inner and outer surfaces. Prove that the longitudinal strain is constant throughout the cylinder.
24. A thick cylinder with internal diameter 80mm and external diameter 120mm is subjected to an external pressure of 40N/mm^2; when the internal pressure is 120N/mm^2, calculate circumferential stress at external and internal surfaces of the cylinder. Plot the variation of circumferential stress and radial pressure on the thickness of the cylinder.
25. A C.I pipe has200mm internal diameter and 50mm metal thickness and carries water under a pressure of 5 N/mm^2. Calculate the maximumnand minmum intensities of circumferential stress and sketch the disribution of circumferentialstress intensities and intensity of radial pressure across the section.
26. A pipe of 400mm internal diameter and 100mm thickness contains a fluid at a pressure of 80N/mm^2.Find the maximum and minimum hoop stresses across the section. Also sketch radial and hoop stresses distribution across the section
27. A thin cylindrical shell 1.2m in diameter and 3m long has a metal wall thickness of 10mm .it is subjected to an internal fluid pressure of 3.2Mpa .Find the circumferential and longitudinal stress in the wall .determine the change in length .diameter the volume of the cylinder .Assume E=210Gpa and μ=0.3
28. A thick cylinder with internal diameter 80mm and External diameter 120mm is subjected to an external pressure of 40Kn/m^2, when the internal pressure is 120KN/m^2 .Calculate the circumferential stress at external and internal surface of the cylinder. Plot the variation of circumferential stress and radial pressure on the thickness of the cylinder
29. A cylindrical tube with closed ends has an internal diameter of 50mmand a wall thickness of 2.50mm.Yhe tube is

axially loaded in tension with a load of 10KN and is subjected to an axial torque of 500NM under an internal pressure of 6N/mm^2 .Determine the principle stresses on outer surface of the tube and maximum shear stress.

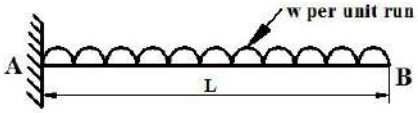
30. A cylindrical shell 1 meter long ,180mm internal diameter ,thickness of the metal is 8mm is filled with a atmospheric pressure .If an additional 20000mm^3 of the fluid is pumped into the cylinder find the pressure exerted by the fluid on the wall of the cylinder .find also the hoop stress induced .Take E=2x10^{5}N/mm^{2}and 1/m.=0.3.
31. A pipe of 200mm internal diameter and 100mm thickness contains a fluid at a pressure of 6N/mm^2.Find the maximum and minimum hoop stresses across the section.
32. Find the thickness of the metal necessary for a steel cylindrical shell of internal diameter 150mm ton with stand an internal pressure of 50N/mm^2.The maximum hoop stress in the section is not to exceed 150N/mm^2.
33. A 1.2 meter long thin cylindrical pressure vessel of 500 mm inner diameter and 14 mm wall thickness undergoes a volume change of 5x10^4 mm^3, when it is subjected to an internal pressure 'p'. Taking E=210GPa and v=0.3 determine the magnitude of P.

Module 2: Shear Forces and Bending Moments:

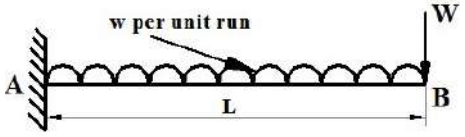
1. What are different types of beams? Explain briefly
2. What are different types of loads
3. Briefly explain different types of beam supports
4. Establish relationship between distriuted load, shear force and bending moment at a cross section of a beam
5. Define i)Shear force ii) Bending moment and iii)Point of contraflecture
6. Draw the SFD &BMD for following for members carrying different loads.



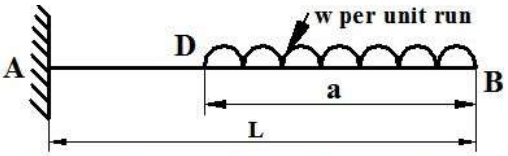
A cantilever of length L carrying a concentraed load w at free end



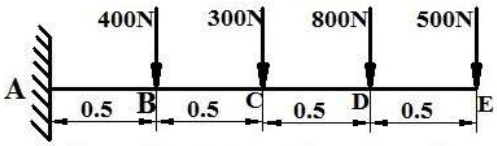
A cantilever of length L carrying a uniformly distributed load w per unit length over the whole length.



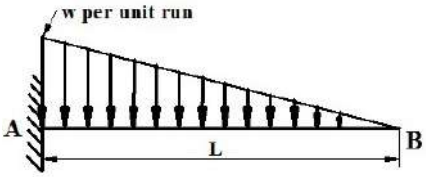
A cantilever of length L carrying a uniformly distributed load w per unit length over the whole length and acomcentrated load W at free end.



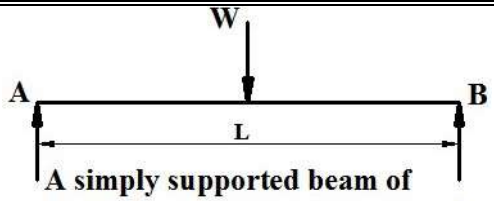
A cantilever of length L carrying a uniformly distributed load w per unit length for a distance 'a' from the free end.



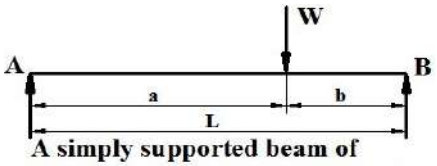
A cantilever carrying several concentraed loads.



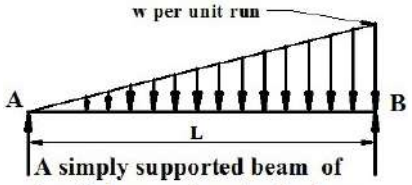
A cantilever of length L carrying a load whose intensity varies uniformly from zero at free end to w per unit run at fixed end.



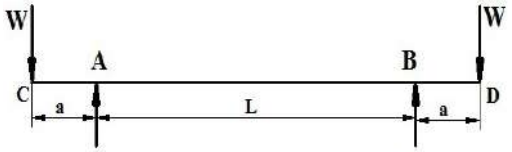
A simply supported beam of length L carrying a concentraed load w at mid span.



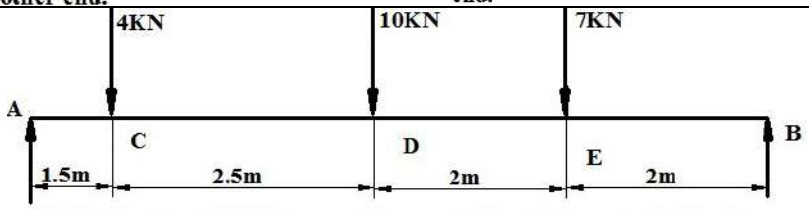
A simply supported beam of length L carrying a concentraed load w placed eccentrically on the span.



A simply supported beam of length L carryinga load whose intensity varies uniformly from zero at one end to w per unit run at other end.

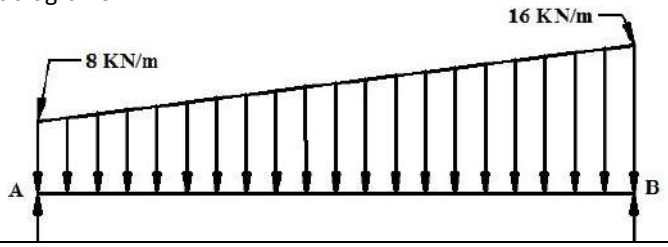


A beam of length (L+2a) has supports 'L' aparts with an overhang 'a' on each side. the beam carries a concentraed load w at each end.



A simply supported beam carrying a number of concentrated loads

7. The intensity of loading on a simply supported beam of length 5m increases uniformly from 8KN/m at one end to 16KN/m at the other end. Find the position and magnitude of the maximum bending moment. Also draw shear and bending moment diagrams.



8. Draw the SFD &BMD for the cantilever beam shown in ***Figure18***

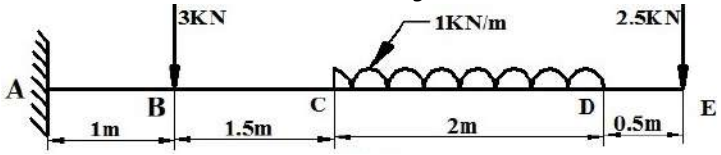


Figure18

9. Draw the beam shown in ***Figure 19***, draw SFD &BMD and mark the values at the salient points.

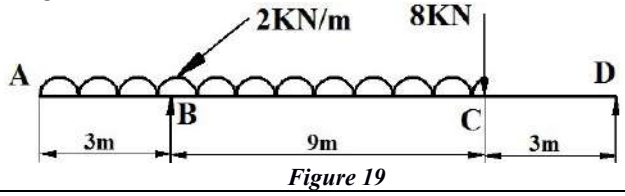


Figure 19

10. Draw the SFD & BMD for the overhanging beam shown in ***Figure 20***. Indicate all significant values including point of contra-flexure.

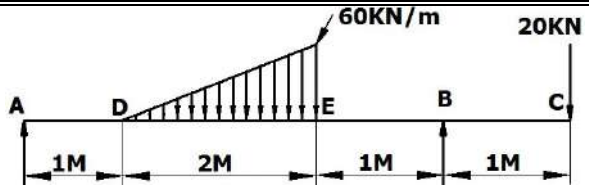


Figure 20

11. Draw the SFD & BMD for the overhanging beam shown in ***Figure 21***. Indicate all significant values including point of contra-flexure.

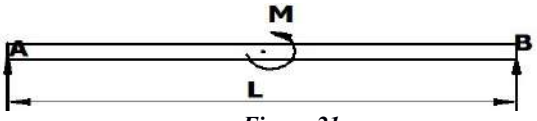


Figure 21

12. A cantilever beam is loaded as shown in ***Figure 22***. Draw the shear force and bending moment diagrams, for the beam.

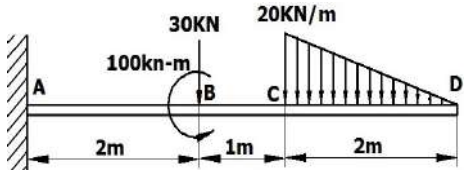


Figure 22

13. Draw shear force and bending moment diagram for overhanging beam as show in ***Figure 23*** and locate the point of contra flexure.

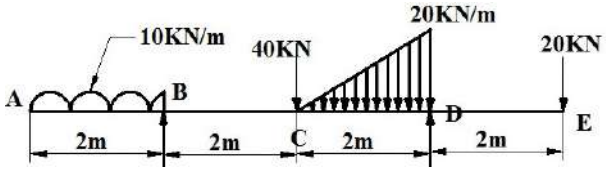


Figure 23

14. Draw shear force and bending moment diagram for the beam loaded as shown in the ***Figure*** 24.

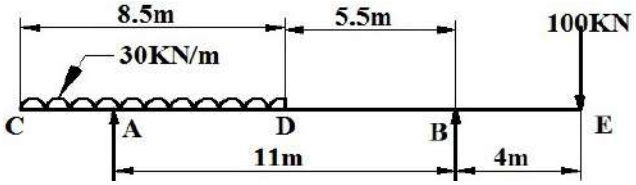


Figure 24

15. For the beams shown in ***Figure 25***, draw shear force and bending moment diagram. Locate point of contra flexure if any

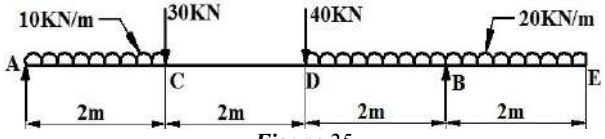


Figure 25

16. For the beam shown in ***Figure 26***. Draw shear force and bending moment diagram and indicating the principle values (June/July 08)

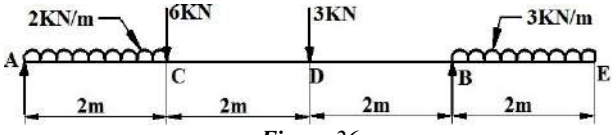


Figure 26

17. Draw shear force and bending moment diagram for the loading factor on the beam as shown in ***Figure 27***.

Indicate where the inflection and contra flexure points are located. Also locate maximum bending moment with its magnitude

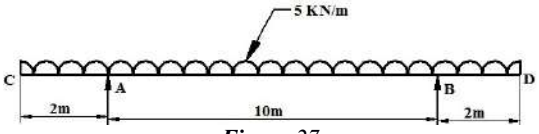


Figure 27

18. For the beam shown in ***Figure 28***. Draw shear force and bending moment diagram

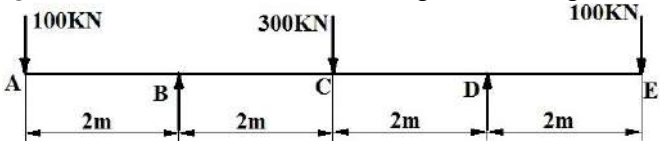


Figure 28

19. For the beam shown in ***Figure 29***. Draw shear force and bending moment diagram

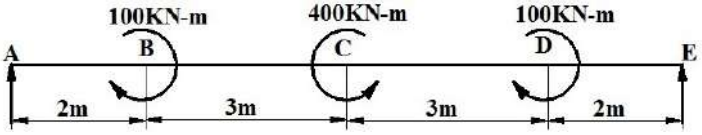


Figure *29*

Module-4 Theory of Simple bending :BENDING STRESS & SHEAR STRESS:

1. What are the assumptions made in simple theory of bending?
2. Prove that $\frac{M}{I} = \frac{\sigma}{Y} = \frac{E}{R}$ with usual notations.
3. Derive an expression for relationship between bending stress and radius of curvature.
4. A beam of an I-section consists of 180mmx15mm flanges and a web of 280mmx 15 mm thicknesses. It is subjected to a shear force of 60KN. Sketch the shear stress distribution along the depth of the section.
5. An I section has the following dimensions, Flanges 200mm x 10mm; web 380mm x 8mm. The maximum shear stress developed in the beam is 20M/mm^2. Find the shear force to which the beam is subjected.
6. A simply supported beam of span 5m has a cross section 150mm x 250mm. if the permissible stress is 10N/mm^2,find i) Maximum intensity of uniformly distributed load it can carry, ii) The maximum concentrated load P applied at 2m from one end it can carry.
7. Prove that the maximum shear stress in a circular section of a beam is 4/3 times the average shear stress.
8. Derive an equation for moment carrying capacity of rectangular and circular sections
9. Explain plain neutral axis and modulus of section as applied to beam.
10. Prove that maximum shear stress in a rectangular section of width b and depth d is equal to 1.5 times of its average shear stress
11. At a given position in a beam of uniform I-section is subjected to a bending moment of 100KN-m. Plot the variation of bending stress across the section (refer ***Figure 30***).

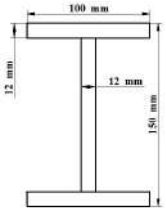


Figure 30

12. A T shaped cross section of a beam as shown in ***Figure 31*** is subjected to a vertical shear force of 100KN. Calculate the shear stress at the neutral axis and at the junction of the web and flange. M I about horizontal neutral axis is 0.000113m^4.

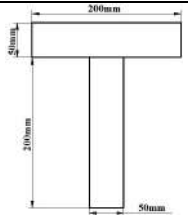


Figure 31

13. Determine the maximum allowable span length "L" for a simple beam as shown in ***Figure 32***. The beam is of rectangular cross section (140mmx240mm) subjected to a uniformly distributed load q=6.5KN/m and allowable bending stress is 8.2Mpa

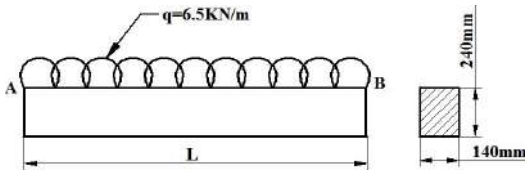


Figure 32

14. Determine the deflection under the loads in the beam as shown in ***Figure 33***. Take flexural rigidity as IE through out

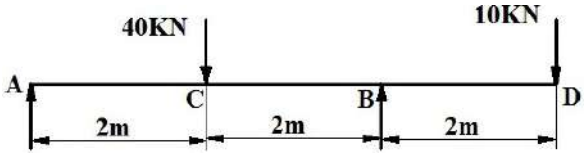


Figure 33

15. An unequal angle section shown in ***Figure 34*** is used as simply supported beam over a span of 2 m and uniformly distributed load of 10 KN/m, inclusive of its own weight. Determine the maximum tensile and compressive stresses in the section

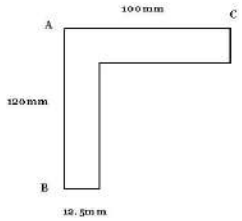


Figure 34

16. A beam of T section has a length of 2.5m and is subjected to a point load as shown in the ***Figure 35***. Calculate compressive bending stress and plot the stress distribution across the cross section of the beam .The maximum tensile stress is limited to 300MPa .Calculate the value of W.

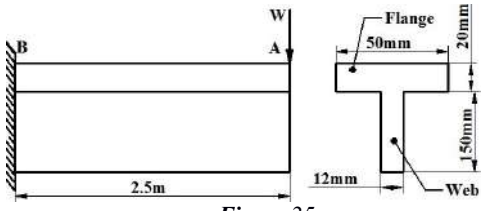


Figure 35

17. A 1 m long cantilever with T section is subjected to a point load 10KN at its free end. The size of the flange is (140 mm x 10mm) and overall depth of the section is 150mm.thickness of web is 10mm.Determine the maximum tensile stress and maximum compressive stress induced in the section and draw the bending stress distribution.

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Mech. Engg. Dept.
Course Plan
III rd Semester
2023-24

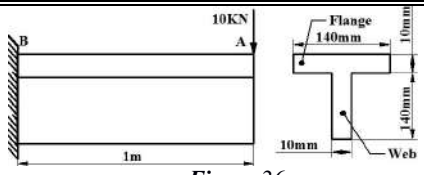

Figure 36

18. A cantilever has an I section with unequal flanges .The upper and lower flanges are (200mmx14mm) and (100mmx14mm) respectively .The web is (14mmx250mm).The cantilever is subjected to UDL of magnitude 4KN/m over its entire length and a point load W at the free end as shown in the Figure 37 Yield stress for the material of cantilever is 330MPa .Taking the factor of safety as 2. Determine the magnitude of maximum load W that can be applied.

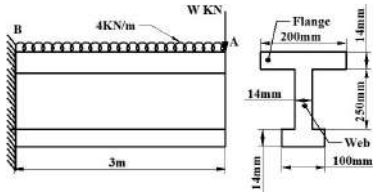

Figure 37

19. When a simply supported beam is subjected to the loads as shown in the ***Figure 38***. The longitudinal strain induced at a point P is found to be $500x10^{-6}$. Determine the magnitude of W. Take E=200GPa.

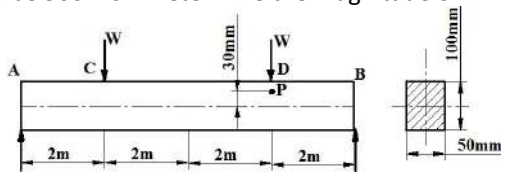

Figure 38

MODULE 5: TORSION

1. State the assumptions made in the theory of pure torsion
2. Define Polar Modulus and Torsional rigidity
3. Derive the torsion equation with usual notations. State the assumptions made in the derivation.
4. Define a Column. What are different types of columns?
5. What are the assumptions made in the theory of column?
6. A hallow steel shaft 3m long must transmit a torque of 25 KN-m .The total angle of twist in this is not to exceed 2.5degree an allowable shearing stress is 90Mpa .Determine inside and outside diameter of the shaft if G=85Gpa
7. A solid shaft rotating at 500rpm transmits 30KW.Maximum torque is 20% more than mean torque .Allowable shear stress 65MPa and modulus of rigidity 81Gpa ,angle of twist in the shaft should not exceed 1˚ in 1m length .Determine suitable diameter
8. A hollow circular steel shaft has to transmit 60KW at 210rpm such that the maximum shear stress does not exceeds 60MPa.if the ratio of internal to external diameters is equal to ¾ and the value of rigidity is 84GPa, find the dimensions of the shaft and angle of twist in a length of 3m.
9. Find the diameter of the shaft required to transmit 60KW at 150rpm if the maximum torque is 25% of the mean torque for a maximum permissible shear stress of $60MN/m^2$. Find also the angle of twist for a length of 4m.Take G=80GPa
10. A 2 meters long hollow cylinder shaft has 80mm outer diameter and 10mm wall thickness. When the tortional load on the shaft is 6KN-m.determine i)Maximum shear stress induced ii) angle of twist .Also draw the distribution of shear stress in the wall of the shaft. Take G as 80GPa (ρ =344)
11. A solid shaft rotating at 500rpm transmits 30KW .The maximum torque is 20% more than the mean torque .Material of shaft has the allowable shear stress 65MPa and modulus of rigidity 81GPa.Angle of twist in the shaft should not exceed 1˚ in 1m length .Determine the diameter of the shaft(ρ=346)

Thick & Thin Cylinders, Columns

What is a thin cylinder and thick cylinder?

	What do you understand by circumferential and longitudinal stresses?
	Derive the expressions for the change in the dimensions of a cylinder subjected to internal pressure
	Derive an expression for strain energy, when member subjected to impact loads.
	Derive an expression for circumferential stress of a thin cylinder.
	Define i) strain energy ii) work.
	Prove that volumetric strain in thin cylinder is given by $\frac{Pd}{4tE}(5-4\mu)$, with usual notations.
	Calculate the i) change in diameter; ii) change in length and iii) change in volume of a thin cylinder shell 1000mm diameter, 10mm thick and 5m long when subjected to internal pressure of 3N/mm^2. Take the value of **E = 2 x 10^5 N/mm^2** and **1/m= 0.3.**
34.	A pressure vessel with outer and inner diameters of 400mm and 320mm respectively is subjected to an external pressure of 80MPa. Determine the circumferential stress induced at the inner and outer surfaces. Prove that the longitudinal strain is constant throughout the cylinder.
35.	A thick cylinder with internal diameter 80mm and external diameter 120mm is subjected to an external pressure of 40N/mm^2; when the internal pressure is 120N/mm^2, calculate circumferential stress at external and internal surfaces of the cylinder. Plot the variation of circumferential stress and radial pressure on the thickness of the cylinder.
36.	A C.I pipe has200mm internal diameter and 50mm metal thickness and carries water under a pressure of 5 N/mm^2. Calculate the maximumnand minmum intensities of circumferential stress and sketch the disribution of circumferentialstress intensities and intensity of radial pressure across the section.
37.	A pipe of 400mm internal diameter and 100mm thickness contains a fluid at a pressure of 80N/mm^2.Find the maximum and minimum hoop stresses across the section. Also sketch radial and hoop stresses distribution across the section
38.	A thin cylindrical shell 1.2m in diameter and 3m long has a metal wall thickness of 10mm .it is subjected to an internal fluid pressure of 3.2Mpa .Find the circumferential and longitudinal stress in the wall .determine the change in length .diameter the volume of the cylinder .Assume E=210Gpa and μ=0.3
39.	A thick cylinder with internal diameter 80mm and External diameter 120mm is subjected to an external pressure of 40Kn/m^2, when the internal pressure is 120KN/m^2 .Calculate the circumferential stress at external and internal surface of the cylinder. Plot the variation of circumferential stress and radial pressure on the thickness of the cylinder
40.	A cylindrical tube with closed ends has an internal diameter of 50mmand a wall thickness of 2.50mm.Yhe tube is axially loaded in tension with a load of 10KN and is subjected to an axial torque of 500NM under an internal pressure of 6N/mm^2 .Determine the principle stresses on outer surface of the tube and maximum shear stress.
41.	A cylindrical shell 1 meter long ,180mm internal diameter ,thickness of the metal is 8mm is filled with a atmospheric pressure .If an additional 20000mm^3 of the fluid is pumped into the cylinder find the pressure exerted by the fluid on the wall of the cylinder .find also the hoop stress induced .Take E=2x10^{5}N/mm^{2}and 1/m.=0.3.
42.	A pipe of 200mm internal diameter and 100mm thickness contains a fluid at a pressure of 6N/mm^2.Find the maximum and minimum hoop stresses across the section.
43.	Find the thickness of the metal necessary for a steel cylindrical shell of internal diameter 150mm ton with stand an internal pressure of 50N/mm^2.The maximum hoop stress in the section is not to exceed 150N/mm^2.
44.	A 1.2 meter long thin cylindrical pressure vessel of 500 mm inner diameter and 14 mm wall thickness undergoes a volume change of 5x10^4 mm^3, when it is subjected to an internal pressure 'p'. Taking E=210GPa and v=0.3 determine the magnitude of P.
1.	Derive an expression for the critical load in a column subjected to compressive load
2.	Derive an expression for Euler's buckling load for a long column having one end fixed and other end hinged. State the assumption made in the derivation.
3.	Define slenderness ratio and derive Euler's expression for bucking load for column with both ends hinged
4.	A hollow shaft of diameter ratio 3/8 is required to transmit 588KWatt 110 rpm, the maximum torque being 120%of the mean. Shear stress is not to exceed 63 N/mm^2 and twist in length of 3 m not to exceed 1.4 degrees.

	Calculate external iameter of shaft which would satishfy theseconditions. Take modulys of rigidity = 84GPa.
5.	A hollow shaft having an inside diameter 60% of its outer diameter, is to replace a solid shaft transmitting the same power at the same speed. Calculate the percentage saving in material, if the material to be used is also the same.
6.	A hollow C.I. column whose outside diameter is 200mm has a thickness of 20mm. it is 4.5m long and is fixed at both ends. Calculate the safe load by Rankine's formula using a factor of safety of 4. Calculate the slenderness ratio and the ratio of Euler's and Rankine's critical loads. Take f_c = 550N/mm^2, a = 1/1600 in Rankin's formula and E = 9.4 x 10^2.
7.	Find the Euler's clipping load a hallow cylindrical steel column of 38mm external diameter and 2.5mm thick .Take length of column as 2.3m and hinged at its both ends. Take E=2.05x105N/mm2.Also determine the crippling loads by Rankin's formula using constants as 335N/mm2 and 1/7500
8.	A 1.5m long column has a circular cross section of 50mm diameter .One of ends of a column fixed in direction and position and other end is free .Taker factor of safety as 3,calculate safe loading using i)Rankin's formula , take yield stress=560N/mm2 and a=1/1600 for pinned end ii) Euler's formula ,Young's modulus for C.I=1.2x105 N/mm2
9.	Derive an expression for the critical load in a column subjected to compression load, when one end is fixed and the other end free.
10.	Derive an expression for the critical load in a column subjected to compression load, when one end is fixed and the other end free.
11.	Derive an expression for strain energy due to shear stresses
12.	Write a note on: (i) Maximum principal stress theory. (ii) Maximum shear stress theory
13.	A hollow circular shaft 2 m long is required to transmit 1000 KW power, when running at a speed of 300 rpm. If the outer diameter of the shaft is 150 mm and inner diameter is 120 mm. find the maximum shear stress and strain energy stored in the shaft.
14.	A solid circular shaft is subjected to a bending moment of 40 KN-m and a torque of 10KN-m.design the diameter of the shaft according to, (i) Maximum principal stress theory. (ii) Maximum shear stress theory. Take μ=0.25, stress at elastic limit=200 N/mm^{2}and FOS=2.
15.	Derive one expression for strain energy stored in an elastic bar when subjected to axial load, torque and bending moment.
16.	The maximum stress produced by a pull in a bar of length 1100 mm is 100 N/mm^2. The area of cross-section and length are shown in fig. calculate the total strain energy stored in the bar if E= 200GPa.
17.	Define strain energy, Resilience, proof resilience and Modulus of resilience.
18.	A cantilever beam of length 'L' carries UDL 'W' per unit length over its entire length. Determine (i) strain energy stored in beam (ii) If 'W'= 10KN/m; L=2m &EI =2X 10^5 KN -mm^2 determine strain energy.

16.0 University Result

Examination	Number of Students Appeared	Number of Students Appeared	FCD	FC	PC	Fail	% Passing
Jan-Feb-20-21(2018 Scheme)	25	17	1	2	6	08	**68.00%**

Prepared & Checked by		
		
Prof. D.N.Inamdar	HOD	Principal

Subject Title	Manufacturing Process		
Subject Code	BME302	IA Marks	50
No of Lecture Hrs + Practical Hrs / Week	03+2	Exam Marks	50
Total No of Lecture + Practical Hrs	40+10	Exam Hours	03
CREDITS – 04			

FACULTY DETAILS:		
Name: Mr. : Girish Zulapi	**Designation:** Asst. Professor	**Experience:** 16 Years
No. of times course taught: 00 Time	**Specialization:** Product Design and Manufacturing	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
1	Mechanical Engineering	I / II	Elements of Mechanical Engineering

2.0 Course Objectives

- To provide knowledge of various casting process in manufacturing.
- To provide in-depth knowledge on metallurgical aspects during solidification of metal and alloys, also to provide detailed information about the moulding processes.
- To acquaint with the basic knowledge on fundamentals of metal forming processes and also to study various metal forming processes.
- To impart knowledge of various joining process used in manufacturing.
- To impart knowledge about behaviour of materials during welding, and the effect of process parameters in welding.

3.0 Course Outcomes

The student, after successful completion of the course, will be able to

CO	Course Outcome	Cognitive Level	POs
C202.1	Classify manufacturing process and elaborate the parts of casting process.	U	1,6,12
C202.2	Summarize the different casting process and select the melting furnace based on ferrous and non-ferrous alloys.	U	1,6,12
C202.3	Understand the classification of various forming process like forging, rolling, extrusion, wire drawing and sheet metal processes.	U	1,2,5,6,12
C202.4	List and explain different types of conventional welding processes like Arc and Gas welding processes	U	1,2,3,6,12
C202.5	Explain different special types of advance welding processes, soldering, brazing and adhesive bonding.	U	1,2,3,5,6,12
Total Hours of instruction		**40**	

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Recognized under 2(f) &12B of UGC Act, 1956.Accredited at 'A' Grade by NAAC and Programmes Accredited by NBA:CSE and ECE.

Mech. Engg. Dept.
Course Plan
III rd Semester
2023-24

4.0 Course Content

MODULE -1

INTRODUCTION & BASIC MATERIALS USED IN FOUNDRY

Introduction: Definition, Classification of manufacturing processes. Metals cast in the foundry-classification, factors that determine the selection of a casting alloy.Introduction to casting process & steps involved– *(Brief Introduction)-Not for SEE*

Patterns: Definition, classification, materials used for pattern, various pattern allowances and their importance.

Sand molding: Types of base sand, requirement of base sand. Binder, Additives definition, need and types ,Preparation of sand molds: Molding machines- Jolt type, squeeze type and Sand slinger.

Study of important molding process: Green sand, core sand, dry sand, sweep mold, CO2 mould, shell mould, investment mould, plaster mould, cement bonded mould.

Cores: Definition, need, types. Method of making cores.

Concept of gating (top, bottom, parting line, horn gate) and risers (open, blind) Functions and types.

08 Hours

MODULE -2

MELTING FURNACES AND METAL MOLD CASTING METHODS

Melting furnaces: Classification of furnaces, Gas fired pit furnace, Resistance furnace, Coreless induction furnace, electric arc furnace, constructional features & working principle of cupola furnace.

Casting using metal molds: Gravity die casting, pressure die casting, centrifugal casting, squeeze casting, slush casting, thixocasting, and continuous casting processes. Casting defects, their causes and remedies. **08 Hours**

MODULE -3

METAL FORMING PROCESSES

Introduction of metal forming process: Mechanical behavior of metals in elastic and plastic deformation, stress-strain relationships, Yield criteria, Application to tensile testing, train rate and temperature in metal working; Hot deformation,Cold working and annealing.

Metal Working Processes: Fundamentals of metal working, Analysis of bulk forming processes like forging, rolling, extrusion, wire drawing by slab method,

Other sheet metal processes: Sheet metal forming processes (Die and punch assembly, Blanking, piercing, bending etc., Compound and Progressive die), High Energy rate forming processes. **08Hours**

MODULE -4

JOINING PROCESSES

Operating principle, basic equipment, merits and applications of: Fusion welding processes: Gas welding - Types – Flame characteristics; Manual metal arc welding – Gas Tungsten arc welding - Gas metal arc welding – Submerged arc welding. **08 Hours**

MODULE -5

Weldability and thermal aspects: Concept of weldability of materials; Thermal Effects in Welding (Distortion, shrinkageand residual stresses in welded structures); Welding defects and remedies.

Allied processes: Soldering, Brazing and adhesive bonding

Advance welding processes: Resistance welding processes, friction stir welding (FSW). **08 Hours**

PRACTICAL COMPONENT OF IPCC

Course objectives:

- Impart fundamental understanding of various casting, welding and forming processes
- To provide in-depth knowledge on metallurgical aspects during solidification of metal and alloys
- Discuss design methodology and process parameters involve in obtaining defect free component

Sl.NO	Experiments
1	Preparation of sand specimens and conduction of the following tests: Compression, Shear and Tensile tests on Universal Sand Testing Machine.
2	To determine permeability number of green sand, core sand and raw sand.
3	To determine AFS fineness no. and distribution coefficient of given sand sampl.
4	Studying the effect of the clay and moisture content on sand mould properties.
5	Use of Arc welding tools and welding equipment Preparation of welded joints using Arc Welding equipment L-Joint, T-Joint, Butt joint, V-Joint, Lap joints on M.S. flats
6	Foundry Practice: Use of foundry tools and other equipment for Preparation of molding sand mixture. Preparation of green sand molds kept ready for pouring in the following cases: 1. Using two molding boxes (hand cut molds). 2. Using patterns (Single piece pattern and Split pattern).
7	Preparation of green sand molds kept ready for pouring in the following cases: Incorporating core in the mold.(Core boxes).
8	Forging Operations: Use of forging tools and other forging equipment. Preparing minimum three forged models involving upsetting, drawing and bending operations.
	Demo experiments for CIE
9	Demonstration of forging model using Power Hammer.
10	To study the defects of Cast and Welded components using Non-destructive tests like: a) Ultrasonic flaw detection b) Magnetic crack detection c) Dye penetration testing
11	Mould preparation of varieties of patterns, including demonstration
12	Demonstration of material flow and solidification simulation using Auto-Cast software

5.0 Relevance to future subjects/Area

SL. No	Semester	Subject	Topics / Relevance
01	IV	Machining Science And Metrology (IPCC)	Industry

6.0 Relevance to Real World

SL. No	Real World Mapping
01	Casting Processes and testing
02	Melting Furnaces
03	Metal joining Techniques and Testing
04	Production of different metallic components by forming the metal in different shape and size with the application of different methods.

7.0 Books Used and Recommended to Students

Books

1. Ghosh, A. and Mallik, A. K., (2017), Manufacturing Science, East-West Press.
2. Parmar R. S., (2007), Welding Processes and Technology, Khanna Publishers.
3. Little R. L. – 'Welding and Welding Technology' – Tata McGraw Hill Publishing Company Limited, New Delhi – 1989
4. Grong O. – 'Metallurgical Modelling of Welding' – The Institute of Materials – 1997 – 2nd Edition

5. Kou S. – 'Welding Metallurgy' – John Wiley Publications, New York – 2003 – 2nd Edition.
6. Serope Kalpakjian and Steven R. Schmid – 'Manufacturing Engineering and Technology' – Prentice Hall – 2013 – 7thEdition
7. Principles of foundry technology, 4th edition, P L Jain, Tata McGraw Hill, 2006.
8. Advanced Welding Processes technology and process control, John Norrish, Wood Head Publishing, 2006.

Additional Study Material and e-Books

1Nptel.ac.in, 2 VTU, E- learning, 3 MOOCS, 4 Open courseware

8.0 Relevant Websites (Reputed Universities and Others) for Notes/Animation/Videos Recommended

Website and Internet Contents References

9.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	Global Casting Magazines	http://www.globalcastingmagazine.com/
2	Science Direct	http://www.sciencedirect.com
3	Metal Forming Magazine	http://www.metalformingmagazine.com/home
4	International Journal of Material Forming	https://link.springer.com/journal/12289

10.0 Examination Note

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

Assessment Details (both CIE and SEE)

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

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

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

CIE for the practical component of the IPCC

- **15 marks** for the conduction of the experiment and preparation of laboratory record, and **10 marks** for the test to be conducted after the completion of all the laboratory sessions.

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

SEE for IPCC

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

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

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

11.0 Course Delivery Plan

Module	Lecture No.	Content of Lecturer	% of Portion
1	1	Definition, Classification of manufacturing processes. Metals cast in the foundry-classification	20%
	2	Factors that determine the selection of a casting alloy.Introduction to casting process & steps involved– (Brief Introduction)-Not for SEE.	
	3	Patterns: Definition, classification, materials used for pattern, various pattern allowances and their importance.	
	4	Sand molding: Types of base sand, requirement of base sand. Binder, Additives definition, need and types.	
	5	Preparation of sand molds: Molding machines- Jolt type, squeeze type and Sand slinger.	
	6	Study of important molding process: Green sand, core sand,	
	7	Dry sand, sweep mold, CO2 mold, shell mold, investment mold, plaster mold, cement bonded mold..	
	8	Cores: Definition, need, types. Method of making cores,	
	9	concept of gating (top, bottom, parting line, horn gate)	
	10	Risering (open, blind) Functions and types	
2	11	Melting furnaces: Classification of furnaces,	40%
	12	Gas fired pit furnace, Resistance furnace,	
	13	Coreless induction furnace, electric arc furnace,	
	14	Constructional features & working principle of cupola furnace.	

	15	Casting using metal molds: Gravity die casting,	
	16	Pressure die casting,	
	17	Centrifugal casting,	
	18	Squeeze casting,	
	19	Slush casting,	
	20	Thixocasting and continuous casting processes	
	21	Casting defects, their causes and remedies	
3	22	Introduction of metal forming process: Mechanical behaviour of metals in elastic and plastic	60%
	23	deformation,stress-strain relationships, Yield criteria	
	24	Application to tensile testing, train rate and temperature in metal working	
	25	Hot deformation,Cold working and annealing.	
	26	Metal Working Processes: Fundamentals of metal working, Analysis of bulk forming processes like forging,	
	27	Rolling, extrusion, wire drawing by slab method,	
	28	Other sheet metal processes: Sheet metal forming processes (Die and punch assembly,	
	29	Blanking, piercing, bending etc.,	
	30	Compound and Progressive die), High Energy rate forming processes	
4	31	Operating principle, basic equipment, merits and applications of: Fusion welding processes: Gas welding - Types	80%
	32	Flame characteristics; Manual metal arc welding	
	33	Gas Tungsten arc welding	
	34	Gas metal arc welding	
	35	Submerged Arc Welding (SAW)	
5	36	Weldability and thermal aspects: Concept of weldability of materials	100%
	37	Thermal Effects in Welding (Distortion, shrinkageand residual stresses in welded structures);	
	38	Welding defects and remedies.	
	39	Allied processes: Soldering, Brazing and adhesive bonding	
	40	Advance welding processes: Resistance welding processes	
	41	Friction stir welding (FSW).	

12.0 Assignments, Pop Quiz, Mini Project, Seminars

Sl.No.	Title	Outcome expected	Allied study	Week No.	Individual / Group activity	Reference: book/website /Paper
1	Assignment 1: University Questions	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 1 syllabus	3	Individual Activity and submission of hard copy.	Book 1 and all the reference book
2	Assignment 2: University Questions	Students study the Topics and write the Answers. Get practice to solve university	Module 2 syllabus	6	Individual Activity and submission of hard copy.	Book 1 and all the reference book

		questions.				
3	Assignment 3: University Questions	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 3 syllabus	9	Individual Activity and submission of hard copy.	Book 1 and all the reference book
4	Assignment 4: University Questions	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 4 syllabus	12	Individual Activity and submission of hard copy.	Book 1 and all the reference book
5	Assignment 5: University Questions	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 5 syllabus	15	Individual Activity and submission of hard copy.	Book 1 and all the reference book

13.0 QUESTION BANK

Sample Questions	Questions
I	**MODULE 1** 1. Define manufacturing and explain the classification of manufacturing processes. 2. Define casting. Enumerate different steps involved in producing a component by casting process. 3. Define Pattern and explain the various pattern allowances. 4. What are the common materials used for pattern making? Discuss their relative merits and demerits. 5. Explain match plate pattern with sketch. 6. Explain with neat sketch sand slinger machine. 7. Explain with neat sketch Jolt machine. 8. Explain with neat sketch Squeeze machine. 9. Draw gating system and show all the elements. 10. Explain cement bonded mould. 11. Explain with neat sketch shell moulding process. 12. Explain with neat sketch CO_2 moulding process. 13. Explain with neat sketch sweep moulding process. 14. Explain method of core making. 15. Discuss functions and types of gating system. 16. Explain with neat sketches Open Riser and Blind Riser.
II	**MODULE 2** 1. Mention the factors to be considered in the selection of a suitable melting furnace. 2. What are the different types of crucible furnaces? With a sketch explain the principle of operation of a gas fired pit furnace. 3. Explain with neat sketch the operation of a high frequency induction furnace. 4. What are the differences between core type and coreless type induction furnaces? 5. Explain with neat sketch the operation of an indirect arc furnace. How does it differ from a direct arc furnace? 6. Explain with neat sketch Cupola furnace.. Mark the different zones clearly and discuss the importance of each zone. 7. Explain with neat sketch Hot chamber pressure die casting process. Explain with neat sketch Casting defects

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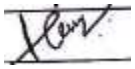
III	**MODULE 3** 1. Explain the following Yield Criteria a) Tresca's Yield Criterion b) von Mises Criterion 2. Explain temperature in metal forming and write the comparison between hot working and cold working. 3. Derive the expression for forging by slab method. 4. Derive the expression for rolling load by slab method. 5. Derive the expression for extrusion by slab method. 6. Derive the expression for wire drawing load by slab method. 7. Explain the various dies and punches. 8. Explain with neat sketch sheet metal forming process like blanking, Piercing and bending. 9. Explain with neat sketch compound and progressive die. 10. Explain with neat sketches the following High Energy rate forming processes 11. a) Explosive Forming b) Electro-hydraulic forming c) Electro-magnetic forming
IV	**MODULE 4** 1. Explain with a neat sketch oxy-acetylene welding. 2. Explain types of flame characteristics in oxy-acetylene welding. 3. What is the working principle of arc welding? 4. Explain with a neat sketch the MMAW welding process along with its advantages and limitations. 5. Explain with a neat sketch the MIG welding process along with its advantages and limitations. 6. Explain with a neat sketch the TIG welding process along with its advantages and limitations. 7. Explain with a neat sketch the SAW welding process along with its advantages and limitations.
V	**MODULE 5** 1. Define weldability and briefly explain the factors that affect the weldability of materials. 2. Explain Distortion, shrinkageand residual stresses in welded structures. 3. Explain with neat sketches welding defects and remedies. 4. Differentiate between soldering and brazing. 5. Explain with neat sketch Resistance spot welding process. 6. Explain with neat sketch Resistance seam welding process. 7. Explain with neat sketch Resistance butt welding process. 8. Explain with neat sketch Resistance projection welding process. Explain with neat sketch friction stir welding (FSW).

14.0 University Result

Examination	S+	S	A	B	C	D	E	% Passing
--	--	--	--	--	--	--	--	New subject

Prepared by	Checked by		
			
Prof. Girish Zulapi	**Prof. M A Hipparagi**	**HOD**	**Principal**
Faculty	**Module coordinator**		

Subject Title	MATERIAL SCIENCE & ENGINEERING		
Course Code	BME303	CIE Marks	50
Number of Lecture Hrs / Week(L:T:P: S)	3:0:2:0	SEE Marks	50
Total Number of Lecture Hrs	40 hours Theory + 8-10 Lab slots	Exam Hours	03
CREDITS – 04			

FACULTY DETAILS:		
Name: Prof. P.M.Kokitakar	Designation: Asst .Professor	Experience: 5 Years
No. of times course taught:1	Specialization: Machine Design	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	High School	8, 9,10th Std.	Physics, Chemistry
02	PU Science	I and II year	Atomic Physics, Physical Chemistry. Periodic Tables

2.0 Course Objectives

CLO1: Explain the basic concepts of geometrical crystallography, crystal structure and imperfections in Solids.

CLO2: Construct the phase diagrams to know the phase transformations and concept of diffusion in solids.

CLO3: Identify the heat treatment, cooling method for controlling the microstructure and plastic deformation to modify their properties.

CLO4: Explain the powder metallurgy process, types and surface modifications.

CLO5: Apply the method of materials selection, material data, properties and knowledge sources for computer-aided selection of materials.

3.0 Course Outcomes

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

	Course Outcome	Cognitive Level	Pos
C203.1	Understand the atomic arrangement in crystalline materials and describe the periodic arrangement of atoms in terms of unit cell parameters.	U	PO1, PO2, ,PO7, PO5,
C203.2	Understand the importance of phase diagrams and the phase transformations.	U	PO1, PO2, ,PO7, PO5,
C203.3	Explain various heat treatment methods for controlling the microstructure.	U	PO1, PO2, ,PO7, PO5,
C203.4	Correlate between material properties with component design and identify various kinds of defects.	U	PO1, PO2, ,PO7, PO5
C203.5	Apply the method of materials selection, material data and knowledge sources for computer-aided selection of materials.	U	PO1, PO2, ,PO7, PO5,
Total Hours of instruction		40	

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4.0 Course Content

MODULE-1 **8 HOURS**

Structure of Materials

Introduction: Classification of materials, crystalline and non-crystalline solids, atomic bonding: Ionic Bonding and Metallic bonding.

Crystal Structure: Crystal Lattice, Unit Cell, Planes and directions in a lattice, Planar Atomic Density, Coordination number, atomic Packing Factor of all the Cubic structures and Hexa Close Packed structure. Classification and Coordination of voids, Bragg's Law.

Imperfections in Solids: Types of imperfections, Point defects: vacancies, interstitials, line defects, 2-D and 3D-defects, Concept of free volume in amorphous solids. Slip, Twinning.

MODULE-2 **8 HOURS**

Physical Metallurgy

Alloy Systems: Classification of Solid solutions, Hume- Rothery Rules

Diffusion: Diffusion Mechanisms: Vacancy Diffusion and Interstitial Diffusion, Fick's laws of diffusion, Factors affecting diffusion.

Phase Diagrams: Gibbs Phase Rule, Solubility limit, phase equilibrium and Phase Diagrams: Isomorphous systems, Invariant Binary Reactions: Eutectic reaction, Eutectoid reaction and Peritectic reaction, Lever Rule, Iron-Carbon Diagram. Effect of common alloying elements in steel. Numerical on Lever rule.

MODULE-3 **8 HOURS**

Nucleation and growth: Introduction to homogeneous and heterogeneous nucleation, critical radius for nucleation.

Heat treatment: Annealing, Normalizing, hardening, Tempering, Nitriding, Cyaniding, Induction Hardening and Flame Hardening, Recent advances in heat treat technology. TTT diagram, Recovery-Recrystallization-Grain Growth. Strengthening mechanisms: Strain hardening, Precipitation hardening (Solid-Solution Strengthening), Grain refinement.

MODULE-4 **8 HOURS**

Surface coating technologies: Introduction, coating materials, coating technologies, types of coating: Electro-plating, Chemical Vapor Deposition(CVD), Physical Vapor Deposition(PVD), High Velocity Oxy-Fuel Coating, advantages and disadvantages of surface coating.

Powder metallurgy: Introduction, Powder Production Techniques: Different Mechanical methods: Chopping or Cutting, Abrasion methods, Machining methods, Ball Milling and Chemical method: Chemical reduction method.

Characterization of powders (Particle Size & Shape Distribution), Powder Shaping: Particle Packing Modifications, Lubricants & Binders, Powder Compaction & Process, Sintering and Application of Powder Metallurgy.

MODULE 5 **8 HOURS**

Engineering Materials and Their Properties: Classification, Ferrous materials: Properties, Compositions and uses of Grey cast iron and steel. Non-Ferrous materials: Properties, Compositions and uses of Copper, Brass, Bronze.

Composite materials - Definition, classification, types of matrix materials & reinforcements, Metal Matrix Composites (MMCs), Ceramic Matrix Composites (CMCs) and Polymer Matrix Composites (PMCs), Particulate-reinforced and fiber- reinforced composites, Applications of composite materials. Mechanical and functional properties of Engineering Materials

The Design Process and Materials Data: Types of design, design tools and materials data, processes of obtaining materials data, materials databases.

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Material Selection Charts: Selection criteria for materials, material property Charts, deriving property limits and material indices.

5.0 Relevance to future subjects

Sl No	Semester	Subject	Topics
01	V/VI	Design of Machine Elements I/II	Material Selection for Design of Joints, Threaded Fasteners and Automotive drive Mechanisms
02	VIII	Project work	Knowledge of metallurgy of engineering materials to be used in fabrication projects under taken

6.0 Relevance to Real World

SL. No	Real World Mapping
01	**Engineering materials used in Aerospace Industries, Automotive Industries, Manufacturing industries of machine tools and SPMs etc.**
02	Study of surface characterization of materials to improve mechanical properties as research and development projects.

7.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
01	Tutorial	Online videos/animated videos, PPTs on the topics as and when required to students
02	NPTEL	Videos of Material Science and Metallurgy and Recent advancement in materials such as smart materials and biomedical application materials

8.0 Books Used and Recommended to Students

Text Books

1. Callister Jr, W.D., Rethwisch, D.G., (2018), Materials Science and Engineering: An Introduction, 10th Edition, Hoboken, NJ: Wiley.
2. Ashby, M.F. (2010), Materials Selection in Mechanical Design, 4th Edition, Butterworth- Heinemann.
3. Azaroff, L.V., (2001) Introduction to solids, 1st Edition, McGraw Hill Book Company.
4. Avner, S.H., (2017), Introduction to Physical Metallurgy, 2nd Edition, McGraw Hill Education.

Reference Books

1. Jones, D.R.H., and Ashby,M.F., (2011), Engineering Materials 1: An Introduction to Properties, Application and Design, 4th Edition, Butterworth-Heinemann.
2. Jones, D.R.H., and Ashby,M.F., (2012), Engineering Materials 2: An Introduction to Microstructure and Processing, 4th Edition, Butterworth-Heinemann.
3. Abbaschian, R., Abbaschian, L., Reed-Hill, R. E., (2009), Physical Metallurgy Principles, 4th Edition, Cengate Learning.
4. P. C. Angelo and R. Subramanian: Powder Metallurgy- Science, Technology and Applications, PHI, New Delhi,2008.

Web links and Video Lectures (e-Resources):

1. Prasad, R., Introduction to Materials Science and Engineering, NPTEL Course Material, Department

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of Materials Science and Engineering, Indian Institute of Technology Delhi, http://nptel.ac.in/courses/113102080/
2. Bhattacharya,B., Materials Selection and Design, NPTEL Course Material, Department of Mechanical Engineering, Indian Institute of Technology Kanpur, http://nptel.ac.in/courses/112104122/
3. Subramaniam, A., Structure of Materials, NPTEL Course Material, Department of Material Science and Engineering, Indian Institute of Technology Kanpur, https://nptel.ac.in/courses/113104014/
4. Ghosh, R.N., Principles of Physical Metallurgy, IIT Kharagpur, http://nptel.ac.in/syllabus/113105024/

9.0 Relevant Websites (Reputed Universities and Others) for Notes/Animation/Videos Recommended

Website and Internet Contents References
1. Bhattacharya., Materials Selection and Design, NPTEL Course Material, Department of Mechanical Engineering, Indian Institute of Technology Kanpur, http://nptel.ac.in/courses/112104122/

10.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	Website
1	Materials Science and Metallurgy Engineering	http://www.sciepub.com/journal/MSME
2	Journal Of Materials Science & Technology	https://www.elsevier.com/journals/journal-of-materials-science-and-technology/1005-0302?generatepdf=true
3	International Journal of Minerals, Metallurgy and Materials	http://www.sciencedirect.com/journal/international-journal-of-minerals-metallurgy-and-materials
4	International Journal of Minerals, Metallurgy, and Materials	http://www.springer.com/materials/journal/12613

11.0 Examination Note

Assessment Details (both CIE and SEE)

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

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

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

CIE for the practical component of IPCC

- 15 marks for the conduction of the experiment and preparation of laboratory record, and 10 marks for the test to be conducted after the completion of all the laboratory sessions.

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• On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.

• The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.

• The laboratory test (duration 02/03 hours) after completion of all the experiments shall be conducted for 50 marks and scaled down to 10 marks.

• Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for 25 marks.

• The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

SEE for IPCC

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

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

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

12.0 Course Delivery Plan

Module No.	Lecture No.	Content of Lecture	Teaching Method	%of Portion
I	1	Introduction: Classification of materials, crystalline and non-crystalline solids, atomic bonding	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk. Laboratory Demonstrations and Practical Experiments -	2.5
		Geometrical Crystallography: Symmetry elements: the operation of rotation,	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk. Laboratory Demonstrations and Practical Experiments -	2.5
	2	Proper and Improper rotation axes, Screw axes, Glide planes	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk. Laboratory Demonstrations and Practical Experiments -	2.5
	3	Crystal Structure: Crystal Lattice, Unit Cell, Planes and directions in a lattice, Planar Atomic Density,	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk. Laboratory Demonstrations and Practical Experiments -	2.5
	4	packing of atoms and packing fraction	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk.	2.5

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			Laboratory Demonstrations and Practical Experiments -	
	5	Classification and Coordination of voids, Bragg's Law	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk. Laboratory Demonstrations and Practical Experiments -	**2.5**
	6	Imperfections in Solids: Types of imperfections, Point defects: vacancies, interstitials	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk. Laboratory Demonstrations and Practical Experiments -	**2.5**
	7	line defects, 2-D and 3D-defects,	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk. Laboratory Demonstrations and Practical Experiments -	**2.5**
	8	Concept of free volume in amorphous solids.	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk. Laboratory Demonstrations and Practical Experiments -	**2.5**
II	1	Alloy Systems: Classification of Solid solutions, Hume- Rothery Rules	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk. Laboratory Demonstrations and Practical Experiments -	2.5
	2	Phase Diagrams: Gibbs Phase Rule, Solubility limit, phase equilibria	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk. Laboratory Demonstrations and Practical Experiments -	**2.5**
	3	Binary Reactions, Lever Rule;	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk. Laboratory Demonstrations and Practical Experiments -	**2.5**
	4	Numerical on Lever Rule	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk. Laboratory Demonstrations and Practical Experiments -	**2.5**
	5	Important phase- diagrams	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk. Laboratory Demonstrations and Practical Experiments -	**2.5**
	6	Iron-Carbon Diagram.	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk. Laboratory Demonstrations and Practical Experiments -	**2.5**
	7	Iron-Carbon Diagram continued..	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk. Laboratory Demonstrations and Practical	**2.5**

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			Experiments -	
	8	Diffusion: Diffusion-Fick's Laws, Role of imperfections in diffusion.	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk	**2.5**
III	1	Nucleation and growth: Introduction to homogeneous and heterogeneous nucleation, critical radius for nucleation	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk. Laboratory Demonstrations and Practical	**2.5**
	2	Heat treatment: Annealing, Normalizing, hardening, Tempering	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk. Laboratory Demonstrations and Practical Experiments -	**2.5**
	3	Nitrating, Cyaniding, Induction Hardening and Flame Hardening, Recent advances in heat treat technology	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk. Laboratory Demonstrations and Practical Experiments -	**2.5**
	4	TTT diagram,	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk. Laboratory Demonstrations and Practical Experiments -	**2.5**
	5	Recovery-Recrystallization-Grain Growth.	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk. Laboratory Demonstrations and Practical Experiments -	**2.5**
	6	Strengthening mechanisms: Strain hardening,	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk. Laboratory Demonstrations and Practical Experiments -	**2.5**
	7	Precipitation hardening (Solid-Solution Strengthening), Grain refinement.	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk. Laboratory Demonstrations and Practical Experiments -	**2.5**
	8	Precipitation hardening (Solid-Solution Strengthening), Grain refinement.	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk. Laboratory Demonstrations and Practical Experiments -	**2.5**
IV	1	Surface coating technologies: Introduction, coating materials, coating technologies.	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk. Laboratory Demonstrations and Practical Experiments -	**2.5**
	2	Types of coating: Electro-plating, Chemical Vapor Deposition(CVD), Physical Vapor Deposition(PVD),	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk. Laboratory Demonstrations and Practical Experiments -	**2.5**
	3	High Velocity Oxy-Fuel Coating, advantages and disadvantages of surface coating.	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk. Laboratory Demonstrations and Practical	**2.5**

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			Experiments -	
	4	High Velocity Oxy-Fuel Coating, advantages and disadvantages of surface coating.	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk. Laboratory Demonstrations and Practical Experiments -	**2.5**
	5	Powder metallurgy: Introduction, Powder Production Techniques: Different Mechanical methods: Chopping or Cutting, Abrasion methods,	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk. Laboratory Demonstrations and Practical Experiments -	**2.5**
	6	Machining methods, Ball Milling and Chemical method: Chemical reduction method.	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk. Laboratory Demonstrations and Practical Experiments -	**2.5**
	7	Characterization of powders (Particle Size & Shape Distribution), Powder Shaping: Particle Packing Modifications	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk. Laboratory Demonstrations and Practical Experiments -	**2.5**
	8	Lubricants & Binders, Powder Compaction & Process, Sintering and Application of Powder Metallurgy	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk. Laboratory Demonstrations and Practical Experiments -	**2.5**
V	1	Engineering Materials and Their Properties: Classification, Ferrous materials: Properties, Compositions and uses of Grey cast iron and steel.	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk. Laboratory Demonstrations and Practical Experiments -	**2.5**
	2	Non-Ferrous materials: Properties, Compositions and uses of Copper, Brass, Bronze.	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk. Laboratory Demonstrations and Practical Experiments -	**2.5**
	3	**Composite materials** - Definition, classification, types of matrix materials & reinforcements,	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk. Laboratory Demonstrations and Practical Experiments -	**2.5**
	4	Metal Matrix Composites (MMCs), Ceramic Matrix Composites (CMCs)	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk. Laboratory Demonstrations and Practical Experiments -	**2.5**
	5	Polymer Matrix Composites (PMCs), Particulate-reinforced and fiber- reinforced composites,	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk. Laboratory Demonstrations and Practical Experiments -	**2.5**
	6	Applications of composite materials. Mechanical	Power-point Presentation, Video demonstration or Simulations,	**2.5**

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	and functional properties of Engineering Materials	Chalk and Talk. Laboratory Demonstrations and Practical Experiments -	
7	**The Design Process and Materials Data:** Types of design, design tools and materials data, processes of obtaining materials data, materials databases.	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk. Laboratory Demonstrations and Practical Experiments -	**2.5**
8	**Material Selection Charts:** Selection criteria for materials, material property Charts, deriving property limits and material indices.	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk. Laboratory Demonstrations and Practical Experiments -	**2.5**

13.0 Assignments, Pop Quiz, Mini Project, Seminars

Sl.No	Title	Outcome expected	Allied study	Week No.	Individual / Group activity	Reference: book/website /Paper
1	Assignment 1	Students should able study the Topics and write appropriate answers. Have practice to solve university questions.	Module 1 of Syllabus	2nd week of the semester	Individual Activity.	Book 1, 2 of the text book list and 1,2,3 of the Reference list
2	Assignment 2	Students should able study the Topics and write appropriate answers. Have practice to solve university questions.	Module 2 of Syllabus	4th week of the semester	Individual Activity.	Book 1, 2 of the text book list and 1,2,3 of the Reference list
3	Assignment 3	Students should able study the Topics and write appropriate answers. Have practice to solve university questions.	Module 3 of Syllabus	6th week of the semester	Individual Activity.	Book 1, 2 of the text book list and 1,2,3 of the Reference list
4	Assignment 4	Students should able study the Topics and write appropriate answers. Have practice to solve university questions.	Module 4 of Syllabus	8th week of the semester	Individual Activity.	Book 1, 2 of the text book list and 1,2,3 of the Reference list
5	Assignment 5	Students should able study the Topics and write appropriate answers. Have practice to solve university questions.	Module 5 of Syllabus	10th week of the semester	Individual Activity.	Book 1, 2 of the text book list and 1,2,3 of the Reference list
6	Pop Quiz	Students should be able to answer all the questions.	Module 1, 2 3 4 5	12th week of the semester	Individual Activity.	Book 1, 2 of the text book list and 1,2,3 of the Reference list

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14.0 QUESTION BANK

Module-I

1. Define unit cell, space lattice, and lattice parameter and coordination number.
2. List the fourteen Bravais space lattices.
3. Explain with neat sketch the following crystal structure I) BCC II)FCC and III)HCP.
4. Define atomic packing factor. Calculate Atomic Packing Factor for BCC structure.
5. Write the sketch of HCP unit cell and determine its APF.
6. If the atomic radius of lead (FCC) is 0.175 nm, calculate its unit cell, volume in meters also calculates APF.
7. Tantalum at 20 deg Celsius is BCC and has Atomic Radius 0.143 nm. Calculate its lattice parameter.
8. Classify crystal imperfections in the order of their geometry.
9. Explain with neat sketch I) Frenkel defect ii) interstitialacy
10. Draw a crystal lattice containing an edge dislocation and show the burgers vector.
11. With the help of neat sketch draw conventional stress-strain diagram for mild steel under uni-axial static tensionand explain the behavior of the material till fracture.
12. What is plastic deformation & with neat sketches plastic deformation by slip
13. With neat sketches plastic deformation by twinning.
14. Differentiate between slip and twinning deformations in materials.

Module – II

1. What is a solid solution & explain substitutional & interstitial solid solution with neat sketches.
2. State the Hume-Rothery rules.
3. State & explain Gibb's phase rule.
4. Explain Homogeneous nucleation & Heterogeneous nucleation.
5. Explain with neat sketches cast metal structures.
6. What are the different types of solid solutions, explain it.
7. List the Hume-Rothery rules for the formation of substitutional solid solutions.
8. State and explain Gibb's phase rule and its applicability to metallic systems.
9. Draw a binary eutectic phase diagram between two components, which are partially soluble in each other in thesolid state. Label all the phase fields.
10. Considering the example of an isomorphism system and describe the construction of phase diagrams.
11. State and discuss lever rule with an example.
12. Give typical examples for eutectic and eutectoid reactions mentioning for each the temperature and compositionat which it occurs. What is an invariant reaction? Write down the following invariant reactions
    a) Eutectic, b) Peritectic , c) Eutectoid.
13. A binary alloy of composition 40 percent B, 60 percent A contains two phases namely liquid and solid at particular temperature. The composition of solid phase is 23 percent and that of liquid phase is 68 percent B. estimate the amount of solid and liquid phases in alloy.
14. Describe the construction of phase diagrams by thermal analysis.
15. Draw Fe-C equilibrium diagram and label all the fields, also explain all the invariant reactions in the system.
16. Define austenite, ferrite, cementite, martensite and pearlite.
17. Explain effect of non-equilibrium cooling.
18. Explain the effect of common alloying elements in steel.

Module – III

1. Explain the steps to construct TTT diagram. Draw a labeled sketch of TTT diagram for an eutectoid steel.
2. What are TTT curves? Explain with neat sketch for eutectoid steels.
3. What are CCT curves and mention its uses.
4. Distinguish between TTT and CCT diagrams. Which is its practical use? Justify.
5. Define the process of heat treatment and classify various heat treatment processes.
6. What is meant by heat treatment? What are its objectives?
7. Explain recrystallization during annealing of metals.
8. Explain annealing and normalizing.
9. Differentiate between annealing and normalizing.
10. Write short notes on cyaniding and high frequency induction surface hardening.
11. Explain the concept of hardenability.
12. Describe Jominy hardenability test and its practical applications.

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13. Both pearlite and tempered martensite contain ferrite and cementite, but tempered martensite is stronger andtougher. Explain?
14. What is the purpose of case hardening? Classify the methods of case hardening and describe briefly any two ofthem.
15. Explain recovery, recrystallization & grain growth in case of annealing.
16. Explain types of annealing.
17. What are the factors affecting the hardenability.
18. Explain austempering & martempering.
19. Explain age hardening & explain it for aluminium-copper alloys & PH steels.
20. Explain the composition, properties & uses for Grey cast iron, malleable cast iron & S.G. iron.

Module – IV

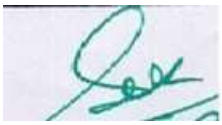
1. What is mean by powder metallurgy?
2. What are advantages and limitations of powder metallurgy.
3. What are the steps in powder metallurgy?
4. What is blending ? How it is achieved?
5. Explain in brief liquid penetrant test

Module –V

1. Write an engineering brief about the creep test?
2. Explain the mechanism of plastic deformation of metals by slip and twinning?
3. Describe the characteristics of ductile fracture and brittle fracture.
4. Explain the testing procedure for Vickers hardness testing?
5. Explain the two modes of plastic deformation in metals with neat sketches?
6. What is brittle fracture? Explain the Griffith theory on brittle fracture and deduce an expression for the critical stress required to propagate a crack simultaneously in a brittle materials?
7. Critically compares the deformation by slip and twinning?
8. Explain the types of impact tests and how ductile to brittle transition is occur with diagram.
9. Draw the engineering stress – strain curve for mild steel, aluminium and cast iron. Discuss the tensile test and different mechanical properties obtained in tensile testing. Write a short note on compression test.
10. Discuss fatigue test for a metallic material. What is S-N diagram?
11. What are the different types of fractures in metallic materials? Give the important features of these fractured surfaces. What is the use of this study?
12. What are the properties measured from tensile testing and write their engineering significance? Draw the stress and strain curve for aluminium, cast iron and low carbon steel.
13. Describe fatigue testing and methods for improving fatigue strength of the components. Draw the S-N curve for aluminium and titanium.
14. Draw creep curve and explain the different stages of creep damage.
15. Draw S-N curve for ferrous and non-ferrous metals and explain how endurance strength can be determined. Also discuss the factors that affect the fatigue life.

16.0 University Result

Examination	S+	S	A	B	C	D	E	F	% Passing

Prepared by	Checked by		
			
Prof. P. M. Kokitakar	Prof. D. N. Inamdar	HOD	Principal

Subject Title	BASIC THERMODYNAMICS		
Subject Code	BME304	IA Marks(25)+Assignments(10)+ Activity (15)	50
Number of Lecture Hrs / Week	2+2 hrs	Exam Marks(appearing for)	50 (100)
Total Number of Lecture Hrs	40	Exam Hours	03
CREDITS – 03			

FACULTY DETAILS:		
Name: Dr. K. M. Akkoli	**Designation:** Associate Professor	**Experience:** 20Years
No. of times course taught: 11	**Specialization:** Thermal Power Engineering	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Students should have the knowledge of basic subjects	PUC	**Mathematics, Physics and chemistry**

2.0 Course Objectives

- Learn about thermodynamic system and its equilibrium, basic law of zeroth law of thermodynamics.
- Understand various forms of energy - heat transfer and work, Study the first law of thermodynamics.
- Study the second law of thermodynamics.
- Interpret the behaviour of pure substances and its application in practical problems.
- Study of Ideal and real gases and evaluation of thermodynamic properties.

3.0 Course Outcomes

Having successfully completed this course, the student will be able to understand construction and working mechanical systems.

CO'S	Course Outcome	Cognitive Level	POs
C204.1	Explain fundamentals of thermodynamics and evaluate energy interactions across the boundary of thermodynamic systems.	L1,L2&L3	PO1, PO2,PO3
C204.2	Apply 1st law of thermodynamics to closed and open systems and determine quantity of energy transfers.	L1,L2&L3	PO1, PO2,PO3
C204.3	Evaluate the feasibility of cyclic and non-cyclic processes using 2nd law of thermodynamics	L1,L2&L3	PO1, PO2,PO3
C204.4	Apply the knowledge of entropy, reversibility and irreversibility to solve numerical problems and Interpret the behaviour of pure substances and its application in practical problems.	L1,L2&L3	PO2, PO3
C204.5	Recognize differences between ideal and real gases and evaluate thermodynamic properties of ideal and real gas mixtures using various	L1,L2&L3	PO1, PO2,PO3
Total Hours of instruction		**40**	

4.0 Course Content

Module - 1

Introduction and Review of fundamental concepts: Thermodynamic definition and scope, Microscopic and Macr

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approaches. Characteristics of system boundary and control surface, examples. Thermodynamic properties; definition and intensive, extensive properties, specific properties, pressure, specific volume, Thermodynamic state, state point, state diagram, p process, quasi-static process, cyclic and non-cyclic; processes; Thermodynamic equilibrium; definition, mechanical equil diathermic wall, thermal equilibrium, chemical equilibrium *(The topics are Only for Self-study and not to be asked in SEE. H may be asked for CIE)*

Zeroth law of thermodynamics, Temperature; concepts, scales, international fixed points and measurement of temperature. C volume gas thermometer, constant pressure gas thermometer, mercury in glass thermometer, thermocouples, electrical res thermometer. Numerical.

Work and Heat: Mechanics, definition of work and its limitations. Thermodynamic definition of work; examples, sign conv Displacement work; as a part of a system boundary, as a whole of a system boundary, expressions for displacement work in processes through p-v diagrams. Shaft work; Electrical work. Other types of work. Heat; definition, units and sign conv Problems. **8 Hours**

Module- 2

First Law of Thermodynamics: Joules experiments, equivalence of heat and work. Statement of the First law of thermodynamics, extension of the First law to non - cyclic processes, energy, energy as a property, modes of energy, Problems.

Extension of the First law to control volume; steady flow energy equation (SFEE), Problems **8 Hours**

Module- 3

Second Law of Thermodynamics: Limitations of first law of thermodynamics, Thermal reservoir, heat engine and heat pump: Schematic representation, efficiency and COP. Reversed heat engine. Kelvin - Planck statement of the Second law of Thermodynamics; PMM I and PMM II, Clausius statement of Second law of Thermodynamics, Equivalence of the two statements; Carnot cycle, Carnot principles. Problems

Entropy: Clausius inequality, Statement- proof, Entropy- definition, a property, change of entropy, entropy as a quantitative test for irreversibility, principle of increase in entropy, entropy as a coordinate. Problems

8 Hours

Module- 4

Availability, Irreversibility and General Thermodynamic relations. Introduction, Availability (Exergy), Unavailable energy, Relation between increase in unavailable energy and increase in entropy. Maximum work, maximum useful work for a system and control volume, irreversibility. Problems

Pure Substances: P-T and P-V diagrams, triple point and critical points. Sub-cooled liquid, saturated liquid, mixture of saturated liquid and vapor, saturated vapor and superheated vapor states of pure substance with water as example. Enthalpy of change of phase (Latent heat). Dryness fraction (quality), T-S and H-S diagrams, representation of various processes on these diagrams. Steam tables and its use. Throttling calorimeter, separating and throttling calorimeter. Problems. **8 Hours**

Module- 5

Ideal gases: Ideal gas mixtures, Daltons law of partial pressures, Amagat's law of additive volumes, evaluation of properties of perfect and ideal gases, Air- Water mixtures and related properties (*Processes are not to be asked for SEE*).

Real gases – Introduction, Van-der Waal's Equation of state, Van-der Waal's constants in terms of critical properties, Beattie-Bridgeman equation, Law of corresponding states, compressibility factor; compressibility chart. Difference between Ideal and real gases.

Thermodynamic relations: Maxwell's equations, TdS equation. Ratio of Heat capacities and Energy equation, Joule-Kelvin effect, Clausius-Clapeyron equation. **8Hours**

5.0 Relevance to future subjects

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SL. No	Semester	Subject	Topics / Relevance
01	IV	Applied Thermodynamics	Industry
02	V	Turbo Machines	Power Sector
03	VI	Heat Transfer	Industry

6.0 Relevance to Real World

SL. No	Real World Mapping
01	Automotive Industry
02	Power Sector
03	Aerospace Industray

7.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
01	NPTEL Tutorial	Topic: Energy resources, internal combustion engines, Turbines, Automation and Robotics.

8.0 Books Used and Recommended to Students

Text Books

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Basic and Applied Thermodynamics	P.K.Nag,	Tata McGraw Hill	2nd Ed., 2017
2	Basic Engineering Thermodynamics	A.Venkatesh	Universities Press	2008
3	Basic Thermodynamics	B.K Venkanna, Swati B. Wadavadagi	PHI, New Delhi	2010
4	Thermodynamics, An Engineering Approach,	Yunus A Cenegal, Michael A Boles, and Mehmet Kanoglu	Tata McGraw Hill publications	9th Edition 2019

Additional Study material & e-Books

- Nptel.ac.in
- VTU, E- learning
- MOOCS
- Open courseware

9.0 Relevant Websites (Reputed Universities and Others) for Notes /Animation / Videos Recommended

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Website and Internet Contents References
• https://www.youtube.com/watch?v=9GMBpZZtjXM&list=PLD8E646BAB3366BC8 • https://www.youtube.com/watch?v=jkdMtmXo664&list=PL3zvA_WajfGAwLuULH-L0AG9fKDgplYne •https://www.youtube.com/watch?v=1lk7XLOxtzs&list=PLkn3QISf55zy2Nlqr5F09oO2qcIwNNfrZ&index=3 • https://www.youtube.com/watch?v=Dy2UeVCSRYs&list=PL2_EyjPqHc10CTN7cHiM5xB2qD7BHUry7

10.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	International Journal of Heat transfer	https://www.journals.elsevier.com/international-journal-of-fluid flow and fluid dynamics/
2	**International Journal of Thermodynamics**	http://dergipark.ulakbim.gov.tr/eoguijt/

11.0 Examination Note

Continuous Internal Evaluation (CIE):

• For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.

• The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered

• Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.

• For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

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

12.0 Course Delivery Plan

Module	Lecture No.	Content of Lecturer	Teaching Method	% of Portion
1	42	Thermodynamic definition and scope, Microscopic and Macroscopic approaches. Characteristics of system boundary and control surface, examples. Thermodynamic properties; definition and units, intensive, extensive properties, specific properties, pressure, specific volume,	Chalk and Talk, Power-point Presentation	20%
	43	Thermodynamic state, state point, state diagram, path and process, quasi-static process, cyclic and non-cyclic; processes; Thermodynamic equilibrium; definition, mechanical equilibrium; diathermic wall, thermal equilibrium, chemical	Power-point Presentation	
	44	Zeroth law of thermodynamics, Temperature; concepts, scales, international fixed points and measurement of temperature.	Chalk and Talk	

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	45	Constant volume gas thermometer, constant pressure gas thermometer, mercury in glass thermometer, thermocouples, electrical resistance thermometer. Numerical.	Chalk and Talk	
	46	Mechanics, definition of work and its limitations. Thermodynamic definition of work; examples, sign convention.	Power-point Presentation	
	47	Displacement work; as a part of a system boundary, as a whole of a system boundary, expressions for displacement work in various processes through p-v diagrams.	Chalk and Talk	
	48	Shaft work; Electrical work. Other types of work. Heat; definition, units and sign convention.	Video demonstration or Simulations,	
	49	Problems.	Chalk and Talk	
2	50	Joules experiments, equivalence of heat and work.	Chalk and Talk, Power-point Presentation	40%
	51	Statement of the First law of thermodynamics, extension of the First law to non - cyclic processes,	Chalk and Talk, Power-point Presentation	
	52	energy, energy as a property,	P Chalk and Talk, ower-point Presentation	
	53	modes of energy,	Chalk and Talk, Power-point Presentation	
	54	Problems.	Power-point Presentation	
	55	Extension of the First law to control volume;	Power-point Presentation	
	56	steady flow energy equation (SFEE),	Power-point Presentation	
	57	Problems	Video demonstration or Simulations,	
3	58	Limitations of first law of thermodynamics, Thermal reservoir, heat engine and heat pump:	Chalk and Talk	60%
	59	Schematic representation, efficiency and COP. Reversed heat engine.	Chalk and Talk, Power-point Presentation	
	60	Kelvin - Planck statement of the Second law of Thermodynamics; PMM I and PMM II, Clausius statement of Second law of Thermodynamics,	Power-point Presentation	
	61	Equivalence of the two statements; Carnot cycle, Carnot principles.	Power-point Presentation	
	62	Problems	Chalk and Talk,	
	63	Entropy: Clausius inequality, Statement- proof, Entropy- definition, a property, change of entropy,	Chalk and Talk	
	64	entropy as a quantitative test for irreversibility, principle of increase in entropy, entropy as a coordinate.	Chalk and Talk, Power-point Presentation	
	65	Problems	Chalk and Talk	
4	66	Availability, Irreversibility and General Thermodynamic relations.	Power-point Presentation	80%

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	67	Introduction, Availability (Exergy), Unavailable energy, Relation between increase in unavailable energy and increase in entropy.	Power-point Presentation	
	68	Maximum work, maximum useful work for a system and control volume, irreversibility.	Power-point Presentation	
	69	Problems	Chalk and Talk	
	70	P-T and P-V diagrams, triple point and critical points. Sub-cooled liquid, saturated liquid, mixture of saturated liquid and vapor, saturated vapor and superheated vapor states of pure substance with water as example. Enthalpy of change of phase (Latent heat).	Power-point Presentation	
	71	Dryness fraction (quality), T-S and H-S diagrams, representation of various processes on these diagrams. Steam tables and its use.	Power-point Presentation	
	72	Throttling calorimeter, separating and throttling calorimeter.	Chalk and Talk	
	73	Problems.	Chalk and Talk	
5	74	Ideal gases: Ideal gas mixtures, Daltons law of partial pressures, Amagat's law of additive volumes, evaluation of properties of perfect and ideal gases,	Chalk and Talk	100%
	75	Air- Water mixtures and related properties	Power-point Presentation	
	76	Real gases – Introduction, Van-der Waal's Equation of state, Van-der Waal's constants in terms of critical properties,	Power-point Presentation	
	77	Beattie-Bridgeman equation, Law of corresponding states, compressibility factor; compressibility chart.	Power-point Presentation	
	78	Difference between Ideal and real gases.	Power-point Presentation	
	79	Thermodynamic relations: Maxwell's equations, TdS equation. Ratio of Heat capacities and Energy equation,	Power-point Presentation	
	80	Joule-Kelvin effect, Clausius-Clapeyron equation.	Chalk and Talk	
	81	Problems	Chalk and Talk	

13.0 Assignments, Pop Quiz, Mini Project, Seminars

Sl.No.	Title	Outcome expected	Allied study	Week No.	Individual / Group activity	Reference: book/website /Paper
1	Assignment 1: University Questions on Introduction and Review of fundamental concepts, Work and Heat, First Law of Thermodynamics Second Law of Thermodynamics	Students study the Topics and prepare the multiple choice questioner with answer.	1,2 and ½ of 3rd Module of the syllabus	3	Individual Activity.	Book 1, 2 of the reference list. Website of the Text Book list.

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	and Entropy,					
2	Assignment 2: University Questions on Thermodynamic relations, Combustion thermodynamics Pure Substances, Introduction and Review of Ideal and Real gases Thermodynamic relations	Students study the Topics and prepare the multiple choice questioner with answer.	4,5 and ½ of 3rd Module of the syllabus	6	Individual Activity.	Book 1, 2 of the reference list. Website of the Text Book list.

15.0 QUESTION BANK

Sample Questions	Questions
VI	**Module 1** 1. Define the word' Thermodynamics', and differentiate microscopic and macroscopic approaches. 2. Illustrate open and closed systems with examples. 3. Differentiate the intensive and extensive properties. 4. Describe thermodynamic equilibrium. 5. Explain Zeroth law of thermodynamics. 6. Explain the definition of temperature, its scale and measurement. 7. Describe the various thermodynamic temperature scale. 8. Explain International Temperature Scales, Standards 9. Solve numericals on temperature scales 10. Explain System, Boundary and Control volume 11. Define, differentiate and illustrate the heat and work and its sign conventions. 12. Explain the displacement work. 13. Analyze the various thermodynamic processes through PV diagram. 14. Formulate different types of works and describe the conversion to heat and vice versa. 15. Explanation about shaft work and also various work conversion factors 16. Explain the similarities and dissimilarities between work and heat Describe the Joule's experiment and analyze the formulation. 17. Define and explain the first law of thermodynamics. 18. Apply the first law of thermodymics to non-cyclic processes and control volume. 19. Explain the specific heat and enthalpy and their relations. 20. Derive the SFEE and formulate the different applications of SFEE. 21. Explain what are the significance of SFEE 22. Explain PMM I 23. Solve numericals on first law of thermodynamics
VII	**Module 2** 1. Define and explain the different definitions of Second Law of Thermodynamics. 2. Explain thermal energy reservoir, sink 3. Explain the two statements on second law and draw similarity between them 4. Explain PMM II and differentiate between PMM-I and PMM-II. 5. Explain and differentiate reversible and irreversible processes and their factors to make different principles. 6. Define heat engine and heat pump. Explain their schematic diagram.Define the "Entropy" and explain the Classius inequality.

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	7. Derive the proof of inequality statement and explain its applications. 8. Derive to show that the entropy of universe is always increasing. 9. Solve the examples by using TDS relation. 10. Explain different available and unavailable energy
VIII	**Module 3** 1. Derive and explain Vander Waal's Equation and also define compressibility factor. 2. Describe and use of compressibility chart. 3. Derive and Explain Dalton Law of partial pressure 4. Define Amagat's law of additive volumes, evaluation of properties, Analysis of various processes. 5. Concept of Maxwell Relation 6. Concept of Clausius Clayperson's Equations 7. Derive and explain Ideal gas; equation of state, internal energy and enthalpy as functions of temperature only, universal and particular gas constants, specific heats, perfect and semi-perfect gases. 8. Evaluate heat and work for different qausi-static process. 9. What is Theoretical (Stoichiometric) air for combustion of fuels, excess air, actual combustion. 10. Explain enthalpy of formation, enthalpy and internal energy of combustion, adiabatic flame temperature, 11. Explain combustion efficiency.
IX	**Module 4** 1. Explain different available and unavailable energy 2. Derive and explain Ideal gas; equation of state, internal energy and enthalpy as functions of temperature only, universal and particular gas constants, specific heats, perfect and semi-perfect gases. 3. Evaluate heat and work for different qausi-static process. 4. Explain PT and PV diagram of pure substances. 5. Define the dryness fraction and the change of phase. 6. Represent the various processes on T-S and H-S diagram. 7. Use the steam tables. 8. Explain the throttling and separating calorimeter.
X	**Module 5** 1. Derive and explain Vander Waal's Equation and also define compressibility factor. 2. Describe and use of compressibility chart. 3. Derive and Explain Dalton Law of partial pressure 4. Define Amagat's law of additive volumes, evaluation of properties, Analysis of various processes. 5. What are the thermodynamic relations. 6. Concept of Maxwell Relation 7. Concept of Clausius Clayperson's Equations

16.0 University Result

Examination	S^+	S	A	B	C	D	E	F	% Passing

Prepared by	Checked by		
			
Dr. K. M.Akkoli	Dr. M. M. Shivashimpi	HOD	Principal

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Subject Title	Introduction to Modeling and Design for Manufacturing		
Subject Code	**BMEL305**	**IA Marks**	**50**
Teaching Hours/Week (L:T:P:	**0:0:2:0**	**Exam Marks**	**50**
Total Hours of pedagogy	**14 Sessions**	**Exam Hours**	**03**
CREDITS – 01			

FACULTY DETAILS:		
Name: Prof. P. M. Kokitakar	**Designation:** Asst. Professor	**Experience:** 05 Years
No. of times course taught: 02	**Specialization:**Machine Design	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Mechanical Engineering	I/II	CAED
02	Mechanical Engineering	III	Mechanical Measurements

2.0 Course Objectives

- Develop a comprehensive understanding of mechanical assemblies and design for manufacturing.
- Learn and Apply best practices to create designs that are robust, adaptable, and cost effective.
- Master the art of maintaining control over designs throughout the entire lifecycle, from initial sketch to final production
- Gains hands on experience in practical exercises and projects to reinforce theoretical concepts.
- Acquire effective communication and collaboration skills for multidisciplinary teamwork in design and production processes

3.0 Course Outcomes

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

CO	Description
C205.1	Create and modify a form-based design.
C205.2	Use design tools for moulded parts.
C205.3	Demonstrate proficiency in the setup and creation of a design.
C205.4	Simulate the assembly of machine components in 3D environment.

4.0 Course Content

Module 1 **02**
Sessions

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Introduction to Computer Aided Sketching Review of graphic interface of the software. Review of 2D Sketching, Parametric Solid Modelling, Assembly creation and product rendering, Limits, Fits and Tolerances: Introduction, Fundamental tolerances, Devlations, Methods of placing limit dimensions, Types of fits with symbols and applications, Geometrical tolerances on drawings, Standards followed in industry. (Above topics to be studied as a review)

Geometrical Dimensioning and Tolerances (GD&T): Introduction, Fundamental tolerances, Deviations, Methods of placing limit dimensions, machining symbols, types of fits with symbols and applications, geometrical tolerances on drawings. Standards followed in industry. **(Only for CIE)**

The basics of sketching and modelling: Explore Fusion 360 User Interface, Navigation and display settings. Create new projects and designs, creating basic 2D sketches, Creating & Modifying a solid 3D body with Sections. **(For SEE)**

Module 2 (only for CIE), 02 Sessions

Create draft during a feature, create draft as a feature. Add ribs and plastic supports, Create holes and threads. **Thread Forms:** Terminologies, ISO Metric, BSW, Square & Acme. Seller threads, American Standard Thread. Use a coil feature, Mirrors and patterns. **Fasteners:** 3D & Section views - Hexagonal headed bolt and nut with washer, Square headed bolt and nut with washer. Keys: Parallel Key, Taper Key & Feather Key.

Module 3 **04 Sessions**

The different ways to create components, Use scripts to create gears, Component color swatch and color cycling. Use McMaster Carr parts in a design.

Assembly of Joints and Coupling using 3D environment

Joints: Like Cotter joint (socket and spigot), knuckle joint (pin joint).

Couplings: Like flanged coupling universal coupling.

Module 4 **06 Sessions**

Assembly Drawings: (Part drawings shall be given) Drawing Basics-Detailing Drawings. Explode a 3D model for a drawing, Create a drawing sheet and views. Add geometry and dimensions to a drawing, Add GD & T test, BOM, tables and symbols, Place an exploded view, Edit a title block, Export to different file formats.

1. LIFTING DEVICE (Screw Jack)
2. BEARINGS (Plumber Block)
3. MACHINE TOOL COMPONENT (Machine Vice or Tailstock)
4. VALVES (Ram's Bottom Safety Valve)
5. IC ENGINE COMPONENTS (Piston or Connecting rod)

5.0 Relevance to future subjects

Sl No	Semester	Subject	Topics
01	VIII	Project work	Drawings, Part Modeling
02	V/VI	Design of Machine Elements I/II	Fasteners, Keys and Joints, Rivets and Assembly drawings

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6.0 Relevance to Real World

SL.No	Real World Mapping
01	Industrial drawings and design of various components
02	Model creation for analysis
03	Development of a software applications

7.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
01	Tutorial	Topic: Lettering, Line, Methods of dimensioning
02	NPTEL	Assembly Application

8.0 Books Used and Recommended to Students

Text Books

1) K L Narayana, P Kannaiah, K Venkata Reddy, "Machine Drawing", New Age International, 3rd Edition. ISBN-13: 978-81-224-2518-5, 2006
2) N D Bhatt, "Machine Drawing", Charotar Publishing House Pvt. Ltd., 50th Edition, ISBN-13: 978-9385039237, 2014
3) Machine drawing by KR Gopalakrishna, Subhash Publication

Reference Books

1) "A Text Book of Computer Aided Machine Drawing", S. Trymbakaa Murthy, CBS Publishers, New Delhi, 2007.
2) 'Machine Drawing', K.R. Gopala Krishna, Subhash publication.

Additional Study material & e-Books

1) Sadhu Singh, P. L. Sah, "Fundamentals of Machine Drawing", PHI Learning Pvt. Ltd, 2nd Edition, ISBN:9788120346796, 2012
2) Ajeet Singh, "MACHINE DRAWING", Tata McGraw-Hill Education, , ISBN: 9781259084607, 2012

9.0 Relevant Websites (Reputed Universities and Others) for Notes/Animation/Videos Recommended

Web links and Video Lectures (e-Resources):

1) Learn fusion 360:https://www.autodesk.com/certification/learn/course/learn-fusion-360-in-90-minutes
2) Complete Screw Jack Assembly: https://youtube.com/playlist?list=PLU-GpaMbhzztmf69-pn09XXoJXRdFGVzx&feature=shared
3) Learn Fusion 360 in 2.25 Hours Complete Course for Beginners! - 2023 EDITION :https://youtu.be/M0TQR8t0pQ8?feature=shared

10.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	Website
1	Journal of Aircraft	http://arc.aiaa.org/loi/ja
2	International Journal of Solids and Structures	http://www.sciencedirect.com/science/journal/00207683
3	Journal of Manufacturing Science and Engineering	http://manufacturingscience.asmedigitalcollection.asme.org/issue.aspx?journalid=125&issueid=27340

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4	American Fastener Journal	http://www.fastenerjournal.com/

11.0 Examination Note

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and that for SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/course if the student secures not less than 40% (40 Marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is 50 Marks.

● CIE shall be evaluated for max marks 100. Marks obtained shall be accounted for CIE final marks, reducing itby 50%.

●CIE component should comprise of

- Continuous evaluation of Drawing work of students as and when the Modules are covered.
- At least one closed book Test covering all the modules on the basis of below detailed weightage.
- Weightage for Test and Continuous evaluation shall be suitably decided by respective course coordinators.

Module	Max.Marksweightage	EvaluationWeightageinmarks	
		Computerdisplay&printout	Preparatoryskeptching
Module1	15	10	05
Module2	15	10	05
Module3	30	20	10
Module4	40	30	10
Total	**100**	**70**	**30**

SemesterEndEvaluation(SEE):

SEEmarksforthepracticalcourseis50Marks.

- ThedurationofSEEis03hours.**Questionsshallbesetworthof3hours**
- SEEshallbeconductedjointlybythetwoexaminers(one internal and one external)areappointedbytheUniversity.
- SEEshallbeconductedandevaluatedformaximumof 100 marks as shown in table below.MarksobtainedshallbeaccountedforSEEfinalmarks,reducingitto50marks.
- Questionpapershallbesetjointlybybothexaminersandmadeavailableforeachbatchasperschedule.
- Evaluationshallbecarriedjointlybyboththeexaminers.
- Schemeof Evaluation:Tobedefinedbytheexaminersjointlyandthesameshallbesubmittedtotheuniversityalongwithquestionpaper.

One fullquestionshallbesetfrom each Modulesasperthe

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belowtabledweightagedetails.***However,thestudentmaybeawardedfullmarks,if he/shecompletessolutiononcomputerdisplaywithoutsketch.***

Module	Max.Mark sweightage	EvaluationWeightageinmarks	
		Computerdisplay &printout	Preparatoryske tching
Module1or2	20	15	05
Module3	30	20	10
Module4	50	40	10
Total	**100**	**75**	**25**

12.0 Course Delivery Plan

Module	Session	Content of Lecturer	% of Portion
I	**1**	Introduction to Computer Aided Sketching Review of graphic Interface of the software, Geometrical Tolerances and Dimensioning	**14.28**
	2	The Basics of sketching and Modelling: Creating Basic 2D sketches and Creating 3D Solid with sections.	
II	**3**	Use of a Draft, ribs, coil feature, mirror and pattern commands. Thread Forms: Terminologies, ISO Metric, BSW, Square, Acme and seller Threads, American Standard thread.	**14.28**
	4	Fasteners: Hexagonal Headed bolt and Nut with washer, Square Headed bolt and Nut with washer. (3D & Sectional views), Keys: Parallel key, Taper key, Feather Key	
III	**5**	Assembly of Joints using 3D Environment : Cotter Joint(Socket and Spigot),	**28.57**
	6	Knuckle joint(Pin Joint)	
	7	Assembly of Couplings using 3D Environment: Flanged Coupling,	
	8	Universal Coupling	
IV	**9**	Assembly Drawings: Drawing Basics-Detailing Drawings. Explode a 3D model for a drawing, Create a drawing sheet and views.	**42.85**
	10	1) Lifting Device(Screw Jack)	
	11	2) Bearings(Plummer Block)	
	12	3) Machine Tool Component(Machine Vice or tail stock),	
	13	4) Tailstock of lathe/Valves(Rams Bottom safety valve),	
	14	5) IC Engine Component(Piston or Connecting Rod)	

Sl. No	Title	Outcome expected	Allied study	Week No.	Individual / Group activity	Reference: book/website /Paper

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1	Assignment 1: Geometrical DimensioningandTolerances (GD&T)	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 1 of the syllabus	2	Individual Activity. Printed solution expected.	Book 1, 2 of the reference list. Website of the Reference list
2	Assignment 2: Questions on Orthographic Projections	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 1 of the syllabus	4	Individual Activity. Printed solution expected.	Book 1, 2 of the reference list. Website of the Reference list
3	Assignment 3: Questions on Thread forms and fasteners Keys	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 2 of the syllabus	6	Individual Activity. Printed solution expected.	Book 1, 2 of the reference list. Website of the Reference list
4	Assignment 4: Questions on AssemblyofJoints,couplings	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 3 of the syllabus	8	Individual Activity. Printed solution expected.	Book 1, 2 of the reference list. Website of the Reference list
5	Assignment 5: Questions on AssemblyofMachineComponents	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 4 of the syllabus	10	Individual Activity. Printed solution expected.	Book 1, 2 of the reference list. Website of the Reference list
6	Mini Project Rivets based for the students groups	Students study the Rivets applications from Real World Example view. Gain Knowledge of Rivets Applications.	Syllabus with Real World Mapping	12	Group Activity. Student Group need to perform Project and do a brief Report	All Books / paper Resources / Study Material. All Internet / Web resources.

14.0 QUESTION BANK

MODULE 1:
LIMITS, FITS AND TOLERANCES

1. Define Limits, Fits and Tolerances

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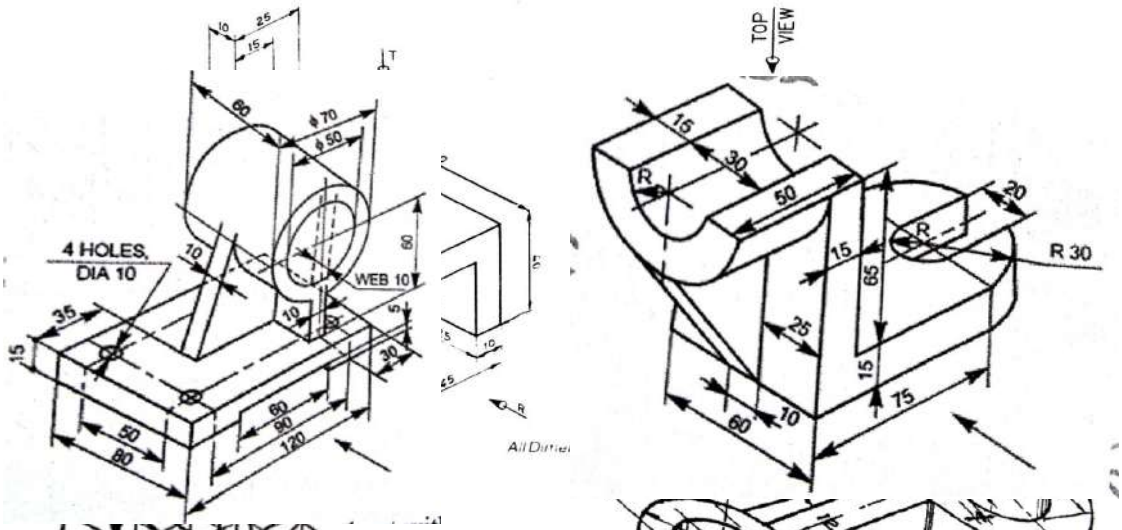
2. Explain with neat sketch Types of fits with symbols and applications

ORTHOGRAPHIC VIEWS

Draw the following views of machine components Sectional FV, TV, Left side view.



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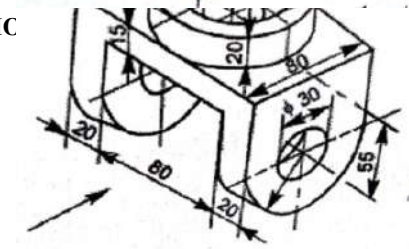

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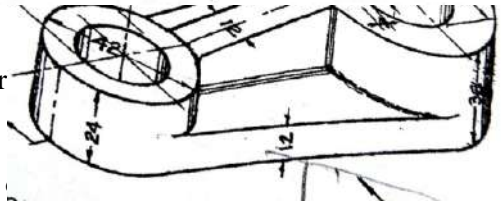

3. Draw neat and proportionate sketches of the following.
   i) ISO screw thread profile of pitch 50mm indicate all proportions and dimensions.
   ii) Two views of hexagonal headed bolt with nut for a 30mm diameter bolt. Take length of bolt equal to 125mm.
   iii) Castle nut.
4. Make neat and proportionate sketches of the following.
   i) Acme thread,
   ii) Two view of M20 hexagonal bolt with flanged nut. Consider length of the Shank as 150mm,
   iii) Counter sunk head screw.
5. Draw a proportional neat sketch of a Knuckle joint to connect two rods of 20mm dia. Indicate all the proportions with dimensions.
6. Sketch a proportionate sectional front view of a knuckle joint to connect two rods of diameter 20mm. Indicate a few important dimensions in terms of diameter 'd'.

FASTNERS:

1. Draw two views of

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a.Hexagonal bolt and
b.Square headed bolt of size 25mm dia and 100mm long. Indicate all the dimensions.

2. Draw the three views of an ISO-threaded hexagonal bolt 140mm long, 24mm diameter and a threaded length of 60mm, with a hexagonal nut. Indicate all the proportions and actual dimensions.

KEYS:

1. Draw the tow views of a sunk key fastening a boss to a shaft of 40mm diameter. The noncircular views of the assembly should be shown in half section. Indicate the actual dimensions and empirical proportions of the key.
2. Sketch to 1:1 scale, inserting all the dimensions, tow views of a wheel boss fixed to a shaft by means of a sunkgib-head key using the following dimensions. Diameter of the shaft=50mm, diameter of boss=100mm, length of boss=75mm.
   Using empirical proportions for the gib-head key, the view showing the length of the key should be drawn in section. Indicate the actual dimensions of the key.
3. Draw in assembly the flat and hollow saddle keys for 40mm diameter shaft. Use empirical proportions. The drawing should be completely dimension.Draw the feather key locked to a shaft of 40mm diameter fastened to a boss. Show the non circular view of the assembly in half section. Fully dimension the drawing.
4. Sketch to 1:1 scale, inserting dimensions, two views of a boss fixed to a shaft by means of woodruff key. Diameter of the shaft is 50mm. diameter of the boss is 100mm. the length of the boss is 75mm.

MODULE 3: COUPLINGS:

1. Draw i) half sectional front view with top half section and ii) Side view of a protected type flange coupling to connect two shafts of diameter 25mm each.
2. Prepare free hand sketches of a protected type flange coupling as per instruction given below: i) Sectional elevation with top half in section. Ii) Right view. Take diameter of shaft D=30mm and a scale of 1:1. Indicate important dimensions on the sketches.
3. Prepare free hand sketches (half sectional front view-top half) of a protected type flange coupling for a shaft of 30mm dia adopt. Standard proportions add side view. Mark important dimensions/proportions on the views.
4. Draw to 1:1 scale, the following views of a protected type flange coupling (diameter of shaft=20mm):
   i) Front view with top half section.
   ii) Left view looking form the nut end. Indicate important dimensions, add parts list.
5. Draw the following views of a UNIVERSAL COUPLING used to connect two rods of diameter 20mm:
   i. Sectional front view.
   ii) Profile view.
6. Draw a free hand sketch of a flanged nut assuming the nominal diameter to be 20mm.
7. Draw a neat and proportionate sketch of a protected type of flanged coupling to connect two shafts of 25mm showing the following views.
   i) Front view with top half in section.
   ii) Simple top view.

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iii) Right side view.

8. draw i) Half sectional front view, with top half in section ii) side view of a bushed pin type flange coupling to connect two shafts, each of diameter 30mm.

i) Prepare a neat and proportionate free hand sketch of a bushed-pin type of flexible coupling to connect two shafts of 20mm diameter for the following views: i)Front view with top half in section. ii) Side view form pin-head end.

2. Sketch neat proportional half sectional front view of protected type flanged coupling to connect two shafts of 20mm diameter. Indicate all proportions with dimensions. Prepare parts list.
3. Sketch the following view of a Flanged coupling (protected type) to connect two shafts of 20mm diameter.
   i) Front view with top half in section.
   ii) Left side view.
4. Sketch half sectional front view of a flange coupling unprotected type to connect two shafts 20mm diameter. Indicate all proportions. Add parts list.
5. Sketch sectional front view of a **Universal** coupling to connect two rods of diameter 30mm. indicates all dimensions, add parts lists.
6. Draw the following, views of pin type flexible coupling, to connect to shafts of 30mm diameter.
   i) Front view with top half in section,
   ii) Side view from the pin end.
7. Sketch the sectional front view of a flexible coupling to connect two shafts of 25mm dia with all dimensions.

MODULE4 :

ASSEMBLY DRAWINGS: (Part drawings should be given)

1. Details of a "PLUMMER BLOCK" is shown in fig. Assemble the parts and draw the following views with all important dimensions.i) Left half sectional view.ii) Top view.
2. Fig. shows the details of "SCREW JACK". Assemble the parts and draw the following views

   i) Front view showing right half in section and ii) top view.
3. Fig. shows the details of a "Ramsbottom safety valve". Assemble the parts and draw the following views. Dimension the drawings.i) Front view in section.ii) Top view.
4. Details of a "PLUMMER BLOCK" are shown in fig.1.2. Assemble the parts and draw the following views of the assembly.i) Front view showing right half in section.ii) Top view.
5. Fig. shows the details of an I.C Engine Connecting Rod. Assemble the parts and draw the following views. Dimension the drawings.i) Front view with top half in section.ii) Top view.
6. Fig. shows the details of a Tail-Stock of a Lathe. Assemble the parts and draw.i) Sectional Front view.ii) Top view.
7. Fig. shows the details of a "CONNECTING ROD". Assemble the parts and draw the following views. Dimension the drawings .i) Front view and ii) Top view.

Prepared by	Checked by		
Prof.P. M. Kokitakar	Prof.D. N. Inamdar	HOD	Principal

Subject Title	Smart Materials & Systems (Elective:Emerging Trend Course-ETC)		
Subject Code	BME306B	**CIE(50)+SEE(50)**	100
Number of Lecture Hrs/Week	3L	**Exam Marks(appearing for)**	100 & reduced to 50 for grade
Total Number of Lecture Hrs	40	**Exam Hours**	03
CREDITS – 03			

FACULTY DETAILS:		
Name: Dr.S.N.Topannavar	**Designation:** Professor & Head	**Experience:** 25 years
No. of times similar course taught: First time (New Course)	**Specialization:** Thermal Power Engineering	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Any	PUC and diploma level	Chemistry, Physics and materials related topics

2.0 Course Objectives

Student is able to…
To make the students understand about smart materials
To make students to know about making of material smart
To enable the students to appreciate the material properties

3.0 Course Outcomes

CO	Course Outcome	RBTL	POs
C207.1	Understand, and apply the smart materials structure, components, stimuli-response for various applications and select and justify appropriate materials for specific applications	L3	PO1-PO4, PO6, PO7 & PO12
C207.2	Understand and analyze the basic principles, properties and classifications of various electrically activated materials and their applications and evaluate based on the stimuli and actuation	L3	PO1-PO4, PO6, PO7 & PO12
C207.3	Understand and analyze the basic principles, properties and classifications of various thermally activated materials and their applications and evaluate based on the stimuli and actuation	L2	PO1-PO4, PO6, PO7 & PO12
C207.4	Understand and analyze the basic principles, properties and classifications of various smart polymers and their applications and evaluate based on the stimuli and actuation	L3	PO1-PO4, PO6, PO7 & PO12
C207.5	Understand and analyze the basic principles, properties and classifications of various chemically activated materials and their applications and evaluate based on the stimuli and actuation	L2	PO1-PO4, PO6, PO7 & PO12

4.0 University Course Content

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Module-01:
Smart materials and structures: System intelligence- components and classification of smart structures, common smart materials and associated stimulus-response, Application areas of smart systems

Module-02:
Electrically Activated Materials: Piezoelectricity, Piezoresistivity, Ferroelectricity, Piezoelectric materials- piezoelectric effect, Piezoceramics, Piezopolymers, Piezoelectric materials as sensors, Actuators and bimorphs, nanocarbon tubes

Module-03:
Thermally activated materials: Shape memory materials; Shape memory alloys (SMAs), Classification – Transformation - Ni-Ti Alloys, Shape memory effect, Martensitic transformation, One way and two-way SME, binary and ternary alloy systems, Functional properties of SMAs, Shape memory ceramics – Shape memory polymers – Applications

Module-04:
Smart polymers: Thermally responsive polymers, Electroactive polymers microgels, Synthesis, Properties and Applications, Protein-based smart polymers, pH-responsive and photo-responsive polymers, Self-assembly, Drug delivery using smart polymers

Module-05:
Chemically Activated Materials - Chemical Gels - Self healing materials Optically Activated Materials – Optically activated polymers - Azobenzene - Liquid Crystal, Smart materials for space applications: Elastic memory composites, Smart corrosion protection coatings, Sensors, Actuators, Transducers

5.0 Relevance to future Subjects/Lab/Project

Sl. No	Semester	Subject/Lab/Project	Topics
01	All Sem	Understanding and apply to the design and development of mechatronic devices for specific task. Required to complete innovative Mini projects and projects to achieve greater effectiveness and efficiency. Material related subjects	All modules

6.0 Relevance to Real World

SL.No	Real World Mapping
01	Resolving real time problems and issues through innovations and projects
02	Solving of complex engineering problems through innovations through multidisciplinary concepts
03	Business modeling and prototyping

7.0 Gap Analysis and Mitigation

Sl. No	Gap/s	Mitigation
01	Realization of multidisciplinary and material properties	Chalk & Talk, Presentations, Activities, Video shows, case studies, simulation, doing project/product etc.
02	Realization of application and properties of materials in the class	Using e-resources and lab visits
03	Detailed information about chemistry and multidisciplinary concepts	Using e-resources and Class presentations
04	Ability to resolve real-time problems with	Chalk & Talk, Presentations, Activities, Video

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	available resources	shows, case studies, simulation, doing project/product etc.

8.0 Books Used and Recommended to Students

Text Books

1. D.J. Leo, Engineering Analysis of Smart Material Systems, Wiley 2007.
2. M. Addington, D.L. Schodek, Smart Materials and New Technologies in Architecture, Elsevier 2005.
3. Donald R. Askeland and Pradeep P. Fulay, Essentials of Materials Science and Engineering, 2009, Cengage Laerning.

References

1. Gandi, M.V. and Thompson, B.S., "Smart Materials and Structures," Chapman & Hall, UK, 1992,
2. Culshaw, B., "Smart Structures and Materials," Artech House, Inc., Norwood, USA, 1996.
3. Dimitris C. Lagoudas, Shape Memory Alloys: Modelling and Engineering Applications, Springer, 2008.
4. T. Yoneyama & S. Mayazaki, Shape memory alloys for biomedical applications, CRCPress, 200

9.0 Relevant Websites (Reputed Universities and Others) for Notes/Animation/Videos Recommended

e-Resources, Pedagogy and Videos

E-Resources: Web links, YouTube links etc.
Links to strengthen curriculum Pedagogy
https://www.slideshare.net/sureshdaravath/shape-memory-alloys-71483726 https://padeepz.net/shape-memory-alloys/ https://www.youtube.com/watch?v=r-o-neQiT24
https://youtu.be/EKimWj8c-MQ?si=xt2lV2XroB-TGDCU https://youtu.be/60G1KCe31DA?si=-fH9w8qgdcF6tA4i
https://youtu.be/7PKJ1TSCQWk?si=94xqFo17R6Gd6dpk https://youtu.be/M4lDuktUaeI?si=31_nLc_qIrO4Brwt https://youtu.be/yR-6_IS9vts?si=NytO45sqMLpHUPGh https://youtu.be/I7doX1zWGdw?si=Cc3GafcswLn-HvxE
https://youtu.be/5hYOxFFjZ-8?si=Vw4bGVDbBb6HKR46 https://youtu.be/I7doX1zWGdw?si=eese-szhufVg6pU6
https://youtu.be/_XABS0dR15o?si=w_Ip1UghKxbuqPF5 https://youtu.be/4nbBAG-848c?si=GPQBzxnSeCjOYNhl https://youtu.be/pnvpsl3bzwQ?si=7LT4KBfRU_1Y04ll https://youtu.be/INaPVsVZkR8?si=5L7Axd4M7UMZSlDW https://youtu.be/ULbNZuZulPg?si=BKmQ69mMmVV_J2fi https://youtu.be/p-rPep0-3cE?si=yC-m6ocf7OkFMl3p
https://youtu.be/xDp3PU8azmY?si=HDAEMX9awZIzcpMr
https://youtu.be/N_ijvkl51LM?si=4M0VGpAwO1X6_aMb
https://youtu.be/XnJbH9re2rI?si=fMa7FPwTGcmjecxx
https://youtu.be/2k2BLFFQssg?si=ydD6e0s6PkXiWBl9
https://youtu.be/AqWzqhDaoz0?si=ws0g9YWplRmF4Txg
https://www.youtube.com/watch?v=w79wTb2zOQQ
https://www.youtube.com/watch?v=-XAIQQUcQk0
https://www.youtube.com/watch?v=FQ5Fe5I8vYU

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https://www.youtube.com/watch?v=novE6nQrBmU
https://www.youtube.com/watch?v=HiI22ttaBf0
https://www.youtube.com/watch?v=YGqEgrcnfXc
https://www.youtube.com/watch?v=6PJuJ1-fp7c
SMS Current Applications Links
https://youtu.be/T0w_r8hrt5Q?si=CA-kfloLc4CyKiSz
https://youtu.be/C2CYClNVkCs?si=43Puhf-ifBMLKY7G
https://youtu.be/fVTfSHEPnr8?si=uH6hdCcQRxt2cR2T
https://youtu.be/xElVrV9zxRY?si=OczXLNpdu-Rof3bZ
https://youtu.be/tx6lVsErnj8?si=ITeg26itxUnTBnx_
https://www.youtube.com/watch?v=mAAT5fvbl4Y
https://www.youtube.com/watch?v=NpxoUU1rLTs
https://www.youtube.com/watch?v=SIif11QOsRI
https://www.youtube.com/watch?v=UpjLULz9Aq8
https://www.youtube.com/watch?v=6hVJvXL3tMs
https://www.youtube.com/watch?v=4-_rwDgLMpk
https://www.youtube.com/watch?v=NTZDy8jkw68
https://www.youtube.com/watch?v=c4UtMI_xEQY
https://www.youtube.com/watch?v=66mpHrlk_Fk
https://www.youtube.com/watch?v=yD1Bt-jIwHw
Pedagogies
Models and charts to realise atomic structures of different materials and phase transformations
Material Testing lab visit to realise the strengths and properties of different materials
Models show the stimuli and responses of smart materials
Application oriented pedagogical teaching in the class

10.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	Elsevier	https://www.journals.elsevier.com
2	Journal of Composite Materials	http://journals.sagepub.com
3	Journal of Manufacturing Science and Engineering	http://manufacturingscience.asmedigitalcollection.asme.org
4	International Journal of Renewable Energy Research (IJRER)	http://www.ijrer.org

11.0 Examination Note

Methods of CIE need to be defined topic wise i.e.- Tests, MCQ, Quizzes, Seminar or micro project/Course Project, Term Paper)
The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The student has to obtain a minimum of 35% of maximum marks in SEE and a minimum of 40% of maximum marks in CIE. Semester End Exam (SEE) is conducted for 100 marks (3 hours' duration) and scaled down to 50 marks. Based on this grading will be awarded.
The student has to score a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

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12.0 Course Delivery Plan

Module	Content of Lecturer	Delivery	Cumulative Coverage
82	**Module-01:** **Smart materials and structures**: System intelligence-components and classification of smart structures, common smart materials and associated stimulus-response, Application areas of smart systems	Chalk & Talk, e-resources and Activities	20%
83	**Module-02:** **Electrically Activated Materials:** Piezoelectricity, Piezoresistivity, Ferroelectricity, Piezoelectric materials-piezoelectric effect, Piezoceramics, Piezopolymers, Piezoelectric materials as sensors, Actuators and bimorphs, nanocarbon tubes	Chalk & Talk, e-resources and Activities	40%
84	**Module-03:** **Thermally activated materials**: Shape memory materials; Shape memory alloys (SMAs), Classification – Transformation - Ni-Ti Alloys, Shape memory effect, Martensitic transformation, One way and two-way SME, binary and ternary alloy systems, Functional properties of SMAs, Shape memory ceramics – Shape memory polymers – Applications	Chalk & Talk, e-resources and Activities	60%
85	**Module-04:** **Smart polymers**: Thermally responsive polymers, Electroactive polymers microgels, Synthesis, Properties and Applications, Protein-based smart polymers, pH-responsive and photo-responsive polymers, Self-assembly, Drug delivery using smart polymers	Chalk & Talk, e-resources and Activities	80%
86	**Module-05:** **Chemically Activated Materials** - Chemical Gels - Self healing materials Optically Activated Materials – Optically activated polymers - Azobenzene - Liquid Crystal, Smart materials for space applications: Elastic memory composites, Smart corrosion protection coatings, Sensors, Actuators, Transducers	Chalk & Talk, e-resources and Activities	100%

13.0 Continuous Internal Evaluation (CIE)

Assessment Details (both CIE and SEE)

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

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Continuous Internal Evaluation:

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

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

Module	CIE Method	Marks	Conduction
1,2,3,4 &5	3 IA Tests Duration:1 hour	Conduction for 50 marks & reduced to 20 marks	I IA-5th week, II IA-10th week & III IA-15th week
	2 Assignments	Each assignment evaluation for 25 marks & average of all assignments shall be reduced to 10 marks	I Asignment-4thweek &II Assignment-9th week
	Report writing or presentation or Seminar or GD	Each activity shall be evaluated for 50 marks with proper rubrics and average of all evaluations shall be reduced to 20 marks	13th week

Module	Topic	CIE Method
1	Smart materials and structures:	Internal Assessment Test (IAT), CCA: 1) Assignment 2) Class Presentation
2	Electrically Activated Materials	Internal Assessment Test (IAT), CCA: 1) Assignment 2) Class Presentation
3	Thermally activated materials	Internal Assessment Test (IAT), CCA: 1) Assignment 2) Class Presentation
4	Smart polymers	Internal Assessment Test (IAT), CCA: 1) Assignment 2) Class Presentation
5	Chemically Activated Materials	Internal Assessment Test (IAT), CCA: 1) Assignment 2) Class Presentation

13.0 Semester End Examination (SEE)

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

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

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15.0 QUESTION BANK

Module-01: Smart Materials and Structures

S.N.	Question
1	Explain the components of smart structure
2	Explain how the components of smart structures are related and how they are classified?
3	List the 6 common smart materials and also explain the stimulus response associated with them.
4	List and explain the application areas of smart systems (At least 8 areas)
5	Classify the smart materials
6	What are the good properties of smart materials
7	Briefly explain the following smart materials with the help of applications i) Piezoelectric Materials ii) Shape Memory Alloys iii) Thermo responsive Materials iv) Smart Gels
8	Briefly explain the following smart materials with the help of applications i) Electrostrictive Materials ii) Magnetostrictive Materials iii) Rheological Materials iv) Fullerences v) Biometric Materials vi) Electrochromic Materials

Module-02: Electrically Activated Materials

S.N.	Question
1	Define piezoelectricity and explain the piezoelectric effect
2	Define and explain piezoresistivity
3	Define and explain ferroelectricity
4	List and explain atleast 6 applications of the following piezoelectric materials i) Piezoceramics ii) Piezopolymers
5	With the help of neat sketch explain the bimorph piezoelectric actuators
6	With the help of neat sketch explain the piezoelectric Carbon Nano Tubes (CNTs)
7	With the help of neat sketches explain any two piezoelectric actuators
8	With the help of neat sketches explain any two piezoelectric sensors

Module-03: Thermally Activated Materials

S.N.	Question
1	What do you mean by Shape Memory Alloys and List the properties of Nitinol (NiTi) or Shape Memory Alloys (SMAs)
2	What do you mean by transformation temperature and with the help of graphs (Temperature Vs Load and Temperature Vs Fraction of Crystalline Structure) differentiate the martensite and austenite phase transformations of SMAs
3	With the help of figures and graphs differentiate the types of SMAs i) One way ii) Two way
4	List the examples of SMAs
5	Differentiate the following properties of the SMAs with the help of graphs and figures i) Shape Memory Effect ii) Pseudo elasticity or Super elasticity iii) Hysteresis

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6	What are the advantages and disadvantages of SMAs
7	Explain the applications of SMAs
8	Differentiate the binary and ternary alloy systems

Module-04: Smart Polymers

S.N.	Question
1	What are the thermally responsive polymers and write their Synthesis, properties, advantages and applications
2	What are the electro active polymers and write their synthesis, properties, advantages and applications
3	Write a short note on following smart polymers: a) Drug delivery, b) Self assembly
4	What are the classification of Thermo responsive polymers
5	What are the characteristics, applications and classification of the following polymers a) pH responsive polymers, b)Photo responsive polymers
6	What are the protein based smart polymers and write their properties, advantages and applications
7	Write a short note on the followings a) Microgels smart polymer, b) Viscoelasticity property of smart polymer

Module-05: Chemically Activated Materials

S.N.	Question
1	What are the self healing materials and write their design, properties, advantages and applications
2	Explain the methods of self healing
3	Write a short note on followings: a) Microsphere embedment, b) Chemical gels
4	What are the optically activated materials/polymers or photo sensitive polymers and write their properties, advantages and applications
5	Write a short note on the followings a) Azobenzene b) Hydrogels
6	What are the liquid crystels (LCs) and write their properties, advantages, classification and applications
7	Write a short note on the following smart materials for space applications: a) Elastic Memory Composites (EMCs) b) Smart corrosion protection coatings
8	Write a short note on the following smart materials for space applications: a) Actuators, b) Sensors, c) Transducers

16.0 University Result

VTU Examination	S+	S	A	B	C	D	E	F	% Passing
New course introduced in the VTU 2022 Scheme of study									

Prepared by	Checked by		
Dr.S.N.Topannavar	Module Coordinator	HOD	Principal

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Subject Title	**Social Connect and Responsibility**		
Subject Code	21UH36/ 22BSCk307	**Activity & Reports (10) x 5**	50
Number of Lecture Hrs/Week /	01(P)	**Exam Marks (appearing for)**	50
Total Number of Lecture Hrs	15 Lab Slots	**Exam Hours**	03
CREDITS – 01			

FACULTY DETAILS:		
Name: S.B. Sarawadi	**Designation: lecturer**	**Experience:**23 years
No. of times course taught: 00	**Specialization:** VLSI Design & ES	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Students should have the knowledge of basic subjects	1 & 2	Universal Human Values

2.0 Course Objectives

- Enable the student to do a deep drive into societal challenges being addressed by NGO(s), social enterprises & The government and build solutions to alleviate these complex social problems through immersion, design & technology.
- Provide a formal platform for students to communicate and connect with their surroundings.

3.0 Course Outcomes

Having successfully completed this course, the student will be able to

CO's	Course Outcome	Cognitive Level	PO's
206.1	Develop an eco-friendly relationship for saving the natural resources and preservation of nature.	U	
206.2	Develop multicultural awareness and appreciation for Music and Drama by exposing learners to various forms of Art.	U	
206.3	Understand the concept of agricultural operations.	U	
206.4	Develop an eco-friendly relationship for saving the natural resources and preservation of nature.	U	
206.5	Describe the regional culinary practices and its importance in day-to-day life	U	
Total Hours of instruction		**15**	

4.0 Course Content

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Practical/Theory		
Modules	**Teaching Hours**	**Bloom's Taxonomy (RBT) level**
Module 1		
Plantation and adoption of a tree: Plantation of a tree that will be adopted for four years by a group of B.Tech. students. They will also make an excerpt either as a documentary or a photoblog describing the plant's origin, its usage in daily life, and its appearance in folklore and literature.	03	L1
Module -2		
Heritage walk and crafts corner: Heritage tour, knowing the history and culture of the city, connecting to people around through their history, knowing the city and its craftsman, photoblog and documentary on evolution and practice of various craft forms.	03	L1
Module-3		
Organic farming and waste management: usefulness of organic farming, wet waste management in neighboring villages, and implementation in the campus.	03	L1
Module-4		
Water Conservation: knowing the present practices in the surrounding villages and implementation in the campus, documentary or photo blog presenting the current practices.	03	L1
Module-5		
Food Walk: City's culinary practices, food lore, and indigenous materials of the region used in cooking.	03	L1

5.0 Relevance to future subjects

Sl. No	Semester	Subject	Topics
01	I/II	Universal Human Values	Social Connectivity

6.0 Relevance to Real World

SL.No	Real World Mapping
01	Connecting to Nature and

7.0 Books Used and Recommended to Students

Reference Books
1. Universal Human Values and Professional Ethics, Dr. Ritu Soryan,2022 2. Universal Human Values and Professional Ethics - S.K. Kataria

8.0 Relevant Websites (Reputed Universities and Others) for Notes/Animation/Videos Recommended

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Website and Internet Contents References
15) https://nptel.co.in
16) http://www.uhv.org.in/uhv-1

9.0 Examination Note

Assessment Details both (CIE and SEE):

Continuous Internal Evaluation (CIE)
After completion of, the social connect, the student shall prepare, with daily diary as reference, a comprehensive report in consultation with the mentor/s to indicate what he has observed and learned in the social connect period. The report should be signed by the mentor. The report shall be evaluated on the basis of the following criteria and/or other relevant criteria pertaining to the activity completed.

Marks allotted for the diary are out of 50.
Planning and scheduling the social connect
Information/Data collected during the social connect
Analysis of the information/data and report writing

Considering all above points allotting the marks as mentioned below-

Excellent	80 to 100
Good	60 to 79
Satisfactory	40 to 59
Unsatisfactoryand fail	<39

Semester End Examination (SEE)
This Jamming session will be conducted at the end of the course for 50 marks
Jamming session includes -Platform to connect to others. Share the stories with others. **Share the experience of Social Connect.** Exhibit the talent like playing instruments, singing, one-act play, art painting, and fine art.
Faculty mentor has to design the evaluation system for the Jamming session.

10.0 Course Delivery Plan

Module No.	Session No.	Content of Lecture	Teaching Method	% Portion Covered
1. Plantation and adoption of a tree	1	Plantation in campus	Activity	20
	2	Excerpt either as a documentary or a photoblog describing the plant's origin, its usage in daily life,	Activity	
	3	Its appearance in folklore and literature.	Activity	
2. Heritage walk and crafts corner	4	Visit Heritage place near to college	Activity	20
	5	Knowing the history and culture of the city, connecting to people around through their history, knowing the city	Activity	
	6	Its craftsman, photoblog and documentary on evolution and practice of various craft forms.	Activity	
3. Organic farming and	7	Visiting nearby Village	Activity	

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waste management	8	Usefulness of organic farming, wet waste management in neighboring villages.	Activity	20
	9	Implementation in the campus	Activity	
4. Water Conservation	10	Visiting nearby Village	Activity	20
	11	Knowing the present practices in the surrounding villages.	Activity	
	12	Implementation in the campus, documentary or photo blog presenting the current practices.	Activity	
5. Food Walk	13	Visiting food streets. Or food corners	Activity	20
	14	City's culinary practices, food lore	Activity	
	15	indigenous materials of the region used in cooking.	Activity	

11.0 Assignments, Pop Quiz, Mini Project, Seminars

Sl.No.	Title	Outcome expected	Allied study	Week No.	Individual / Group activity
1	Activity Report 1: Plantation and adoption of a tree	Students carry the activity and will prepare for Final Exam.	Module-1 of the syllabus	3	Group Activity
2	Activity Report 2: Heritage walk and crafts corner	Students carry the activity and will prepare for Final Exam.	Module-2 of the syllabus	6	Group Activity
3	Activity Report 3: Organic farming and waste management	Students carry the activity and will prepare for Final Exam.	Module-3 of the syllabus	9	Group Activity
4	Activity Report 4: Water Conservation	Students carry the activity and will prepare for Final Exam.	Module-4 of the syllabus	12	Group Activity
5	Activity Report 5: Food Walk	Students carry the activity and will prepare for Final Exam.	Module-5 of the syllabus	15	Group Activity

12.0 University Result

NEW SCHME

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Subject Title	**ADVANCED PYTHON PROGRAMMING**		
Subject Code	**BME358A**	**IA Marks**	50
Practical Hrs / Week	0:0:2:0	**Exam Marks**	50
Total Hours of pedagogy	16	**Exam Hours**	02
			CREDITS – 01

FACULTY DETAILS:		
Name: Dr. K. M. Akkoli	**Designation:** Associate Professor	**Experience: 20** Years
No. of times course taught: 02 Times	**Specialization:** Thermal Power Engineering	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Mechanical Engineering	PUC	Mathematics
02	Mechanical Engineering	I/II	Mathematics

2.0 Course Objectives

1. To understand the problem solving approaches.
2. To learn the basic programming constructs in Python.
3. To practice various computing strategies for Python-based solutions to real world problems.
4. To use Python data structures – lists, tuples, dictionaries.
5. To do input/output with files in Python.

3.0 Course Outcomes

The student, after successful completion of the course, will be able to

CO	Course Outcome	Cognitive Level	POs
C211.1	Develop algorithmic solutions to simple computational problems	U	1,2,7,12
C211.2	Develop and execute simple Python programs.	A	1,2,7,12
C211.3	Use functions to decompose a Python program.	A	1,2,7,12
C211.4	Process compound data using Python data structures	U	1,2,7,12
C211.5	Utilize Python packages in developing software applications	A	1,2,7,12
Total Hours of instruction		**15**	

4.0 Course Content

1. Demonstrate following functions/methods which operates on strings in Python with suitable examples: i) len( ) ii) strip( ) iii) rstrip( ) iv) lstrip( ) v) find( ) vi) rfind( ) vii) index( ) viii) rindex(),ix) count( ) x) replace( ) xi) split( ) xii) join( ) xiii) upper( ) xiv) lower( ) xv) swapcase( ) xvi) title( ) xvii) capitalize( ) xviii) startswith() xix) endswith()
2. Implementing programs using Functions. (Factorial, largest number in a list, area of shape).
3. NESTED LISTS: Write a program to read a 3 X 3 matrix and find the transpose, addition, subtraction, multiplication of two 3 X 3 matrices, check whether two given 3 X 3 matrices are identical or not.
4. Implementing programs using Strings. (Reverse, palindrome, character count, replacing characters). Real time applications using sets and Dictionaries

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5	Scientific problems using Conditionals and Iterative loops. (Number series and different Patterns).
	Numpy Library: Linear Algebra a) Write a python program to find rank, determinant, and trace of an array. b) Write a python program to find eigen values of matrices d) Write a python program to solve a linear matrix equation, or system of linear scalar equations.
7	Graphics: • Consider turtle object. Write functions to draw triangle, rectangle, polygon, circle and sphere. Use object oriented approach. • Design a Python program using the Turtle graphics library to construct a turtle bar chart representing the grades obtained by N students read from a file categorizing them into distinction, first class, second class, third class and failed.
8	Create a colour images using NumPy in Python.
Demonstration Experiments (For CIE)	
9	Write a python program to implement Pandas Series with labels.
10	Implementing real-time/technical applications using File handling. (copy from one file to another, word count, longest word).
11	Implementing real-time/technical applications using Exception handling. (divide by zero error, voter's age validity, student mark range validation).
12	Developing a game activity using Pygame like bouncing ball, car race etc.

5.0 Relevance to future subjects

SL. No	Semester	Subject	Topics / Relevance
01	VIII	Project work & Application	AI & ML, CNC Programming

6.0 Relevance to Real World

SL. No	Real World Mapping
01	Awareness of writing program.
02	Logic development.
03	Knowledge AI and ML.

7.0 Books Used and Recommended to Students

Reference Books

1. G Venkatesh and Madhavan Mukund, "Computational Thinking: A Primer for Programmers and Data Scientists", 1st Edition, Notion Press, 2021.
• John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data'', Third Edition, MIT Press, 2021
• Paul Deitel and Harvey Deitel, "Python for Programmers", Pearson Education, 1st Edition, 2021.
• Eric Matthes, "Python Crash Course, A Hands – on Project Based Introduction to Programming", 2nd Edition, No Starch Press, 2019.
• Martin C. Brown, "Python: The Complete Reference", 4th Edition, Mc-Graw Hill, 2018.

8.0 Relevant Websites (Reputed Universities and Others) for Notes/Animation/Videos Recommended

Website and Internet Contents References

1.http://www.nptel.ac.in

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9.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	Cambridge Journals	*https://www.cambridge.org/core/journals/journal-of-fluid-mechanics*
2	Springer	*www.springer.com › Home › Engineering › Mechanics*
3	Iop-Science	*iopscience.iop.org/journal/1873-7005*

10.0 Examination Note

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination (SEE).

Semester End Evaluation (SEE):

• SEE marks for the practical course are 50 Marks.
• SEE shall be conducted jointly by the two examiners of the same institute; examiners are appointed by the Head of the Institute.
• The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedules mentioned in the academic calendar of the University.
• All laboratory experiments are to be included for practical examination.
• (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
• Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
• Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.
• General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)
• Change of experiment is allowed only once and 15% of Marks allotted to the procedure part are to be made zero.

The minimum duration of SEE is 02 hours

11.0 Course Delivery Plan

Expt No	Lecture / Practical No	Name of the Experiment	% Of Portion
1	1	Demonstrate following functions/methods which operates on strings in Python with suitable examples: i) len( ) ii) strip( ) iii) rstrip( ) iv) lstrip( ) v) find( ) vi) rfind( ) vii) index( ) viii) rindex(),ix) count( ) x) replace( ) xi) split( ) xii) join( ) xiii) upper( ) xiv) lower( ) xv) swapcase( ) xvi) title( ) xvii) capitalize( ) xviii) startswith() xix) endswith()	100
2	2	Implementing programs using Functions. (Factorial, largest number in a list, area of shape).	
3	3	NESTED LISTS: Write a program to read a 3 X 3 matrix and find the transpose, addition, subtraction, multiplication of two 3 X 3 matrices, check whether two given 3 X 3 matrices are identical or not.	

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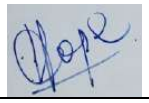
4	4	Implementing programs using Strings. (Reverse, palindrome, character count, replacing characters). Real time applications using sets and Dictionaries
5	5	Scientific problems using Conditionals and Iterative loops. (Number series and different Patterns).
6	6	Numpy Library: Linear Algebra a) Write a python program to find rank, determinant, and trace of an array. b) Write a python program to find eigen values of matrices d) Write a python program to solve a linear matrix equation, or system of linear scalar equations.
7	7	Graphics: • Consider turtle object. Write functions to draw triangle, rectangle, polygon, circle and sphere. Use object oriented approach. • Design a Python program using the Turtle graphics library to construct a turtle bar chart representing the grades obtained by N students read from a file categorizing them into distinction, first class, second class, third class and failed.
8	8	Create a colour images using NumPy in Python.
Demonstration Experiments (For CIE)		
9	9	Write a python program to implement Pandas Series with labels.
10	10	Implementing real-time/technical applications using File handling. (copy from one file to another, word count, longest word).
11	11	Implementing real-time/technical applications using Exception handling. (divide by zero error, voter's age validity, student mark range validation).
12	12	Developing a game activity using Pygame like bouncing ball, car race etc.

12.0 QUESTION BANK

Q1.What is Python?
Q2. Python is an interpreted language. Explain
Q3. What is the difference between lists and tuples?
Q4. What is pep 8?
Q5. What are the Key features of Python?
Q6. How is Memory managed in Python?
Q7. What is PYTHONPATH?
Q8. What are Python Modules?
Q9. What are python namespaces?
Q10. Explain Inheritance in Python with an example?

13.0 University Result

Examination	S+	S	A	B	C	D	E	% Passing

Prepared by	Checked by		
			

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