Department of Mechanical Engineering

COURSE PLAN 2018-19

III Semester "A" division

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

Student Help Desk

S. N	Purpose	Contact Person	
		Faculty	Instructor
Department Level			
1	Attestations	Dr. B. M. Shrigiri	
2	Online submission of exam form/revaluation form to VTU	Prof. S. B. Awade / Prof. N. M. Ukkali / Prof. M. R. Ingalagi	--
3	Students' Counseling & Discussion with parents (Class Teachers from 3rd A to 7th B)	Prof. Jagadeesh A. Prof. Kushal Ambli Prof. B. M. Doddamani Prof. N. M. Ukkali Prof. R. V. Nyamagoud Prof. M. R. Ingalagi	
4	Department Association Coordinator	Prof. M. M. Shivashimpi/ Prof. M. R. Ingalagi	
5	Students Activities Coordinator	Prof. Jagadeesh A.	
6	Extra-Curricular Activities/ Induction/ Robo Vidya	Prof. T. S. Vandali	
7	Dept.TP Cell Coordinator	Prof. R. V. Nyamagoud	Shri S. R. Nakade
8	I I I coordinator, (INTERNSHIP)	Prof. Chitagopkar Ravi	Shri R. B. Kumbar
9	I I I coordinator (INDUSTRY)	Prof. G. A. Naik	
10	Time Table Coordinator	Prof. G. V. Chiniwalar	
11	I. A. Test Coordinator	Prof. A. M. Biradar	Shri S. C. Jotawar
12	Choice of Electives	Prof. S. N. Toppannavar Prof. D. N. Inamdar Prof. T. S. Vandali	---
13	Department Library Coordinator	Prof. Mahantesh I Tanodi	Shri R. M. Hunachyali
14	Department News Letter Coordinator	Prof. M. M. Shivashimpi/ Prof. S. R. Kulkarni/ Prof. M. R. Ingalagi	
15	Department Technical Magazine Coordinator	Prof. M. S. Futane/ Prof. D. N. Inamdar/ Prof. S. R. Kulkarni	
16	Dept. Alumni / Robo Vidya	Prof. Mahesh Hipparagi	
17	Project Coordinators	Prof. Mahantesh I. Tanodi	Shri R. B. Kumbar
18	Dispensary	Dr. Arun G. Bullannavar	Cell No. 9449141549
Institute Level			
01	Student Welfare Convener	Prof. S. B. Akkoli (9480422508)	
02	TP Cell Coordinator	Prof. S. N. Topannavar (9480849332)	
03	Anti Ragging Convener	Prof. M. S. Futane (9480849334)	
04	Anti Squad Convener	Prof. K. M. Akkoli (9739114856)	
05	Anti Sexual Harassment Convener	Smt. Y. S. Patil (9620945478)	
06	Grievance Redressal Convener	Prof. G. A. Naik (9480539283)	
07	Institute News & publicity	Prof. Mahesh Hipparagi (7411507405)	
08	First Year Coordinator	Dr. R. M. Galagali (9945082054)	

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	25	16
2	Technical staff	12	13
3	Helper / Peons	05	08

Major Laboratories

S.N.	Name of the laboratory	Area in Sq. Meters	Amount Invested (Rs.)
1	Basic Workshop Laboratory	170	3,91,550=00
2	Fluid Mechanics Machinery Laboratory	172	7,71,941=00
3	Energy Conversion Engg. Laboratory	173	12,37,586=00
4	Machine shop Laboratory	170	13,25,837=00
5	Foundry & Forging Laboratory	179	2,92,984=00
6	Design Laboratory	73	3,64,818=00
7	Heat & Mass Transfer Laboratory	148	5,24,576=00
8	Metallography & Material Testing Laboratory	149	10,73,461=00
9	Mechanical Measurements & Metrology Laboratory	95	5,48,011=00
10	CIM & Automation/CAMA Laboratory	66	36,98,180=00
11	Computer Aided Machine Drawing Laboratory	66	10,04,195=00
12	Computer Aided Engg Drawing Laboratory	66	12,89,363=00
13	Department/Other	--	13,60,486=00
	Total	**1527**	**1,38,82,696=00**

Teaching Faculty Details

S.N.	Faculty Name	Designation	Qualification	Area of specialization	Professional membership	Industry Experience (in years)	Teaching Experience (in years)	Contact Nos.
1	Dr. S. C. Kamate	Principal	Ph. D	Thermal(Cogeneration)	LMISTE	03	25	9480849331
2	Dr. S. A. Alur	Professor	Ph. D	Thermal Power Engg.	LMISTE	---	23	9686856029
3	Dr. B M Shrigiri	HOD/Professor	Ph. D	Thermal Power Engg.	LMISTE	01	19	9741483339
4	Dr. R. M. Galagali	Assoc.Professor	M Tech., Ph.D	PDM, Tribology	-----	02	17	9945082054
5	Prof.S.N.Topannavar	Assoc.Professor	M Tech.(Ph.D)	Thermal Power Engg.	LMISTE	01	17	9482440235
6	Prof. D. N. Inamdar	Asso.Professor	M Tech.(Ph.D)	Tool Engg	LMISTE	08	13	9591208980
7	Prof. K. M. Akkoli	Asso.Professor	M Tech.(Ph.D)	Thermal Power Engg.	LMISTE	1.5	13	9739114856
8	Prof.R.K.Chitgopkar	Asst. Professor	M Tech.	Thermal Power Engg.	LMISTE	1.5	25	9886070475
9	Prof.G. A. Naik	Asst. Professor	M Tech.	Production Management	LMISTE	02	20	9480539283
10	Prof. G. V. Chiniwalar	Asst. Professor	M Tech.	Machine Design	LMISTE	04	13	8762336434
11	Prof.M.S.Futane	Asst. Professor	M Tech.	Computer Integrated Manufacturing	LMISTE	01	11	9164105035
12	Prof. T. S. Vandali	Asst. Professor	M Tech.	Machine Design	LMISTE	8.5	07	9686235904
13	Prof.S. A. Goudadi	Asst. Professor	M Tech.	Design Engineering	LMISTE	--	09	9448876682
14	Sri. S.R. Kulkarni	Asst. Professor	M Tech.	Design Engineering	LMISTE	--	09	8123661692
15	Prof.M.M.Shivashimpi	Asst. Professor	M Tech.(Ph.D)	Thermal Power Engg.	LMISTE	01	07	9742197173
16	Prof.M.A.Hipparagi	Asst. Professor	M Tech.(Ph.D)	Production Technology	LMISTE	02	06	7411507405
17	Prof. A. M. Biradar	Asst. Professor	M Tech.	Machine Design	LMISTE	02	06	9986127703
18	Prof. K. G. Ambli	Asst. Professor	M Tech.(Ph.D)	Product Design and Manufacturing	LMISTE	0.8	05	9164534514
19	Prof. S. B. Awade	Asst. Professor	M Tech.	Machine design	LMISTE		04	9632606108
20	Prof.Mahantesh Tanodi	Asst. Professor	M Tech.	Machine design	LMISTE	--	05	9611998812
21	Prof. N. M. Ukkali	Asst. Professor	M Tech.	Machine Design	LMISTE	--	04	9620152199
22	Prof. M. R. Inagalagi	Asst. Professor	M Tech.	Thermal Power Engg	LMISTE	--	03	9743868503
23	Prof. Jagadeesh A.	Asst. Professor	M Tech.	Thermal Power Engg	LMISTE	--	04	9902847774
24	Prof. R. V. Nyamagoud	Lecturer	M Tech.	Thermal Power Engg	LMISTE	--	03	9964822494
25	Prof. B. M. Dodamani	Asst. Professor	M Tech.	Energy System Engg	LMISTE	02	03	9535447575

CALENDAR OF EVENTS FOR THE ACADEMIC YEAR 2018-19

Date	Events
01-08-2018	Commencement of III/V Sem Classes
06-08-2018	Commencement of VII Sem Classes
13-08-2018 to 01-09-2018	Commencement of Induction Program for I Semester students
14-08-2018	Fresher's Day (I Sem)
15-08-2018	Independence Day
26-08-2018	Women's Equality Day
05-09-2018	Teachers Day
08-09-2018 & 09-09-2018	Indoor Games
10-09-2018 to 12-09-2018	First Internal Assessment of III/V/VII Sem
14-09-2018 & 15-09-2018	Feed Back-1
15-09-2018	Engineers Day
17-09-2018	Display of First Internal Assessment Marks & Submission of Feedback-1 report to office
22-09-2018	EDP Activities
02-10-2018	Gandhi Jayanti & Swachh Bharat Abhiyan
15-10-2018 to 17-10-2018	First Internal Assessment of I Sem Second Internal Assessment of III/V/VII Sem
22-10-2018 & 23-10-2018	Feed Back-2
25-10-2018	Submission of Feedback-2 Report to Office
25-10-2018	Display of Second Internal Assessment Marks
28-10-2018	Compensatory Working Day of Connecting Holiday 20-10-2018 (Half Day)
01-11-2018	Kannada Rajyotsava
18-11-2018	Compensatory Working Day of Connecting Holiday 07-11-2018
16-11-2018 to 18-11-2018	Second Internal Assessment of I Sem Third Internal Assessment of III/V/VII Sem
22-11-2018 to 24-11-2018	Lab Internal Assessment of III/V/VII Sem
28-11-2018	Display of Third & Final Internal Assessment Marks(III/V/VII Sem)
30-11-2018	Last Working Day of III/V Sem
04-12-2018	Last Working Day of VII Sem
03-12-2018 to 14-12-2018	Practical Exams of III/V Sem
17-12-2018 to 18-01-2019	Theory Exams of III/V Sem
06-12-2018 to 14-12-2018	Practical Exams of VII Sem
17-12-2018 to 18-01-2019	Theory Exams of VII Sem
03-01-2019 to 05-01-2019	Third Internal Assessment of I Sem
09-01-2019 to 11-01-2019	Lab Internal Assessment of I Sem
17-01-2019	Display of Third & Final Internal Assessment Marks (I Sem)
17-01-2019	Last Working Day of I Sem
21-01-2019 to 30-01-2019	Practical Exams of I Sem
04-02-2019 to 18-02-2019	Theory Exams of I Sem

August-2018

S	M	T	W	T	F	S
			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	

15- Independance day, 22-Bakrid

September-2018

S	M	T	W	T	F	S
						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						

13- Ganesh Chaturthi , 21-Moharam

October-2018

S	M	T	W	T	F	S
	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			

2- Gandhi Jayanti, 8- Mahalaya Amavasya, 18- Ayudha Pooja, 19- Vijayadashami, 24- Valmiki Jayanti

November-2018

S	M	T	W	T	F	S
				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	

1- Kannada Rajyotsava, 6- Naraka Chaturdashi, 8- Balipadyami, 21- Id-e-Milad, 26- Kanakadasa Jayanthi

December-2018

S	M	T	W	T	F	S
						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					

25- Chrismas

January -2019

S	M	T	W	T	F	S
		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		

14-Sankranti, 26-Republic Day

Dr. Shilpa Shrigiri
IQAC Co-ordinator

Hirasugar Institute of Technology Nidasoshi Pin-591236 Dt. Belgaum

8/5/18
Dr. S C Kamate
Principal
PRINCIPAL
Hirasugar Institute of Technology
NIDASOSHI-591 236

DEPARTMENT CALENDAR OF EVENTS FOR THE ACADEMIC YEAR 2018-19

Date	Events
01-08-2018	Commencement of III/V Sem Classes
06-08-2018	Commencement of VII Sem Classes
24-08-2018	Welcome function and AIMSS inauguration
31-08-2018	Group Discussion Competition
05-09-2018	Teachers Day
07-09-2018	Industrial Institute Interaction Activity
08-09-2018 To 09-09-2018	Indoor Games
10-09-2018 To 12-09-2018	First Internal Assessment of III/V/VII Sem
15-09-2018	Engineers Day
22-09-2018	EDP Activities
29-09-2018	Industrial Visit (III semester)
02-10-2018	Gandhi Jayanti & Swachh Bharat Abhiyan
06-10-2018	Industrial Visit (V semester)
13-10-2018	Expert talk by Academician
15-10-2018 To 17-10-2018	Second Internal Assessment of III/V/VII Sem
26-10-2018	Hobby Project Competition
27-10-2018	Industrial Visit (V semester)
28-10-2018	Compensatory Working Day of Connecting Holiday 20-10-2018 (Half Day)
01-11-2018	Kannada Rajyotsava
03-11-2018	Industrial Visit (VII semester)
10-11-2018	One Day work shop
16-11-2018 To 18-11-2018	Third Internal Assessment of III/V/VII Sem
22-11-2018 To 24-11-2018	Lab Internal Assessment of III/V/VII Sem
28-11-2018	Display of Third & Final Internal Assessment Marks(III/V/VII Sem)
30-11-2018	Last Working Day of III/V Sem
04-12-2018	Last Working Day of VII Sem
03-12-2018 To 14-12-2018	Practical Exams of III/V Sem
17-12-2018 To 18-01-2019	Theory Exams of III/V Sem
06-12-2018 To 14-12-2018	Practical Exams of VII Sem
17-12-2018 To 18-01-2019	Theory Exams of VII Sem

August-2018

S	M	T	W	T	F	S
			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	

15- Independance day, 22-Bakrid

September-2018

S	M	T	W	T	F	S
						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						

13- Ganesh Chaturthi , 21-Moharam

October-2018

S	M	T	W	T	F	S
	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			

2- Gandhi Jayanti, 8- Mahalaya Amavasya, 18- Ayudha Pooja, 19- Vijayadashami, 24- Valmiki Jayanti

November-2018

S	M	T	W	T	F	S
				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	

1- Kannada Rajyotsava, 6- Naraka Chaturdashi, 8-Balipadyami, 21- Id-e-Milad, 26- Kanakadasa Jayanthi

December-2018

S	M	T	W	T	F	S
						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					

25- Chrismas

Prof. M.M. Shivashimpi
AIMSS Co-ordinator

20/8/18
Dr. B.M. Shrigiri
HOD

Scheme of Teaching and Examination

3rd Semester "A" division

Sl. No.	Subject Code	Title	Teaching Hours per week			Examination				Credits
			Lecture	Tutorial	Practical	Duration (hours)	SSE marks	CIE marks	Total marks	
1	17MAT31	Engineering Mathematics -III	04			03	60	40	100	4
2	17ME32	Materials Science	04			03	60	40	100	4
3	17ME33	Basic Thermodynamics	03	02		03	60	40	100	4
4	17ME34	Mechanics of Materials	03	02		03	60	40	100	4
5	17ME35A	Metal casting and Welding	04			03	60	40	100	4
6	17ME36A	Computer Aided Machine Drawing	01		04	03	60	40	100	3
7	17MEL37A	Material Testing Laboratory	01		02	03	60	40	100	2
8	17MEL38A	Foundry and Forging Laboratory	01		02	03	60	40	100	2
9	17CPH39	Constitution of India, Professional Ethics and Human Rights	01			01	30	20	50	1
		Total	**22/24**	**04**	**08/04**		**510**	**340**	**850**	**28**

VTU Scheme

B.E. Mechanical Engineering
III SEMESTER

Sl. No	Subject Code	Title	Teaching Department	Teaching Hours /Week			Examination				Credits
				Lecture	Tutorial	Practical	Duration (Hours)	SEE Marks	CIE Marks	Total Marks	
1	17MAT31	Engineering Mathematics – III	Maths	04			03	60	40	100	4
2	17ME32	Materials Science	ME	04			03	60	40	100	4
3	17ME33	Basic Thermodynamics	ME	03	02		03	60	40	100	4
4	17ME34	Mechanics of Materials	ME	03	02		03	60	40	100	4
5	17ME35A/ 17ME35B	Metal Casting and Welding	ME	04			03	60	40	100	4
		Machine Tools and Operations	ME								
6	17ME36 A/ 17ME36B	Computer Aided Machine Drawing	ME	01		4	03	60	40	100	3
		Mechanical Measurements and Metrology	ME	03							
7	17MEL37A/ 17MEL37B	Materials Testing Lab/	ME	1		2	03	60	40	100	2
		Mechanical Measurements and Metrology Lab	ME								
8	17MEL38A/ 17MEL38B	Foundry and Forging Lab	ME	1		2	03	60	40	100	2
		Machine Shop/	ME								
9	17KL/CPH39/49	Kannada/Constitution of India, Professional Ethics and Human Rights	Humanities	1			01	30	20	50	1
TOTAL				**22/24**	**04**	**08/04**		**510**	**340**	**850**	**28**

17MAT31- Engineering Mathematics-III

Subject Title	**Engineering Mathematics-III**		
Subject Code	17MAT31	**IA Marks**	40
Number of Lecture Hrs /	04	**Exam Marks**	60
Total Number of Lecture Hrs	50	**Exam Hours**	03
CREDITS – 04			

FACULTY DETAILS:		
Name: i) Prof S. A.Patil ii) Prof S. S. Thabaj	**Designation:** i)Asst. Professor ii) Asst. Professor	**Experience: i) 08** **ii) 08**
No. of times course taught: i) 07 **ii) 07**	**Specialization:** Mathematics	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Mechanical Engineering	II	Engineering Mathematics-II

2.0 Course Objectives

The objectives of this course is to introduce students to the mostly used analytical and numerical methods in the different engineering fields by making them to learn Fourier series, Fourier transforms and Z-transforms, statistical methods, numerical methods to solve algebraic and transcendental equations, vector integration and calculus of variations..

3.0 Course Outcomes

On completion of this course, students are able to:

	Course Outcome	POs
CO1	Know the use of periodic signals and Fourier series to analyze circuits and system communications	1,2,3
CO2	Explain the general linear system theory for continuous-time signals and digital signal processing using the Fourier Transform and z-transform.	1,2,3
CO3	Employ appropriate numerical methods to solve algebraic and transcendental equations	1,2,3
CO4	Apply Green's Theorem, Divergence Theorem and Stokes' theorem in various applications in the field of electro-magnetic and gravitational fields and fluid flow problems.	1,2,3
CO5	Determine the externals of functional and solve the simple problems of the calculus of variations.	1,2,3
Total Hours of instruction		**50**

4.0 Course Content

MODULES	RBT Levels	No. Of Hours
MODULE-I **Fourier series:** Periodic functions, Dirichlet's condition, Fourier Series of Periodic functions with period 2π and with arbitrary period 2c, Fourier series of even and odd functions, Half range Fourier Series, practical Harmonic analysis-Illustrative examples from engineering field.	**L1 & L2**	**10**
MODULE-II **Fourier Transforms:** Infinite Fourier transform, Fourier Sine and Cosine transforms, inverse Fourier transforms **Z-transform:** Difference equations, basic definition, z-transform-definition, Standard z-transforms, Damping rule, Shifting rule, Initial value and final value theorems (without proof) and problems, Inverse Z-transform. Applications of z-transforms to solve difference equations.	**L1 & L2**	**10**
MODULE-III **Statistical Methods:** Review of measures of central tendency and dispersion. Correlation-Karl Pearson's coefficient of correlation-problems. Regression analysis- lines of regression (without proof) –problems **Curve fitting:** Curve fitting by the method of least squares, Fitting of the curves of the form y= ax+b, $y = ax^2+bx+c$ & $y = ae^{bx}$ **Numerical Methods:** Numerical solution of algebraic and transcendental equations by: Regular-Falsi method and Newton –Raphson method	**L1 & L2**	**10**
MODULE-IV **Finite differences**: Forward and backward differences, Newton's forward and backward interpolation formulae Divided differences-Newton's divided difference formula. Lagrange's interpolation formula and inverse interpolation formula.(all formulae without proof)-Problems. **Numerical integration:** Simpson's $(1/3)^{th}$ and $(3/8)^{th}$ rules, Weddle's rule (without proof) – Problems	**L1 & L2**	**10**
MODULE-V **Vector integration:** Line integrals-definition and problems, surface and volume integrals-definition, Green's theorem in a plane, Stokes and Gauss divergence theorem (without proof) and problems. **Calculus of Variations:** Variation of function and Functional, variational problems, Euler's equation, Geodesics, hanging chain, problems	**L2 & L3**	**10**

5.0 Relevance to future subjects

Sl No	Semester	Subject	Topics
01	Common to all	Common to all engineering Subjects	Signal and Analysis, Field Theory, Thermodynamics, Fluid Dynamics etc

6.0 Relevance to Real World

SL.No	Real World Mapping
01	Numerical methods are used to solve engineering problems. For examples will be drawn from a variety of engineering problems, including heat transfer, vibrations, dynamics, fluid mechanics, etc.
02	Special functions are used to wave propagation and scattering, fiber optics, heat conduction in solids, and vibration phenomena.
03	In signal processing, sampling is the reduction of a continuous signal to a discrete signal. A common example is the conversion of a sound wave (a continuous signal) to a sequence of samples (a discrete-time signal).

7.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
01	Tutorial	Topic: Sampling Theory

8.0 Books Used and Recommended to Students

Text Books
1) 'B.S. Grewal, Higher Engineering Mathematics, 43rd Edition 2015, Khanna Publishers.
2) E. Kreyszig: Advanced Engineering Mathematics, John Wiley & Sons, 10th Ed., 2015.
Reference Books
1. N P Bali and Manish Goyal, "A text book of Engineering mathematics" , Laxmi publications, 7th Edition, 2010.
2. B.V.Ramana "Higher Engineering M athematics" Tata McGraw-Hill, 2006.
3. H. K Dass and Er. RajnishVerma ,"Higher Engineerig Mathematics", S. Chand Publishing, 1st Edition, 2011.
Additional Study material & e-Books
1. N.P.Bali & Manish.Goyal, A Text book of Engineering Mathematics, 7th edition, Laxmi Publications.

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

Website and Internet Contents References
1. http://nptel.ac.in/courses.php?disciplineID=111
2. http://wwww.khanacademy.org/
3. http://www.class-central.com/subject/math

10.0 Magazines/Journals Used and Recommended to Students

Sl. No	Magazines/Journals	website
1	+ Plus Magazine	https://plus.maths.org/issue44.
2	Mathematics Magazine	www.mathematicsmagazine.com

11.0 Examination Note

Internal Assessment: 40 Marks

Theoretical aspects as well as relevant sketches should be drawn neatly.

Scheme of Evaluation for Internal Assessment (40 Marks)

(a) Internal Assessment test in the same pattern as that of the main examination (All the three Internal Tests marks considered): **30**Marks.

(b) Assignments: **10** Marks

SCHEME OF EXAMINATION:

Question paper pattern:

Note: - The SEE question paper will be set for 100 marks and the marks will be proportionately reduced to 60.

i) The question paper will have **ten** full questions carrying equal marks.
ii) Each full question consisting of **20** marks.
iii) There will be **two** full questions (with a **maximum** of **three** sub questions) from each module.
iv) Each full question will have sub question covering all the topics under a module.
v) The students will have to answer **five** full questions, selecting **one** full question from each module.

12.0 Course Delivery Plan

Module	Lecture No.	Content of Lecturer	% of Portion
MODULE-1	1	Introduction, Periodic functions, Dirichlet's conditions	20
	2	Fourier series of periodic functions of period 2π	
	3	Fourier series of periodic functions of arbitrary period 2c	
	4	Problems	
	5	Fourier series of even functions	
	6	Fourier series of odd functions	
	7	Problems	
	8	Half range Fourier series	
	9	Practical harmonic analysis	
	10	Problems	
MODULE-2	11	Introduction, Infinite Fourier transform	20
	12	Fourier sine transforms	
	13	Fourier cosine transforms	
	14	Inverse transforms	
	15	z-transform-definition	
	16	Standard z-transforms	
	17	Damping rule, Shifting rule	
	18	Initial value and final value theorems (without proof) and problems	
	19	Inverse z-transform	
	20	Applications of z-transforms to solve difference equations	
MODULE-3	21	Introduction, Statistical Methods: Review of measures of central tendency and dispersion	20
	22	Correlation-Karl Pearson's coefficient of correlation	
	23	Problems	
	24	Regression analysis- lines of regression (without proof) –problems	
	25	Curve fitting by the method of least squares, of the form, form y= ax+b,	

	26	Curve fitting by the method of least squares: $y= a+bx+cx^2$	
	27	Curve fitting by the method of least squares $y = ae^{bx}$	
	28	Numerical solutions: Numerical solution of algebraic and transcendental equations.	
	29	Regular-Falsi method	
	30	Newton –Raphson method	
MODULE-4	31	Introduction, Finite differences: Forward & backward differences	**20**
	32	Newton's forward and backward interpolation formulae	
	33	Problems	
	34	Divided differences- Newton's divided difference formula	
	35	Problems	
	36	Lagrange's interpolation & inverse interpolation formula	
	37	Problems	
	38	Numerical integration: Simpson's one third rule	
	39	Simpson's three eighth rule	
	40	Weddle's rule (without proof) Problems	
MODULE-5	41	Introduction, Line integrals-definition and problems	**20**
	42	Surface and volume integrals-definition,	
	43	Green's theorem in a plane	
	44	Stokes theorem (without proof) problems.	
	45	Gauss divergence theorem (without proof) problems	
	46	Calculus of Variations: Variation of function and Functional, variation problems	
	47	Euler's equation	
	48	Problems	
	49	Geodesics	
	50	Hanging chain, problems	

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	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 1 of the syllabus	2	Individual Activity.	Book 1, of the reference list. Website of the Reference list
2	Assignment 2: University Questions	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 2 of the syllabus	4	Individual Activity.	Book 1, 2 of the reference list. Website of the Reference list
3	Assignment 3: University Questions	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 3 of the syllabus	6	Individual Activity.	Book 1, 2 of the reference list. Website of the Reference list
4	Assignment 4: University Questions	Students study the Topics and write the Answers. Get practice to solve university	Module 4 of the syllabus	8	Individual Activity.	Book 1, 2 of the reference list. Website of the

		questions.				Reference list
5	Assignment 5: University Questions	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 5 of the syllabus	10	Individual Activity.	Book 1, 2 of the reference list. Website of the Reference list

14.0 QUESTION BANK

Module-I: Fourier series:

1) Obtain a Fourier series to represent e^{-ax} from (- , x)
2) Expand f(x) = x sin x, 0 < x < 2, in a Fourier series.
3) For a function f(x) defined by f(x) = |x |, $< x < \pi,$ obtain a Fourier series. Deduce that $\frac{1}{1^2}+\frac{1}{3^2}+\frac{1}{5^2}+\frac{1}{7^2}=\frac{\pi^2}{8}$
4) Find the Fourier series for the function $f(x)=\frac{\pi-x}{2}$ in (0, 2π). Hence deduce that $\frac{\pi}{4}=1-\frac{1}{3}+\frac{1}{5}---$
5) Find the Fourier series to represent f(x) = x+x^2 from x=- π to x= π and deduce that $\frac{1}{1^2}-\frac{1}{2^2}+\frac{1}{3^2}-\frac{1}{4^2}=\frac{\pi^2}{12}$
6) Expand f(x) = e^{-x} as a Fourier series in the interval (–l, l)
7) Obtain Fourier series for the function
$f(x)=\begin{cases}\pi x, & 0\le x\le 1\\ \pi(2-x), & 1\le x\le 2\end{cases}$ and deduce that $\frac{1}{1^2}+\frac{1}{3^2}+\frac{1}{5^2}+\frac{1}{7^2}$-------
8) Develop f(x) in Fourier series in the interval (-2, 2) if $f(x)=\begin{cases}0, & -2<x<0\\ 1, & 0<x<2\end{cases}$
9) Find the half range cosine series for the function f(x) = x^2 in the range 0 ≤ x ≤ l
10) Find the complex form of the Fourier series of the periodic function f(x) = cos ax, in $-\pi < x < \pi$.
11) The following table gives the variation of periodic current over a period

t sec	0	T/6	T/3	T/2	2T/3	5T/6	T
A amp	1.98	1.30	1.05	1.30	-0.88	-0.25	1.98

Show that there is a direct current part of 0.75 amp in the variable current and obtain the amplitude of the first harmonic.
12) Obtain the Fourier series for the function

f(x) = $\begin{cases}1-\frac{2x}{\pi} & -\pi\le x\le 0\\ 1+\frac{2x}{\pi} & 0\le x\le\pi\end{cases}$ Hence deduce that $\frac{\pi^2}{8}=\frac{1}{1^2}+\frac{1}{3^2}+\frac{1}{5}+$ _____

13) Obtain the Fourier expansion of $f(x)=2x-x^2$ in $0\le x\le 2$
14) Obtain the constant term and the coefficient of the first sine and cosine terms in the Fourier expansion of y as given below.

x	0	1	2	3	4	5
y	9	18	24	28	26	20

Module-II: Fourier Transforms:

1) Find the Fourier transform of
$f(x)=\begin{cases}1, & |x|<1\\ 0, & |x|<1\end{cases}$ Hence evaluate $\int_0^\infty \frac{\sin x}{x}dx$

2) Find the Fourier transform of the function
$f(x) = \begin{cases} x, & |x| \leq \\ 0, & |x| > a \end{cases}$ Where a is a positive constant?

3) Find the Fourier transform of $\cos ax^2$

4) Find the Fourier sine transform of $e^{-ax/x}$

5) Find the Fourier sine and cosine transform of $f(x) = \begin{cases} 1, & 0 \leq x < a \\ 0, & x \geq a \end{cases}$

6) Find the finite Fourier sine and cosine transform of f(x) = 2x, $0 < x < 4$.

7) Find the cosine transform of $f(x) = \frac{1}{1+x^2}$

8) Find the Fourier sine transform of $e^{-|x|}$

9) Find the Fourier transform of $f(x) = \begin{cases} a^2 - x^2, & |x| < a \\ 0, & |x| > a \end{cases}$ and Evaluate $\int_0^\infty \frac{\sin x - x\cos x}{x^3} dx$.

10) Find the Fourier sine transform of $f(x) = \frac{e^{-ax}}{x}$, $a > 0$.

11) Find the Fourier cosine transform of $(x) = \begin{cases} x, & 0 < x < 1 \\ 2 - x, & 1 < x < 2 \\ 0, & x > 2 \end{cases}$.

12) Find the Fourier transform of $f(x) = e^{-|x|}$ and Evaluate $\int_0^\infty \frac{x \sin mx}{1+x^2} dx$.

13) Find the Fourier transform of $f(x) = e^{-|x|}$ and Evaluate $\int_0^\infty \frac{x \sin mx}{1+x^2} dx$.

Z- Transformation:

1. P.T. $z_T(n^2) = \frac{z^2+z}{(z-1)^3}$

2. P.T. $z_T(n^3) = \frac{z^3+4z^2+2}{(z-1)^4}$

3) P.T. $z_T(\cos\theta) = \frac{z(z-\cos\theta)}{z^2-2z\cos\theta+1}$

4) P.T. $z_T(\sin\theta) = \frac{(z\sin\theta)}{z^2-2z\cos\theta+1}$

5) P.T. $z_T(a^n \cos n\theta) = \frac{z(z-a\cos\theta)}{z^2-2az\cos\theta+a^2}$

6) Find the Z-transform of $\cos h n\theta$ & $\sin h n\theta$.

7) Find the Z-transform of $(n+1)^2$

8) Using the inversion integral method find the inverse Z-transform of $\frac{3z}{(z-1)(z-2)}$

9) Solve $y_{n+2} + 6y_{n+1} + 9y_n = 2^n$ with $y_0 = y_n = 0$ using Z-transform

10) Solve the difference equation $y_{n+2} + 2y_{n+1} + y_n = n$ with $y_0 = y_n = 0$ using Z-Transform.

11) Obtain the z-transform of $\cos n\theta$ and $\sin n\theta$

12) Find the Inverse z-transform of $\frac{2z^2+3z}{(z+2)(z-4)}$.

13) If $\bar{u}(z) = \frac{2z^2+3z+12}{(z-1)^4}$, find the value of u_0, u_1, u_2, u_3.

14) Solve the difference equation $u_{n+2} + 6u_{n+1} + 9u_n = 2^n$, $u_0 = u_1 = 0$.

Module-III: Statistical Methods:

1) Find the correlation coefficient and regration lines of y and x and x and y for the following data

x	1	2	3	4	5
y	2	5	3	8	7

2) Find the coefficient of correlation for the following data.

x	10	14	18	22	26	30
y	18	12	24	6	30	36

3) Compute the rank correlation coefficient for the following data

x	68	64	75	50	64	80	75	40	55	64
y	62	58	68	45	81	60	68	48	50	70

4) Ten students got the following % of marks in two subjects x and y. Compute their rank correlation coefficient.

Marks in x	78	36	98	25	75	82	90	62	65	39
Marks in y	84	51	91	60	68	62	86	58	53	47

Curve Fitting and Optimization:

1) Find the equation of the best fitting straight line for the data

x	0	1	2	3	4	5
y	9	8	24	28	26	20

2) A simply supported beam carries a concentrated load p at its midpoint corresponding to various values of p the Maximum deflection y is measured & is given below

p	100	120	140	160	180	200
y	0.45	0.55	0.60	0.70	0.80	0.85

Find the law of the form y = a+bp & hence estimate y when p = 150.

3) Fit a second degree parabola of best fit $y = a+bx+cx^2$

x	1.0	1.5	2.0	2.5	3.0	3.5	4.0
y	1.1	1.3	1.6	2.0	2.7	3.4	4.1

4) Fit a second degree parabola $y = ax^2+bx+c$ in the least square sense for the following data

x	0	1	2	3	4
y	1	1.8	1.3	2.5	2.3

5) The voltage v across a capacitor at time t sec is given by the following table

t	0	2	4	6	8
v	150	63	28	12	5.6

Use the method of least square of to fit a curve of the form $v= ae^{kt}$ to this data

6) Find the co-efficient of correlation & regression of lines to the following data.

x	1	2	3	4	5
y	2	5	3	8	7

Numerical Methods

1) Find the real root of the equation $\log_{10} x$ =1.2 by Regula-Falsi method correct to four decimal places.
2) Find by Newton's method, the real root of the equation 3x = cosx +1.
3) Using the Newton's Raphson method, find a root of the following equations correct to the three decimal
4) Places. i) 3sin x – 2x+5 = 0 near 3, ii) x sin x + cos x = 0 which is near x =
5) Find by Newton's method, the root of the equation cos x = x ex.
6) Use Newton-Raphson method to find a real root of the equation $x - \cos x = 0$
7) By applying Weddle's Rule evaluate $\int \frac{x}{+x^2}\,dx$ by considering seven ordinates. Hence find the value of $_e2$
8) Evaluate $\frac{1}{+x}\,dx,$ by using Simpson 1/3 rd rule, considering seven ordinates. Hence deduce the

value of $_e2$.

9) Find the interpolating formula that approximates to the function described by the following table

x	0	1	2	5
y	2	3	12	147

10) Find 'y' when x= 0.26 using appropriate interpolation formula to the following data,

X	0.10	0.15	0.20	0.25	0.30
Y	0.1003	0.1511	0.2027	0.2553	0.3093

11) If y(5)=150 , y(7)=392 , y(11)=1492 , y(13)=2366 ,y(17) = 5202 then find y(9) by using Lagrange's Formula

12) Apply Lagrange's Inverse interpolation formula to find a root of the equation f(x)=0 given that

$$f(30) = -30,\ f(34) = -13,\ f(38) = 3,\ f(42) = 18.$$

13) Use Newton's divided difference formula to find f(4) given

x	0	2	3	6
y	- 4	2	14	158

Module-IV: Finite Differences:

1) The following table gives the distances in nautical miles of the visible horizon for the given heights in feet above the earth's surface

x:height	100	150	200	250	300	350	400
y:distance	10.63	13.03	15.04	16.81	18.42	19.90	21.27

Find the values of y when x=218 feet and 410 feet

2) From the following table, estimate the number of students who obtained marks between 40 & 45

Marks	30-40	40-50	50-60	60-70	70-80
No. of students	31	42	51	35	31

3) In the table below the value of y are consegitive terms of a series of which 23.6 are the 6th term. Find The first & tenth terms of the series

x	3	4	5	6	7	8	9
y	4.8	8.7	14.5	23.6	36.2	52.8	73.9

4) Given the values

x	5	7	11	13	17
f(x)	150	392	1452	2366	5202

Find f(15) and f(19)

6) Use Newton's divided difference formula to find f(x) given the data

x	0	2	3	6
f(x)	-4	2	14	158

7) Given the values

x	5	7	11	13	17
f(x)	150	392	1452	2366	5202

Evaluate f (9) using divided difference formula for unequal intervals.

8) Evaluate $\int_0^1 \frac{dx}{1+x^2}$ by using Simpson's 1/3 rd rule taking four equal strips and hence find the value of π

9) If y(1) =3 , y(3) = 9, y(4) = 30, y(6) =132, Find Lagrange's interpolation formula & hence find y at x=5.

12) Evaluate $\int_0^6 \frac{dx}{1+x^2}$ by using

i) Simpson's 1/3 rd rule , ii) Simpson's 3/8th rule, iii) Weddle's rule.

13) Use Simpson's 1/3 rd rule to find $\int_0^{0.6} e^{-x^2} dx$ by taking seven ordinates.

14) Using Simpson's 3/8th rule , evaluate $\int_0^{0.3} \sqrt{1-8x^3}\, dx$ by taking 7 ordinates.

15) Evaluate $\int_0^{\frac{\pi}{2}} \sqrt{\cos\theta}\, d\theta$ using Weddle's rule

Module-V: Vector Integration:

1) If $\vec{F} = xyi + yzj + zxk$ *evaluate* $\int_c \vec{F}.\vec{dr}$ where c is the curve represented by x=t, y=t^2, z=t^3, $-1 \le t \le 1$
2) Find the total work done by the force represented by $3xyi - yj + 2zxk$ in the moving a particle round the circle $x^2 + y^2 = 4$
3) Verify the Greens theorem
   $\oint_c (xy + y^2)dx + x^2 dy$ where c is the closed curve of the region bounded by $y = x$ and $y = x^2$
4) Find the area between the parabola $y^2 = 4x$ and $x^2 = 4y$ with the help of Greens theorem in a plane.
5) Verify the Stroke's theorem for the vector function $\vec{F} = 2xyi + (x^2 - y^2)j$ over the circle $x^2 + y^2 = 1$, z = 0
6) Verify the Stroke's theorem for $\vec{F} = yi + zj + xk$ where S is upper half of the sphere $x^2 + y^2 + z^2 = 1$ and C is its boundary.
7) Verify the Divergence theorem for
   $\vec{F} = (x^2 - yz)i + (y^2 - zx)j + (z^2 - xy)k$ Taken over the rectangular parallelepiped $0 \le x \le a$, $0 \le y \le b$, $0 \le z \le c$.
8) Verify the Gauss divergence theorem for $\vec{F} = 4xzi - y^2 j + yzk$ over the unit cube.
9) Show that the Geodesics on a plane are straight line.
10) Find the Geodesics on a right circular cylinder of radius a.
11) Find the extremals of the functional $\int_{x_0}^{x_1} \frac{(y')^2}{x^3} dx$
12) Evaluate $\int_c xy\, dx + xy^2 dy$. by Stoke's theorem where c is the square in xy-plane with (1, 0), (-1, 0), (0, 1) & (0, -1)
13) Show that the shortest distance between any two points in a plane is a straight line.

16.0 University Result

Examination	FCD (S+, S, A)	FC (B)	SC (C, D, E)	% Passing
Jan 2018	20	19	68	85.08
Jan 2017	12	16	84	78.36

Prepared by	Checked by		
i) Prof S. A.Patil ii) Prof S. S. Thabaj	Prof. Prof S. L.Patil	HOD	Principal

17ME32- Material Science

Subject Title	**MATERIAL SCIENCE**		
Subject Code	17ME32	**CIE**	40
Number of Lecture Hrs / Week	04	**SEE**	60
Total Number of Lecture Hrs	50	**Exam Hours**	03
CREDITS – 04			

FACULTY DETAILS:		
Name: Prof. G. A. Naik	**Designation:** Asst. Professor	**Experience:** 23
No. of times course taught:01	**Specialization:** Production Technology	
Name: Prof. K G Ambli	**Designation:** Asst.Professor	**Experience:**05
No. of times course taught:03	**Specialization:** Product Design and Manufacturing	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Mechanical Engineering	III / IV	MTO, Metal Casting and Welding

2.0 Course Objectives

This course provides'

1. The foundation for understanding the structure and various modes of failure in materials common in mechanical engineering.
2. Topics are designed to explore the mechanical properties of metals and their alloys, polymers, ceramics, smart materials and composites.
3. The means of modifying such properties, as well as the processing and failure of materials.
4. Concepts of use of materials for various applications are highlighted.

3.0 Course Outcomes

The student shall be able to;

1. Describe the mechanical properties of metals, their alloys and various modes of failure.
2. Understand the microstructures of ferrous and non-ferrous materials to mechanical properties.
3. Explain the processes of heat treatment of various alloys.
4. Understand the properties and potentialities of various materials available and material selection procedures.
5. Know about composite materials and their processing as well as applications.

4.0 Course Content

MODULE 1

Basics, Mechanical Behavior, Failure of Materials

Introduction to Crystal Structure – Coordination number, atomic packing factor, Simple Cubic, BCC, FCC and HCP Structures, Crystal imperfections- point, line & volume imperfections Atomic Diffusion: Phenomenon, Fick's laws of diffusion;Factors affecting diffusion.

Mechanical Behavior:

Stress-strain diagrams showing ductile and brittle behavior of materials, Engineering and true strains, Linear and non-linear elastic behavior and properties, Mechanical properties in plastic range. Stiffness, Yield strength, Offset Yield strength, Ductility, Ultimate Tensile strength, Toughness, Plastic deformation of single crystal by slip and twinning, Mechanisms of strengthening in metals

Fracture: Type I, Type II and Type III,

Fatigue: Types of fatigue loading with examples, Mechanism of fatigue, Fatigue properties, S-N diagram, Fatigue testing. **Creep:** Description of the phenomenon with examples, three stages of creep, creep properties, Stress relaxation. Concept of fracture toughness, numerical on diffusion, strain and stress relaxation. **(10Hours)**

MODULE 2
Alloys, Steels, Solidification
Concept of formation of alloys: Types of alloys, solid solutions, factors affecting solid solubility (Hume Rothery rules), Binary phase diagrams: Eutectic, and Eutectoid systems, Lever rule, substitutional and interstitial solid solutions, Intermediate phases, Gibbs phase rule Effect of non- equilibrium cooling, Coring and Homogenization Iron-Carbon (Cementite) diagram: description of phases, Effect of common alloying elements in steel, Common alloy steels, Stainless steel, Tool steel, Specifications of steels. Solidification: Mechanism of solidification, Homogenous and Heterogeneous nucleation, Crystal growth, Cast metal structures Solidification of Steels and Cast irons. Numerical on lever rule. (**10 Hours)**

MODULE 3
Heat Treatment, Ferrous and Non-Ferrous Alloys
Heat treating of metals: Time-Temperature-Transformation (TTT) curves, Continuous Cooling Transformation (CCT) curves, Annealing: Recovery, Recrystallization and Grain growth, Types of annealing, Normalizing, Types of annealing, Normalizing, , Concept of hardenability, Factors affecting it hardenability, surface hardening methods: carburizing, cyaniding, nitriding, flame hardening and induction hardening, Age hardening of aluminum-copper alloys and PH steels. Ferrous materials: Properties, Compositions and uses of Grey cast iron, Malleable iron, SG iron and steel. (**10 Hours)**

MODULE 4
Other Materials, Material Selection
Ceramics: Structure types and properties and applications of ceramics. Mechanical / Electrical behavior and processing of Ceramics.
Plastics: Various types of polymers/plastics and their applications. Mechanical behaviors and processing of plastics, Failure of plastics.
Other materials: Smart materials and Shape Memory alloys, properties and applications. (**10 Hours)**

MODULE 5
Composite Materials
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, Fundamentals of production of composites, Processes for production of composites, Characterization of composites, Constitutive relations of composites, Determination of composite properties from component properties, Hybrid composites, Applications of composite materials, Numericals on determining properties of composites. (**10 Hours)**

5.0 Relevance to future subjects

Sl No	Semester	Subject	Topics
01	VIII	Project work	Advanced / Composite Material Testing

6.0 Relevance to Real World

SL.No	Real World Mapping
01	Aerospace Industries, Automobile Industries
02	Research and Development

7.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
01	Lecture	Topic: Shape / Super Memory Alloys, PVD Techniques

8.0 Books Used and Recommended to Students

Text Books
1. Smith, Foundations of Materials Science and Engineering, 4th Edition, McGraw Hill, 2009. 2. William D. Callister, Material science and Engineering and Introduction, Wiley, 2006.
Reference Books
1. V.Raghavan, Materials Science and Engineering, , PHI, 2002 2. Donald R. Askland and Pradeep.P. Phule, The Science and Engineering of Materials, Cengage Learning, 4lh Ed., 2003. 3. George Ellwood Dieter, Mechanical Metallurgy, McGraw-Hill. 4. ASM Handbooks, American Society of Metals.
Additional Study material & e-Books
1. A V Avner. Principle of Metallurgy

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

Website and Internet Contents References
1) http://nptel.ac.in/courses/113106032/ 2) https://www.youtube.com/channel/UC9sKRSg8Kn5axYdORJUnqFw 3) http://freevideolectures.com/Subject/Metallurgy-and-Material-Science 4) http://www.vssut.ac.in/lecture-notes.php?url=metallurgy-materials-engineering

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

CIE : 40 Marks

Assignment marks = 10

Internal Assessment Marks = 30

Semester End Examination: 60 Marks

Two question to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

12.0 Course Delivery Plan

Module	Lecture No.	Content of Lecturer	% of Portion
1	1	Introduction to Crystal Structure – Coordination number, atomic packing factor, Simple Cubic, BCC, FCC and HCP Structures	20%
	2	Problems on APF, CN.	
	3	Crystal imperfections- point, line & volume imperfections	

	4	Atomic Diffusion: Phenomenon, Fick's laws of diffusion;Factors affecting diffusion.	
	5	Problems on atomic diffusion.	
	6	Stress-strain diagrams showing ductile and brittle behavior of materials, Engineering and true strains Linear and non- linear elastic behavior and properties	
	7	Mechanical properties in plastic range. Stiffness, Yield strength, Offset Yield strength, Ductility, Ultimate Tensile strength, Toughness, Plastic	
	8	Plastic deformation of single crystal by slip and twinning, Mechanisms of strengthening in metals	
	9	Type I, Type II and Type III ,Types of fatigue loading with examples, Mechanism of fatigue, Fatigue properties	
	10	S-N diagram, Fatigue testing. Creep: Description of the phenomenon with examples, three stages of creep, creep properties, Stress relaxation. Concept of fracture toughness, numerical on diffusion, strain and stress relaxation.	
2	11	Concept of formation of alloys: Types of alloys, solid solutions	20%
	12	Factors affecting solid solubility (Hume Rothery rules), Binary phase diagrams: Eutectic and Eutectoid systems,	
	13	Lever rule, Substitutional and interstitial solid solutions	
	14	Intermediate phases, Gibbs phase rule Effect of non- equilibrium cooling	
	15	Coring and Homogenization	
	16	Iron-Carbon (Cementite) diagram: description of phases	
	17	Effect of common alloying elements in steel, Common alloy steels, Stainless steel, Tool steel, Specifications of steels	
	18	Solidification: Mechanism of solidification, Homogenous nucleation.	
	19	Heterogeneous nucleation, Crystal growth, Cast metal structures	
	20	Solidification of Steels and Cast irons. Numerical on lever rule	
3	21	Heat treating of metals: Time-Temperature-Transformation (TTT) curves, Continuous Cooling	20%
	22	Transformation (CCT) curves, Annealing: Recovery, Recrystallization and Grain growth	
	23	Types of annealing	
	24	Normalizing, Difference between annealing & normalizing	
	25	Concept of hardenability, Factors affecting it hardenability	
	26	Factors affecting it hardenability, surface hardening methods: carburizing	
	27	Nitriding, flame hardening and induction hardening, , SG iron and steel.	
	28	Age hardening of aluminum-copper alloys and PH steels	
	29	Ferrous materials: Properties, Compositions and uses of Grey cast iron, Malleable iron	
	30	Properties, Compositions and uses of S.G. iron & steel	
4	31	Structure types and properties and applications of ceramics.	20%
	32	Mechanical behavior and processing of Ceramics	
	33	Electrical behavior and processing of Ceramics	
	34	Various types of polymers/plastics and their applications	
	35	Mechanical behaviors and processing of plastics, Failure of plastics	
	36	Brief description of other materials such as optical and thermal materials Smart materials – fiber optic materials	
	37	Piezo-electrics, shape memory alloys Shape Memory Alloys – Nitinol	

	38	superelasticity, Biological applications of smart materials - materials used as implants in human Body	
	39	Selection of Materials, Performance of materials in service Residual life assessment	
	40	Use of non-destructive testing, Economics, Environment and Sustainability	
5	41	Composite materials - Definition, classification, types of matrix materials & reinforcements	20%
	42	Metal Matrix Composites (MMCs), Ceramic Matrix Composites (CMCs) and Polymer Matrix Composites (PMCs)	
	43	Particulate-reinforced and fiber- reinforced composites, Fundamentals of production of FRPs	
	44	Fundamentals of production of MMCs	
	45	Characterization of composites, Constitutive relations of composites	
	46	Processes for production of composites	
	47	Determination of composite properties from component properties	
	48	Hybrid composites	
	49	Applications of composite materials in different fields	
	50	Numericals on determining properties of composites	

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 study the Topics and write the Answers. Get practice to solve university questions.	Module 1 of the syllabus	2	Individual Activity.	Book 1, 2 of the text book list and 1,2,3 of the Reference list
2	Assignment 2:	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 2 of the syllabus	4	Individual Activity.	Book 1, 2 of the text book list and 1,2,3 of the Reference list
3	Assignment 3:	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 3 of the syllabus	6	Individual Activity.	Book 1, 2 of the text book list and 1,2,3 of the Reference list
4	Assignment 4:	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 4 of the syllabus	8	Individual Activity.	Book 1, 2 of the text book list and 1,2,3 of the Reference list
5	Assignment 5:	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 5 of the syllabus	10	Individual Activity.	Book 1, 2 of the text book list and 1,2,3 of the Reference list

14.0 QUESTION BANK

MODULE 1

1. Define unit cell, space lattice, 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 tension and explain the behavior of the material till fracture.
12. Draw a neat sketch of stress strain diagram of a) ductile material and brittle material.
13. Define a) elastic strength b) stiffness c) resilience d) toughness e) ductility
14. Compare true stress strain diagram and conventional stress strain diagram for typical ductile material.
15. Draw on the same plot, schematic stress strain curves of mild steel, gray cast iron and copper.
16. Differentiate between ductile material & brittle material.
17. What is plastic deformation & with neat sketches plastic deformation by slip
18. With neat sketches plastic deformation by twinning.
19. Differentiate between slip and twinning deformations in materials.
20. With neat sketches explain stages in a ductile type of fracture.
21. Differentiate between ductile and brittle fractures.
22. Explain with a neat sketch the cup and cone fracture.
23. Derive Griffith's criterion for brittle fracture.
24. Define and explain the phenomenon of fatigue.
25. Explain the mechanism of fatigue crack growth in ductile materials.
26. Draw S-N curve for steel and aluminum.
27. Define creep and explain a typical creep curve.
28. Explain stress relaxation.
29. Explain two important creep mechanisms.
30. Explain briefly temperature effect on creep curve and endurance limit and fatigue strength.

MODULE 2

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

MODULE 3

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.
13. Both pearlite and tempered martensite contain ferrite and cementite, but tempered martensite is stronger and tougher. Explain?
14. What is the purpose of case hardening? Classify the methods of case hardening and describe briefly any two of them.
15. Explain recovery, recrystalization & 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 4

1. What is a ceramic material**?**
2. What are the different types of ceramics?
3. Explain the structures of the ceramics.
4. Explain the different properties & applications of ceramics.
5. Explain the mechanical behavior & processing of ceramics.
6. Explain the electrical behavior & processing of ceramics.
7. Define a polymer/ plastic.
8. Write down the applications of plastics/ polymers.
9. Explain the mechanical behavior & processing of plastics.
10. Explain the failure of plastics.
11. Briefly explain the thermal & optical materials (smart materials).
12. Briefly explain the term superelasticity.
13. Write down the biological applications of smart materials.
14. What is the use of non-destructive?
15. List advantages & disadvantages of composite materials.
16. Write down the applications of composite materials.

MODULE 5

1. Define composite material
2. Classify composite materials
3. List & explain different types of matrix materials & reinforcements
4. What is a reinforced composite? List & explain its types.
5. Explain FRP with its applications
6. Explain MMC with its applications
7. List advantages & disadvantages of composite materials.
8. What are hybrid composites?
9. Write down the applications of composite materials.

15.0 University Result

Examination	FCD	FC	SC	% Passing
2015-16	03	15	43	96.82

Examination	+S	S	A	B	C	D	E	F	% Passing
2016-17	0	3	13	32	56	20	8	11	92.3
2017-18	0	3	13	32	32	18	15	11	91.08

Prepared by	Checked by		
Prof. K. G. Ambli	Prof. G. A. Naik	HOD	Principal

17ME33- Basic Thermodynamics

Subject Title	BASIC THERMODYNAMICS		
Subject Code	17ME33	**CIA Marks**	40
No of Lecture Hrs + Practical Hrs / Week	4	**SEE Marks**	60
Total No of Lecture + Practical Hrs	50	**Exam Hours**	03
			CREDITS – 04

FACULTY DETAILS:		
Name: Prof. K M Akkoli	**Designation:** Assistant. Professor	**Experience: 15** Years
No. of times course taught: 03	**Specialization:** Thermal Power Engg	
Name: Prof. Jagadeesh A	**Designation:** Assistant. Professor	**Experience: 06** Years
No. of times course taught: 04	**Specialization:** Thermal Power Engg	

1.0 Prerequisite Subjects:

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

2.0 Course Objectives

- Learn about thermodynamic systems and boundaries
- Study the basic laws of thermodynamics including, conservation of mass, conservation of energy or first law , second law and Zeroth law.
- Understand various forms of energy including heat transfer and work
- Identify various types of properties (e.g., extensive and intensive properties)
- Use tables, equations, and charts, in evaluation of thermodynamic properties
- Apply conservation of mass, first law, and second law in thermodynamic analysis of systems (e.g., turbines, pumps, compressors, heat exchangers, etc.)
- Enhance their problem solving skills in thermal engineering

3.0 Course Outcomes

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

CO	Course Outcome	Cognitive Level	POs
CO1	Explain the fundamental concepts of thermodynamics and energy interactions between the system and surroundings.	A	1,2,6,12
CO2	Interpret and apply first and second law of thermodynamics to flow and non-flow processes	A	1,2,4,6,12
CO3	Estimate the entropy for reversible and irreversible processes and measure Quality, Quantity and Thermodynamic properties of pure substance.	A	1,2,4,6,12
CO4	Analyze the reversible and irreversible processes and derive the thermodynamic relations to evaluate the energy and thermodynamic	A	1,2,4,12
CO5	Evaluate the properties of mixture of ideal and real gases	A	1,2,12
Total Hours of instruction		**50**	

4.0 Course Content

MODULE 1

Fundamental Concepts & Definitions: Thermodynamic definition and scope, Microscopic and Macroscopic approaches. Some practical applications of engineering thermodynamic Systems, Characteristics of system boundary and control surface, examples. Thermodynamic properties; definition and units, intensive , extensive properties, specific properties, pressure, specific volume 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 equilibrium, Zeroth law of thermodynamics, Temperature; concepts, scales, international fixed points and measurement of temperature. Constant volume gas thermometer, constant pressure gas thermometer, mercury in glass thermometer

Work and Heat: Mechanics, definition of work and its limitations. Thermodynamic definition of work; examples, sign convention. 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. Shaft work; Electrical work. Other types of work. Heat; definition, units and signconvention.Problems. **10Hours**

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, Extension of the First law to control volume; steady flow energy equation(SFEE), important applications.

Second Law of Thermodynamics: limitations of first law of thermodynamics Devices converting heat to work; (a) in a thermodynamic cycle, (b) in a mechanical cycle. Thermal reservoir,Direct heat engine; schematic representation and efficiency. Devices converting work to heat in a thermodynamic cycle; reversed heat engine, schematic representation, coefficients of performance. 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. **10Hours**

MODULE 3

Reversibility: Definitions of a reversible process, reversible heat engine, importance and superiority of a reversible heat engine and irreversible processes; factors that make a process irreversible, reversible heat engines. Unresisted expansion, remarks on Carnot's engine, internal and external reversibility, Definition of the thermodynamic temperature scale.Problems

Entropy: Clasius inequality, Statement- proof, Entropy- definition, a property, change of entropy, entropy as a quantitative test for irreversibility, principle of increase in entropy, , calculation of entropy using Tds relations, entropy asacoordinate. **10Hours**

MODULE 4

Availability, Irreversibility and General Thermodynamic relations.Introduction, Availability (Exergy), Unavailable energy (anergy), Relation between increase in unavailable energy and increase in entropy.Maximum work, maximum useful work for a system and control volume, irreversibility, second law efficiency (effectiveness). Gibbs and Helmholtz functions, Maxwell relations, Clapeyron equation, Joule Thomson coefficient, general relations for change in entropy, enthalpy , internal energy and specific heats.

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. **10 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, Psychrometric properties, Construction and use of Psychrometric chart. Real gases – Introduction , Air water mixture and related properties, Van-der Waal's Equation of state, Van-der Waal's constants in terms of critical properties, Redlich and Kwong equation of state Beattie-Bridgeman equation , Law of corresponding states, compressibility factor; compressibility chart.Difference between Ideal and real gases. **10 Hours**

5.0 Relevance to future subjects/Area

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 Books Used and Recommended to Students

Text Books

- Basic Engineering Thermodynamics, A.Venkatesh, Universities Press, 2008
- Basic and Applied Thermodynamics, P.K.Nag, 2nd Ed., Tata McGraw Hill Pub. 2002

Reference Books

- Thermodynamics, An Engineering Approach, YunusA.Cenegal and Michael A.Boles, Tata McGraw Hill publications,2002
- Engineering Thermodynamics, J.B.Jones and G.A.Hawkins, John Wiley and Sons..
- Fundamentals of Classical Thermodynamics, G.J.VanWylen and R.E.Sonntag, Wiley Eastern.
- An Introduction to Thermodynamcis, Y.V.C.Rao, Wiley Eastern, 1993.
- B.K Venkanna, Swati B. Wadavadagi "Basic Thermodynamics, PHI, New Delhi, 2010

Additional Study material & e-Books

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

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

Website and Internet Contents References

1. http://www.nptel.ac.in
2. http://nptel.ac.in/media/pdf/nptel_2018_booklet.pdf

9.0 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/

10.0 Examination Note

Internal Assessment (30 Marks)
Questions shall be answered in Internal Assessment books (blue book).Internal assessment book shall be submitted.

Scheme of Evaluation for Internal Assessment (30 Marks)
Internal Assessment test in the same pattern as that of the main examination (Better of the three Tests):30marks.
Assignments (10 Marks)
Assignments for each module are to be submitted and evaluated for 10 marks for each. Average of five modules is to be considered.

SCHEME OF 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 after evaluation total marks are reduced to 60 marks.

11.0 Course Delivery Plan

Module No.	Lecture No.	Content of Lecture	% of Portion
1	1	Fundamental Concepts & Definitions: Thermodynamic definition and scope, Microscopic and Macroscopic approaches. Some practical applications of engineering thermodynamic Systems,	**20**
	2	Characteristics of system boundary and control surface, examples. Thermodynamic properties; definition and units, intensive , extensive properties,	
	3	specific properties, pressure, specific volume Thermodynamic state, state point, state diagram, path and process, quasi-static process, cyclic and non-cyclic; processes;	
	4	Thermodynamic equilibrium; definition, mechanical equilibrium; diathermic wall, thermal equilibrium, chemical equilibrium, Zeroth law of thermodynamics,	
	5	Temperature; concepts, scales, international fixed points and measurement of temperature. Constant volume gas thermometer, constant pressure gas thermometer, mercury in glass thermometer	
	6	Work and Heat: Mechanics, definition of work and its limitations. Thermodynamic definition of work; examples, sign convention.	
	7	Displacement work; as a part of a system boundary, as a whole of a system boundary,	
	8	Expressions for displacement work in various processes through p-v diagrams. Shaft work; Electrical work. Other types of work.	
	9	Heat; definition, units and sign convention	
	10	Problems.	
2	11	First Law of Thermodynamics: Joules experiments, equivalence of heat and work. Statement of the First law of thermodynamics	**40**
	12	extension of the First law to non - cyclic processes,	
	13	energy, energy as a property, modes of energy,	
	14	Extension of the First law to control volume; steady flow energy equation(SFEE), important applications.	
	15	Second Law of Thermodynamics: limitations of first law of thermodynamics	
	16	Devices converting heat to work; (a) in a thermodynamic cycle, (b) in a mechanical cycle.	
	17	Thermal reservoir, Direct heat engine; schematic representation and efficiency. Devices converting work to heat in a thermodynamic cycle; reversed heat engine,	
	18	Schematic representation, coefficients of performance. Kelvin - Planck statement of the Second law of Thermodynamics;	
	19	PMM I and PMM II, Clausius statement of Second law of Thermodynamics, Equivalence of the two statements; Carnot cycle, Carnot principles.	
	20	Problems.	

3	21	Reversibility: Definitions of a reversible process, reversible heat engine, importance and superiority of a reversible heat engine and irreversible processes;	**60**
	22	Factors that make a process irreversible, reversible heat engines.	
	23	Unresisted expansion, remarks on Carnot's engine,	
	24	Internal and external reversibility, Definition of the thermodynamic temperature scale.	
	25	Problems	
	26	Entropy: Clasius inequality,	
	27	Statement- proof, Entropy- definition, a property, change of entropy,	
	28	entropy as a quantitative test for irreversibility, principle of increase in entropy,	
	29	Calculation of entropy using Tds relations, entropy as a coordinate.	
	30	Problems	
4	31	Availability, Irreversibility and General Thermodynamic relations. Introduction, Availability (Exergy), Unavailable energy (anergy),	**80**
	32	Relation between increase in unavailable energy and increase in entropy.	
	33	Maximum work, maximum useful work for a system and control volume, irreversibility,	
	34	Second law efficiency (effectiveness). Gibbs and Helmholtz functions, Maxwell relations,	
	35	Clapeyron equation, Joule Thomson coefficient, general relations for change in entropy, enthalpy , internal energy and specific heats.	
	36	Pure Substances: P-T and P-V diagrams, triple point and critical points.	
	37	Sub-cooled liquid, saturated liquid, mixture of saturated liquid and vapor, saturated vapor and superheated vapor states of pure substance with water as example.	
	38	Enthalpy of change of phase (Latent heat).Dryness fraction (quality), T-S and H-S diagrams,	
	39	Representation of various processes on these diagrams. Steam tables and its use. Throttling calorimeter, separating and throttling calorimeter.	
	40	Problems	
5	41	Ideal gases: Ideal gas mixtures, Daltons law of partial pressures,	**100**
	42	Amagat's law of additive volumes, evaluation of properties of perfect and ideal gases,	
	43	Air- Water mixtures and related properties,	
	44	Psychrometric properties, Construction and use of Psychrometric chart.	
	45	Real gases – Introduction , Air water mixture and related properties,	
	46	Vander Waal's Equation of state, Van-der Waal's constants in terms of critical properties,	
	47	Redlich and Kwong equation of state Beattie-Bridgeman equation ,	
	48	Law of corresponding states, compressibility factor; compressibility chart.	
	49	Difference between Ideal and real gases.	
	50	Problems	

12.0 Assignments, Pop Quiz, Mini Project, Seminars

Sl.No.	Title	Outcome expected: students able to	Allied study	Week No.	Individual / Group activity	Reference: book/website /Paper
1	The seminar will be conducted on uncovered portion of the subject after the II IA and evaluated the activity.					

12.0 QUESTION BANK

Sample Questions	Questions
I	**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
II	**Module 2** 17. Describe the Joule's experiment and analyze the formulation. 18. Define and explain the first law of thermodynamics. 19. Apply the first law of thermodymics to non-cyclic processes and control volume. 20. Explain the specific heat and enthalpy and their relations. 21. Derive the SFEE and formulate the different applications of SFEE. 22. Explain what are the significance of SFEE 23. Explain PMM I 24. Solve numericals on first law of thermodynamics 25. Define and explain the different definitions of Second Law of Thermodynamics. 26. Explain thermal energy reservoir, sink 27. Explain the two statements on second law and draw similarity between them 28. Explain PMM II and differentiate between PMM-I and PMM-II. 29. Explain and differentiate reversible and irreversible processes and their factors to make different principles. 30. Define heat engine and heat pump. Explain their schematic diagram.
III	**Module 3** 31. Define the "Entropy" and explain the Classius's inequality. 32. Derive the proof of inequality statement and explain its applications. 33. Derive to show that the entropy of universe is always increasing. 34. Solve the examples by using TDS relation. 35. Explain different available and unavailable energy.
IV	**Module 4** 36. Concept of Maxwell Relation 37. Concept of Clausius Clayperson's Equations 38. 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. 39. Evaluate heat and work for different qausi-static process. 40. Explain PT and PV diagram of pure substances. 41. Define the dryness fraction and the change of phase. 42. Represent the various processes on T-S and H-S diagram. 43. Use the steam tables. 44. Explain the throttling and separating calorimeter.

V	**Module 5** 45. Derive and explain Vander Waal's Equation and also define compressibility factor. 46. Describe and use of compressibility chart. 47. Derive and Explain Dalton Law of partial pressure 48. Define Amagat's law of additive volumes, evaluation of properties, Analysis of various process.

13.0 University Result

Examination	FCD	FC	SC	% Passing
-	-	-	-	-
-	-	-	-	-

*New Scheme

Prepared by	Checked by		
Prof. Jagadeesh A.	Prof. K. M. Akkoli	HOD	Principal

17ME34- Mechanics of Materials

Subject Title	MECHANICS OF MATERIALS		
Subject Code	17ME34	CIE Marks	40
Number of Lecture Hrs / Week	05 hrs	SEE Marks	60
Total Number of Lecture Hrs	50 (10 Hours per Module)	Exam Hours	03
			CREDITS – 04

FACULTY DETAILS:		
Name: Prof. D.N.Inamdar / Prof. G. V. Chiniwalar.	**Designation:** Asst. Professor	**Experience:** 14/15
No. of times course taught: 06/06	**Specialization:** Tool Design / Machine Design	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Students should have the knowledge of basic subjects	I/II Sem & PUC	Engineering Mechanics, Trigonometry

2.0 Course Objectives

1. Classify the stresses into various categories and define elastic properties of materials and compute stress and strain intensities caused by applied loads in simple and compound sections and temperature changes.
2. Derive the equations for principal stress and maximum in-plane shear stress and calculate their magnitude and direction. Draw Mohr circle for plane stress system and interpret this circle.
3. Determine the shear force, bending moment and draw shear force and bending moment diagrams, describe behavior of beams under lateral loads.
4. Explain the structural behavior of members subjected to torque, Calculate twist and stress induced in shafts subjected to bending and torsion.
5. Understand the concept of stability and derive crippling loads for columns.
6. Understand the concept of strain energy and compute strain energy for applied loads.

3.0 Course Outcomes

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

CO	Course Outcome	Cognitive Level	POs
C304.1	Understand simple, compound, thermal stresses and strains their relations, Poisson's ratio, Hooke's law, mechanical properties including elastic constants and their relations.	L1,L2	PO1, PO2,PO3,PO4
C304.2	Determine stresses, strains and deformations in bars with varying circular and rectangular cross-sections subjected to normal and temperature loads	L1,L2 & L3	PO1, PO2,PO3,PO4
C304.3	Determine plane stress, principal stress, maximum shear stress and their orientations using analytical method and Mohr's circle	L1,L2 & L3	PO1, PO2,PO3,PO4
C304.4	Determine the dimensions of structural members including beams, bars and rods using Energy methods and also stress distribution in thick and thin cylinders	L1,L2	PO1, PO2,PO3,PO4
C304.5	Draw SFD and BMD for different beams including cantilever beams, simply supported beams and overhanging beams subjected to UDL, UVL, Point loads and couples	L1,L2 & L3	PO1, PO2,PO3,PO4
C304.6	Determine dimensions, bending stress, shear stress and its distribution in beams of circular, rectangular, symmetrical I and T sections subjected to point loads and UDL	L1,L2 & L3	PO1, PO2,PO3,PO4

C304.7	Determine the dimensions of shafts based on torsional strength, rigidity and flexibility and also elastic stability of columns using Rankin's and Euler's theory	L1,L2 & L3	PO1, PO2,PO3,PO4
Total Hours of instruction		**50**	

4.0 Course Content

Module - 1

Stress and Strain: Introduction, Hooke's law, Calculation of stresses in straight, Stepped and tapered sections, Composite sections, Stresses due to temperature change, Shear stress and strain, Lateral strain and Poisson's ratio, Generalized Hooke's law, Bulk modulus, Relationship between elastic constants. 10 hours

Module- 2

Analysis of Stress and Strain: Plane stress, Stresses on inclined planes, Principal stresses and maximum shear stress, Principal angles, Shear stresses on principal planes, Maximum shear tress, Mohr circle for plane stress conditions.
Cylinders: Thin cylinder: Hoop's stress, maximum shear stress, circumferential and longitudinal strains, Thick cylinders: Lames equations. 10 hours

Module- 3

Shear Forces and Bending Moments: Type of beams, Loads and reactions, Relationship between loads, shear forces and bending moments, Shear force and bending moments of cantilever beams, Pin support and roller supported beams subjected to concentrated loads and uniformly distributed constant / varying loads.
Stress in Beams: Pure bending, Curvature of a beam, Longitudinal strains in beams, Normal stresses in Beams with rectangular, circular, 'I' and 'T' cross sections, Flexure Formula, Bending Stresses, Deflection of beams : Columns: (Curvature). 10 hours

Module- 4

Torsion: Circular solid and hallow shafts, Torsional moment of resistance, Power transmission of straight and stepped shafts, Twist in shaft sections, Thin tubular sections, Thin walled sections
Columns: Buckling and stability, Critical load, Columns with pinned ends, Columns with other support conditions, Effective length of columns, and Secant formula for columns. 10 hours

Module- 5

Strain Energy: Castiglione's theorem I and II, Load deformation diagram, Strain energy due to normal stresses, Shear stresses, Modulus of resilience, Strain energy due to bending and torsion.
Theories of Failure: Maximum Principal stress theory, Maximum shear stress theory. 10 hours

5.0 Relevance to future subjects

Sl. No	Semester	Subject	Topics
01	VII/VIII	Project work	Fundamental concepts
	VII	Advanced Mechanical Vibration	Fundamental concepts of vibrations
02	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

Text Books
1. James M Gere, Barry J Goodno, Strength of Materials, Indian Edition, Cengage Learning, 2009.
2. R Subramanian, Strength of Materials, Oxford, 2005.
Reference Books
1. S S Rattan, Strength of Materials, Second Edition, McGraw Hill, 2011.
2. Ferdinand Beer and Russell Johston, Mechanics of materials, Tata McGraw Hill, 2003.
Additional Study material & e-Books
R.C.Hibbler, Sixth Edition, Pearson Education

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

Website and Internet Contents References
Introduction to Strength of materials: https://www.youtube.com/watch?v=GkFgysZC4Vc
Solid Mechanics: https://www.youtube.com/watch?v=A1SWKe6ZwVc
Advanced strength of Materials: https://www.youtube.com/watch?v=_2d8YsXwm7M
GATE: https://www.btechguru.com/GATE--mechanical-engineering--strength-of-materials-video-lecture--23--133.html
Video on Torsion of circular shaft: https://www.youtube.com/watch?v=ICDZ5uLGrI4
Video on Bending of beam: https://www.youtube.com/watch?v=asBW0Ojc0bY
Video on deriving bending equation: https://www.youtube.com/watch?v=AvCkrU3KaZw

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	Definition of stress and strain, Hooke's law	
	3	Calculation of stresses in straight bar	
	4	Calculation of stresses in stepped bar	
	5	Calculation of stresses 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 axially loaded members	
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	Normal stresses in beams with rectangular, I, T, C cross-sections.	
	29	Flexural Formula for beams	
	30	Deflection of beams	
Module-4	31	**TORSION:** Torsion of solid circular and hallow shafts	80 %
	32	Torsional Moment of Resistance	
	33	Power transmission of straight and stepped shafts	
	34	Twisting in shaft sections	
	35	Thin tubular and thin walled sections	
	36	**Columns :**Buckling and Stability of columns, critical load	
	37	Analysis of columns with pinned ends and other support conditions	
	38	Effective length of columns	
	39	Secant formula	
	40	Problems on columns	
Module-5	41	**Strain Energy Theory**	100%
	42	Castigliano's theorem I &II	
	43	Load deformation diagram	
	44	Strain energy due to normal stress	
	45	Strain energy due to Shear stress	
	46	Modulus of resistance	
	47	Strain energy due to Bending and Torsion	
	48	**Theories of Failures**	
	49	Maximum principal stress theory	
	50	Maximum shear stress theory	

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 questioner 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	Students study the Topics and identify components of stresses &construct Mohr's circle for the given plane stress system.	Module-2 of the syllabus	4	Individual Activity.	Book 1, 2 of the reference list. Website of the Reference 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	Book 1, 2 of the reference list. Website of the Reference list
4	Assignment 4: University Questions on Torsion and Columns	Students study the Topics and derive the torsion equation.	Module-4of the syllabus	8	Individual Activity	Book 1, 2 of the reference list. Website of the Reference list
5	Assignment 4: University Questions on Theories of Failure:	Students study the Topics and explain different theories of failures.	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 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 toown weight.

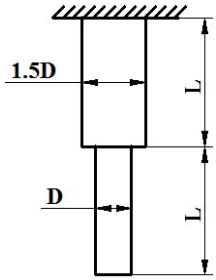
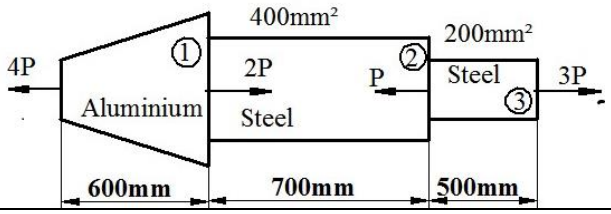


Figure 1

16. 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

17. 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.



18. 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^{5}N/mm^2.

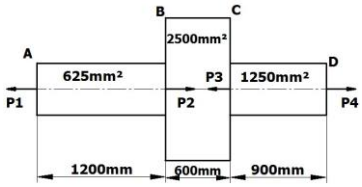


Figure 3

19. 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.

20. 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)

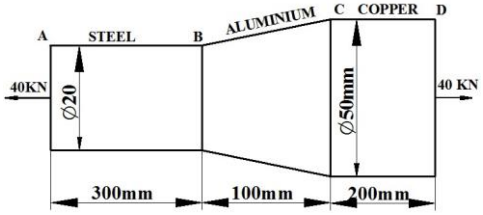


Figure 4

21. 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 $\mu=0.3$.
22. 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.

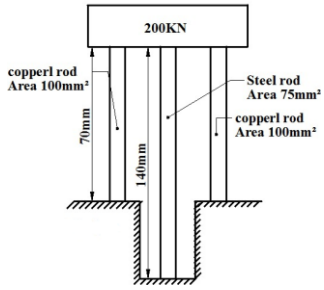


Figure 5

23. 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.
24. 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.
25. Establish the relationship between Modulus of elasticity and Modulus of rigidity
26. Establish the relationship between Modulus of elasticity and Bulk modulus
27. state the concept of shear stress and shear strain
28. 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 $\epsilon_v = \frac{P}{AE}\left(1-\frac{2}{m}\right)$,where E is the young's modulus &1/m is the poisson's ratio.
29. 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.
30. 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, $\alpha_s=1.2x10^{-5}$/°C ,$\alpha_c=1.8x10^{-5}$/°C.

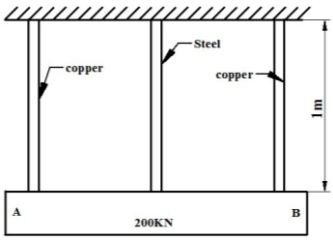


Figure 6

31. 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 $\alpha_s=12x10^{-6}$/°C $\alpha_c=17x10^{-6}$/°C
32. 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 $\alpha_s=1.2x10^{-5}$/°C, $\alpha c=1.75x10^{-5}$/°C, $E_s=2.1x10^5$ N/mm^2,$E_c=1.05x10^5$ N/mm^2
33. 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

34. 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

35. 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.

36. 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

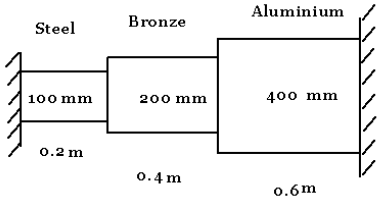


Figure 7

37. 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.

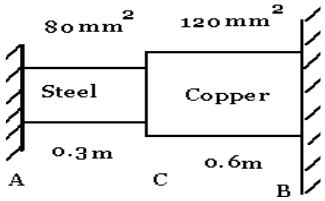


Figure 8

38. 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.

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,

   $\sigma_n = \left(\frac{\sigma_x+\sigma_y}{2}\right) + \left(\frac{\sigma_x-\sigma_y}{2}\right) cos2\theta$ & $\tau = \left(\frac{\sigma_x-\sigma_y}{2}\right)$sin2$\theta$.

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.

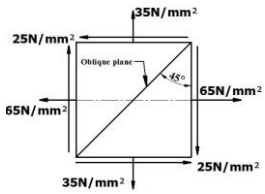


Figure 9

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

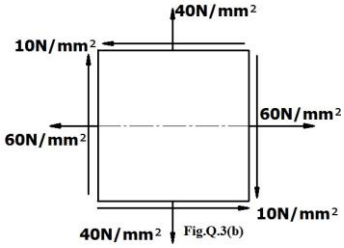


Figure 10

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)

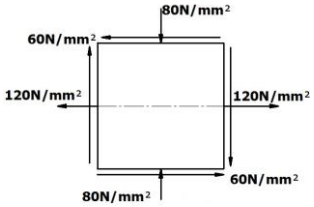


Figure 11

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

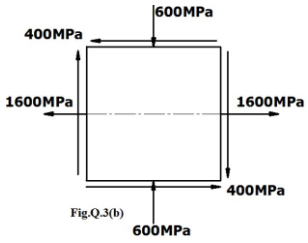


Figure 12

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.

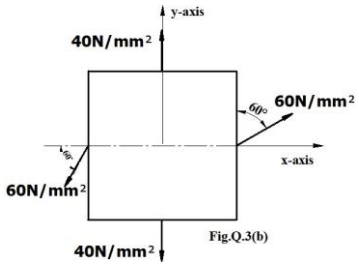


Figure 13

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

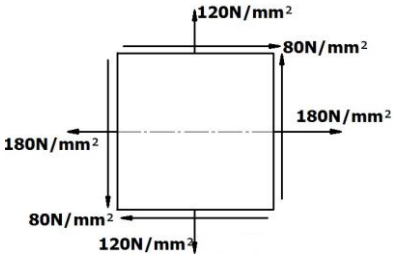


Figure 14

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.

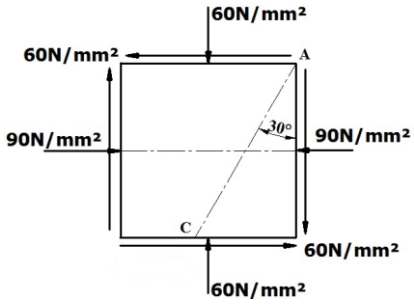


Figure15

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

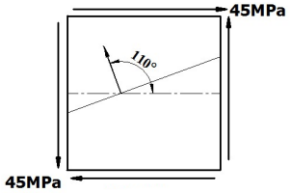


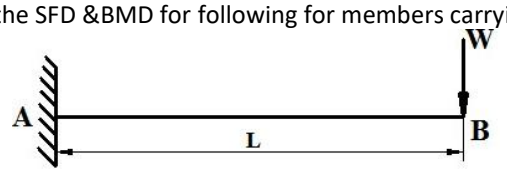
Figure 16

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$(5-4\mu)$, 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.

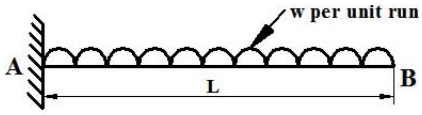
31. A pipe of 200mm internal diameter and 100mm thickness contains a fluid at a pressure of 6N/mm^2.Find the maximum and minimum hoop stresses across the section.
32. Find the thickness of the metal necessary for a steel cylindrical shell of internal diameter 150mm ton with stand an internal pressure 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 3: Shear Forces and Bending Moments: Stress in Beams: Deflection of beams:

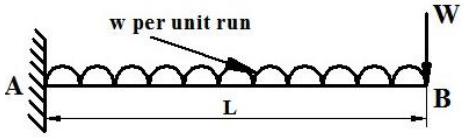
1. What are different types of beams? Explain briefly
2. What are different types of loads
3. Briefly explain different types of beam supports
4. Establish relationship between distriuted load, shear force and bending moment at a cross section of a beam
5. Define i)Shear force ii) Bending moment and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



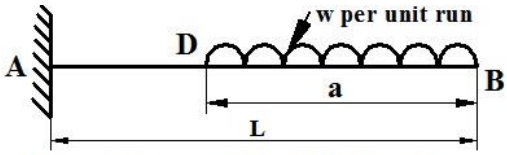
A cantilever of length L carrying a concentraed load w at free end



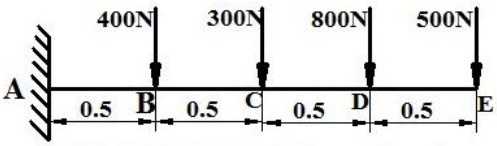
A cantilever of length L carrying a uniformly distributed load w per unit length over the whole length.



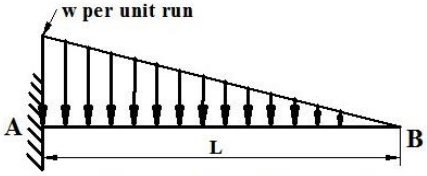
A cantilever of length L carrying a uniformly distributed load w per unit length over the whole length and acomcentrated load W at free end.



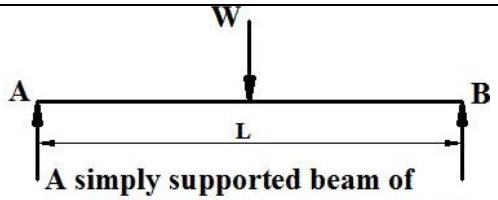
A cantilever of length L carrying a uniformly distributed load w per unit length for a distance 'a' from the free end.



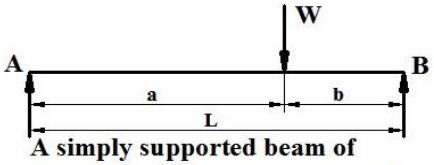
A cantilever carrying several concentraed loads.



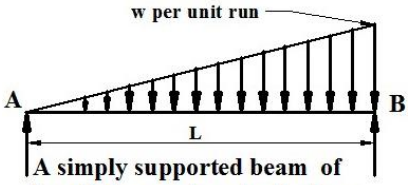
A cantilever of length L carrying a load whose intensity varies uniformly from zero at free end to w per unit run at fixed end.



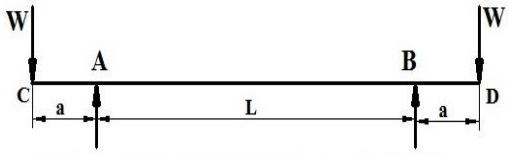
A simply supported beam of length L carrying a concentraed load w at mid span.



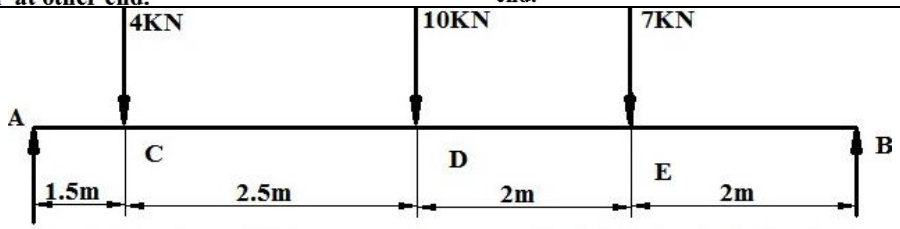
A simply supported beam of length L carrying a concentraed load w placed eccentrically on the span.



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.

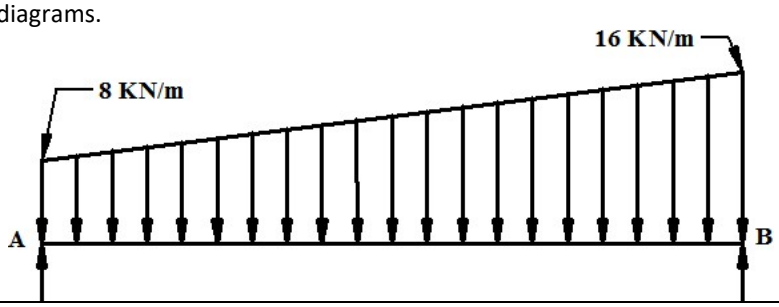


A beam of length (L+2a) has supports 'L' aparts with an overhang 'a' on each side. the beam carries a concentraed load w at each end.



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***

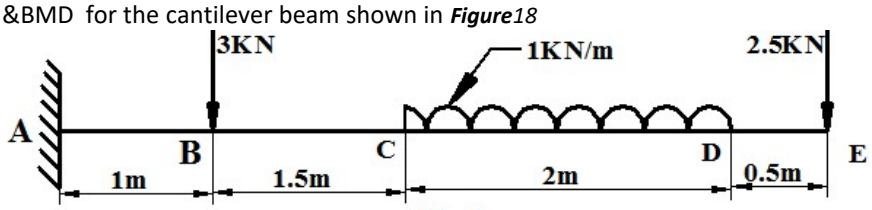


Figure18

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

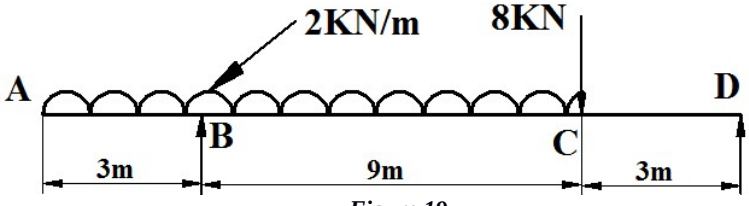


Figure 19

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

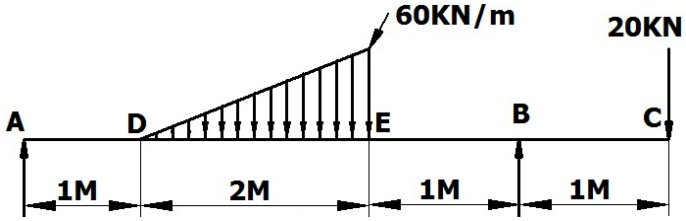


***Figure** 20*

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

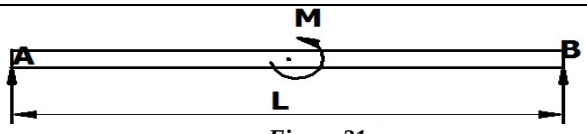


Figure 21

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

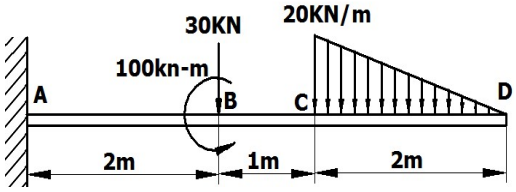


Figure 22

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

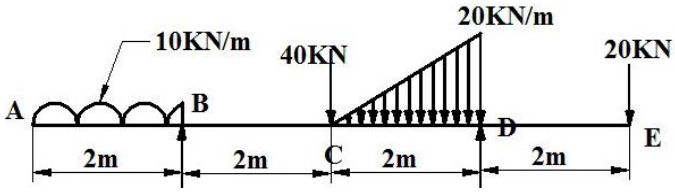


Figure 23

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

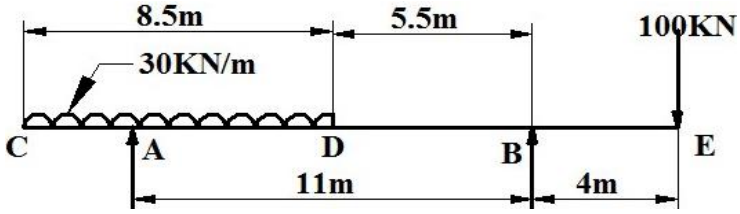


Figure 24

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

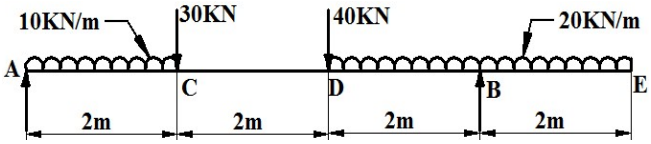


Figure 25

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

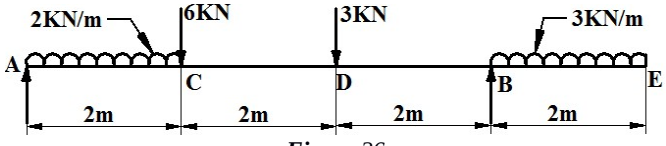


Figure 26

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

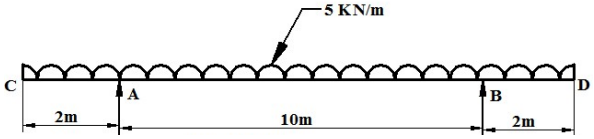


Figure 27

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

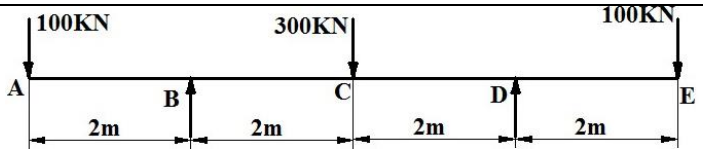


Figure 28

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

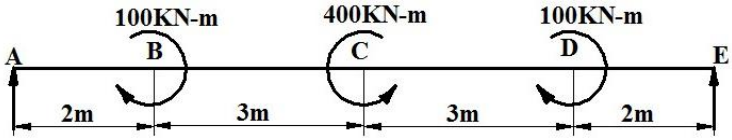


Figure *29*

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. A 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***).

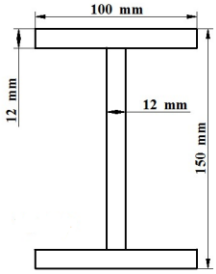


Figure 30

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.

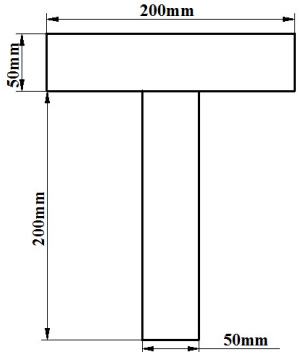


Figure 31

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

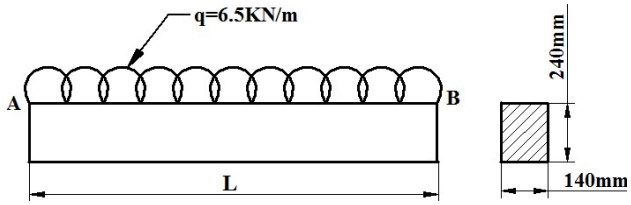


***Figure** 32*

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

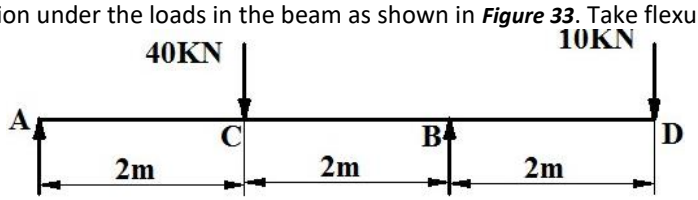


***Figure** 33*

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

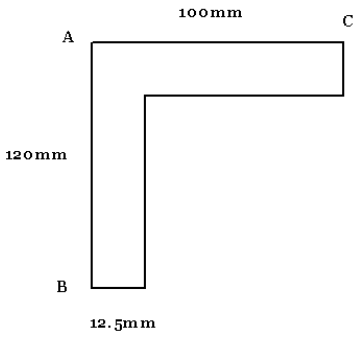


Figure 34

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.

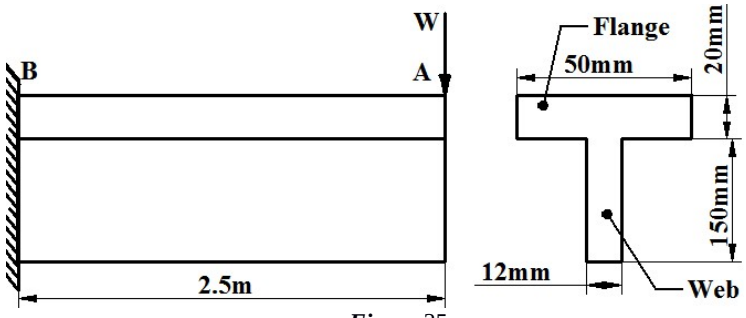


***Figure** 35*

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.

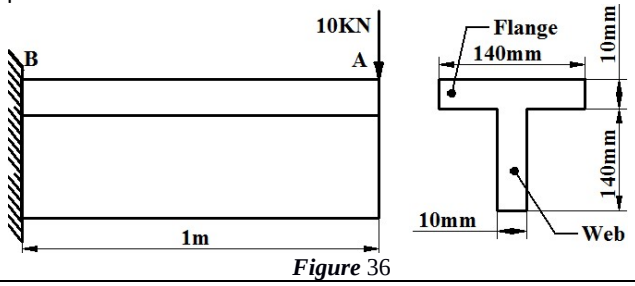


***Figure** 36*

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.

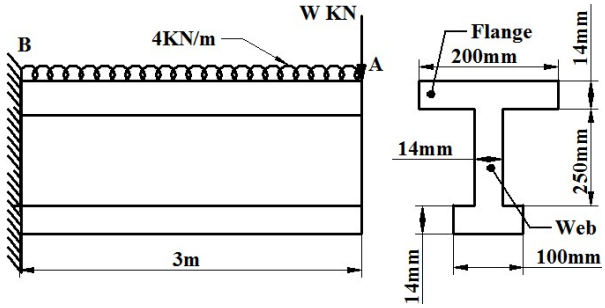


Figure 37

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.

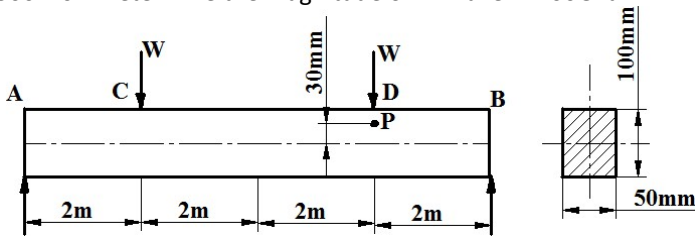


Figure 38

DEFLECTION OF BEAMS:

1. Explain how deflection can be reduced.
2. Derive an expression $EI\frac{d^2y}{dx^2}$= M, with usual notations.
3. For the beam loaded as shown in ***Figure 39***, find the position and magnitude of maximum deflection. Take $E=200x10^6$ N/mm^2 and $I=4.3x10^8$ mm^4.

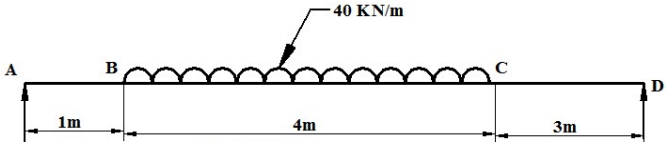


Figure 39

4. Determine the deflection at points C, D, & E in the beam shown in ***Figure 40***. Take $E=200x10^6$ N/mm^2 and $I=60x10^6$ mm^4.

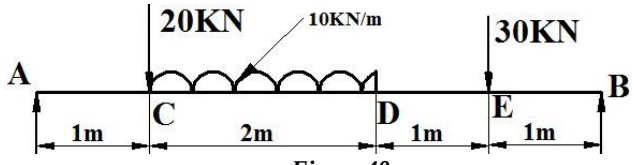


Figure 40

5. A beam of length 5m and of uniform rectangular section is simply supported at its ends. It carries a uniformly distributed load of 9KN/m run over the entire length. Calculate the width and depth of the beam if permissible bending stress is 7N/mm^2 and central deflection is not to exceed 1cm. Take E for beam material = 1×10^4 N/mm^2.
6. Find the expressions for the slope and deflection of a cantilever of length L carrying uniformly distributed load over the whole length.
7. A horizontal girder of steel having uniform section is 14mm long and is simply supported at its ends. It carries concentrated loads of 120KN and 80KN at two points 3m and 4.5m from the two ends respectively. 'I' for the section of the girder is 16×10^8 mm^4 and E= 210KN/mm^2. Calculate the deflections of the girder at points under the two loads. Also find the maximum deflection.
8. A beam of length 6m is simply supported at its ends and carries two points load of 40KN at a distance of 1m and 3m respectively from the left support. By using Macaulay's method , determine (i) Deflection under each load (ii)Maximum deflection (iii)the point at which the maximum deflection occurs .Given E=2x105N/mm^2 and I

=85x10^{6}mm^4

9. A steel grinder of 6m length acting as a beam carries a uniformly distributed load w N/m runs throughout its length as shown in ***Figure 41***. If I=30x10^{-6} m^4 and depth 270mm. Calculate i) Magnitude if "w" so that the maximum stress developed in the beam section does not exceed 72 MN/m^2 ii)The slope and the deflection in the beam at s distance of 1.8m from one end .Take E=200GN/m^2(June/July 09)

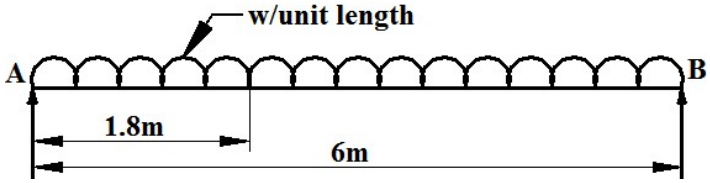


Figure 41

10. A cantilever of square section 200mmx200mm, 2m long just fails in flexure when a load of 12KN is placed at its free end. A beam of same material and having rectangular cross section 150mm wide and 300mm deep is simply supported over a span of 3m.Calculate the minimum central concentrated load required to break the beam(Dec 08/Jan 09)

11. A beam AB of span 6m is simply supported at the ends and is loaded as shown in ***Figure 42***.
    Determine:
    i) deflection at 'C'
    ii) mxximum deflection
    iii) Slope at the end A.
    Take N/mm^{2}E=2x105,I=2x107mm^4

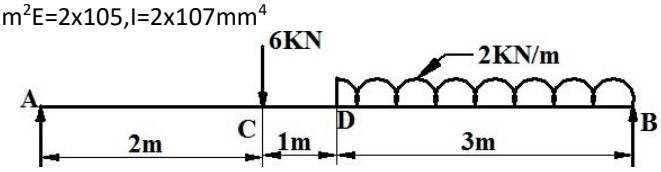


Figure 42

12. A beam of length 4m is simply supported at the ends and carries two concentrated loads of 20 KN and 30KN at a distance 1.5m and 2.5m from left end. Refer below ***Figure 43.*** Find the deflection at mid span. Take E=200GPa and moment of inertia I=3x10^{8}mm^4 of the cross section (June/July 08)

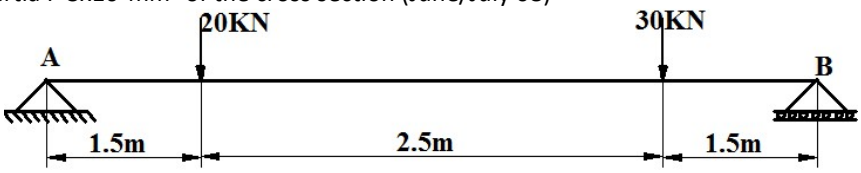


Figure 43

13. A cantilever is subjected to the forces as shown in ***Figure 44***. Determine the deflection at the free end. Taking the flexural rigidity for the beam to be 80x10^4 KN-m^2.

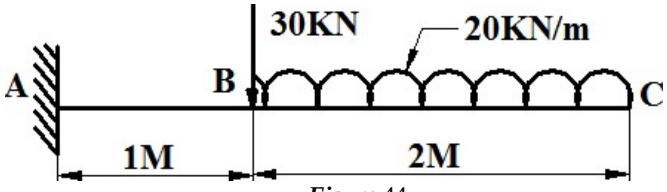


Figure 44

14. A cantilever is subjected to the point load as shown in the ***Figure 45***. Determine the deflection at point A and C

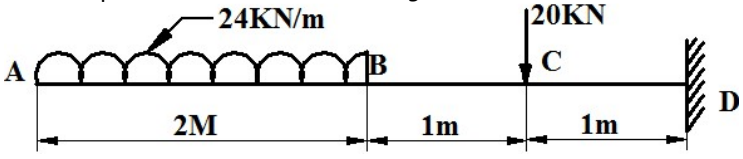


Figure 45

15. A cantilever is subjected to the forces as shown in the ***Figure 46***. Determine deflection and slope at a point which is at a distance of 3m from the free end.

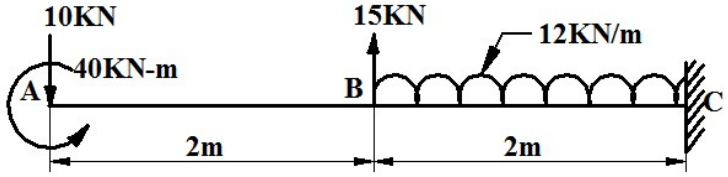


Figure 46

MODULE 4: TORSION&COLUMNS:

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. 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.
7. Define slenderness ratio and derive Euler's expression for bucking load for column with both ends hinged
8. Define slenderness ratio and derive Euler's expression for buckling load for column with both ends hinged.
9. Derive an expression for the critical load in a column subjected to compressive load, when one is fixed and the other end free.
10. 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.
11. 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.
12. 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.
13. 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
14. 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
15. 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
16. 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
17. 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.
18. 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
19. A 2 meters long hollow cylinder shaft has 80mm outer diameter and 10mm wall thickness. When the tensional 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)
20. 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)
21. Derive an expression for the critical load in a column subjected to compression load, when one end is fixed and the other end free.
22. Derive an expression for the critical load in a column subjected to compression load, when one end is fixed and the other end free.

Module 5: Strain Energy &Theories of Failure.	
1.	Derive an expression for strain energy due to shear stresses
2.	Write a note on: (i) Maximum principal stress theory. (ii) Maximum shear stress theory
3.	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.
4.	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.
5.	Define the theories of failures and explain Maximum principal stress theory
6.	A rod of circular section is to sustain torsion of 300KN-m & bending moment of 200KN-m. selecting C40 steel(σ_y=353MPa) & FOS = 3. Determine the diameter of rod as per (i) Maximum principal stress theory. (ii) Maximum shear stress theory.
7.	Derive one expression for strain energy stored in an elastic bar when subjected to axial load, torque and bending moment.
8.	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.
9.	A plate of C45 steel (σ_y=353MPa) is subjected to the following stresses. σ_x= 150 N/mm^2 τ_{xy}= 50 N/mm^2. Find FOS by (i) Maximum principal stress theory. (ii) Maximum shear stress theory
10.	Define strain energy, Resilience, proof resilience and Modulus of resilience.
11.	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	S$^+$ / S/ A	B	C/D/E	F	% Passing
Dec-16/Jan-17(A)	00	1	26	46	37.00%
Dec-16/Jan-17(B)	00	02	25	44	38.00%
Dec-17/Jan-18(B)	05	12	23	21	66.66%

Prepared by	Checked by		
Prof. G. V. Chiniwalar	Prof. D.N.Inamdar	HOD	Principal

17ME35A- Metal Casting and Welding

Subject Title	Metal Casting and Welding		
Subject Code	17ME35A	**IA Marks**	40
No of Lecture Hrs + Practical Hrs / Week	04	**Exam Marks**	60
Total No of Lecture + Practical Hrs	50	**Exam Hours**	03
CREDITS – 04			

FACULTY DETAILS:		
Name: Prof. S.R. Kulkarni	**Designation:** Asst. Professor	**Experience:11** Years
No. of times course taught: 06	**Specialization:** Production Management	

1.0 Prerequisite Subjects:

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

2.0 Course Objectives

- To provide detailed information about the molding processes.
- To provide knowledge of various casting process in manufacturing.
- To impart knowledge of various joining process used in manufacturing.
- To provide adequate knowledge of quality test methods conducted on welded and casted components.

3.0 Course Outcomes

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

CO	Course Outcome	Cognitive Level	POs
C205.1	Classify manufacturing process and elaborate the parts of casting process.	U	1,6,12
C205.2	Summarize the different casting process and select the melting furnace based on ferrous and non-ferrous alloys.	U	1,6,12
C205.3	Know the solidification, gasification, casting defects and different methods of directional solidification.	U	1,2,5,6,12
C205.4	List and explain different types of conventional welding processes.	U	1,2,3,6,12
C205.5	Explain different special types of welding, soldering, brazing and NDT.	U	1,2,3,5,6,12
Total Hours of instruction		**50**	

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. 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 mold, shell mold, investment mold, plaster mold, cement bonded mold. Cores: Definition, need, types. Method of making cores, concept of gating (top, bottom, parting line, horn gate) and risering (open, blind) Functions and types. **10 Hours**

MODULE -2

MELTING & 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.**10 Hours**

MODULE -3

SOLIDIFICATION & NON FERROUS FOUNDRY PRACTICE

Solidification: Definition, Nucleation, solidification variables, Directional solidification-need and methods. Degasification in liquid metals-Sources of gas, degasification methods.

Fettling and cleaning of castings: Basic steps involved. Sand Casting defects- causes, features and remedies. Advantages & limitations of casting process

Nonferrous foundry practice: Aluminum castings - Advantages, limitations, melting of aluminum using lift-out type crucible furnace. Hardeners used, drossing, gas absorption, fluxing and flushing, grain refining, pouring temperature. Stir casting set up, procedure, uses, advantages and limitations.**10 Hours**

MODULE -4

WELDING PROCESS

Welding process: Definition, Principles, Classification, Application, Advantages & limitations of welding. Arc welding: Principle, Metal arc welding (MAW), Flux Shielded Metal Arc Welding (FSMAW), Inert Gas Welding (TIG & MIG) Submerged Arc Welding (SAW) and Atomic Hydrogen Welding (AHW).

Special type of welding: Resistance welding principles, Seam welding, Butt welding, Spot welding and Projection welding. Friction welding, Explosive welding, Thermit welding, Laser welding and electron beam welding.**10 Hours**

MODULE -5

SOLDERING, BRAZING AND METALLURGICAL ASPECTS IN WELDING

Structure of welds, Formation of different zones during welding, Heat Affected Zone (HAZ), Parameters affecting HAZ , Effect of carbon content on structure and properties of steel, Shrinkage in welds& Residual stresses, Concept of electrodes, filler rod and fluxes. Welding defects- Detection, causes & remedy.

Soldering, brazing, gas welding: Soldering, Brazing, Gas Welding: Principle, oxy-Acetylene welding, oxy-hydrogen welding, air-acetylene welding, Gas cutting, powder cutting.

Inspection methods: Methods used for inspection of casting and welding. Visual, magnetic particle, fluorescent particle, ultrasonic, Radiography, eddy current, holography methods of inspection.**10 Hours**

5.0 Relevance to future subjects/Area

SL. No	Semester	Subject	Topics / Relevance
01	V	Non Traditional Machining	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

7.0 Books Used and Recommended to Students

Text Books
1. "Manufacturing Process-I", Dr.K.Radhakrishna, Sapna Book House, 5th Revised Edition 2009.
2. "Manufacturing & Technology: Foundry Forming and Welding", P.N.Rao, 3rd Ed., Tata McGraw Hill, 2003.
Reference Books
1. "Process and Materials of Manufacturing", Roy A Lindberg, 4th Ed.Pearson Edu. 2006.

2. "Manufacturing Technology", SeropeKalpakjian, Steuen. R. Sechmid, Pearson Education Asia, 5th Ed. 2006.
3. "Principles of metal casting", Rechard W. Heine, Carl R. LoperJr., Philip C. Rosenthal, Tata McGraw Hill Education Private Limited Ed.1976.

Additional Study Material & e-Books

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

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

Website and Internet Contents References
http://www.nptel.ac.in
http://me.emu.edu.tr/me364/2.pdf
http://www.weldingtypes.net/

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

10.0 Examination Note

- The question paper will have ten questions.
- Each full question consisting of 16 marks.
- There will be 2 full questions (with a maximum of 4 sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

11.0 Course Delivery Plan

Module	Lecture No.	Content of Lecturer	% of Portion
1	51	Definition, Classification of manufacturing processes. Metals cast in the foundry-classification	20%
	52	Factors that determine the selection of a casting alloy. Introduction to casting process & steps involved.	
	53	Patterns: Definition, classification, materials used for pattern, various pattern allowances and their importance.	
	54	Sand molding: Types of base sand, requirement of base sand. Binder, Additives definition, need and types.	
	55	Preparation of sand molds: Molding machines- Jolt type, squeeze type and Sand slinger.	
	56	Study of important molding process: Green sand, core sand,	
	57	Dry sand, sweep mold, CO2 mold, shell mold, investment mold, plaster mold, cement bonded mold..	
	58	Cores: Definition, need, types. Method of making cores,	
	59	concept of gating (top, bottom, parting line, horn gate)	
	60	Risering (open, blind) Functions and types	
2	61	Melting furnaces: Classification of furnaces,	40%

	62	Gas fired pit furnace, Resistance furnace,	
	63	Coreless induction furnace, electric arc furnace,	
	64	Constructional features & working principle of cupola furnace.	
	65	Casting using metal molds: Gravity die casting,	
	66	Pressure die casting,	
	67	Centrifugal casting,	
	68	Squeeze casting,	
	69	Slush casting,	
	70	Thixocasting, continuous casting processes	
3	71	Solidification: Definition, Nucleation, solidification variables,	60%
	72	Directional solidification-need and methods. Degasification in liquid metals-Sources of gas, degasification methods	
	73	Fettling and cleaning of castings: Basic steps involved.	
	74	Sand Casting defects- causes, features and remedies	
	75	Advantages & limitations of casting process	
	76	Nonferrous foundry practice: Aluminum castings - Advantages, limitations,	
	77	Melting of aluminum using lift-out type crucible furnace.	
	78	Hardeners used, drossing, gas absorption,	
	79	Fluxing and flushing, grain refining, pouring temperature.	
	80	Stir casting set up, procedure, uses, advantages and limitations	
4	81	Welding process: Definition, Principles, Classification,	80%
	82	Application, Advantages & limitations of welding. Arc welding:	
	83	Principle, Metal arc welding (MAW), Flux Shielded Metal Arc Welding (FSMAW),	
	84	Inert Gas Welding (TIG & MIG)	
	85	Submerged Arc Welding (SAW) and Atomic Hydrogen Welding (AHW).	
	86	Special type of welding: Resistance welding principles,	
	87	Seam welding, Butt welding,	
	88	Spot welding and Projection welding.	
	89	Friction welding, Explosive welding,	
	90	Thermit welding, Laser welding and electron beam welding.	
5	91	Soldering, Brazing And Metallurgical Aspects In Welding Structure of welds, Formation of different zones during welding,	100%
	92	Heat Affected Zone (HAZ), Parameters affecting HAZ.	
	93	Effect of carbon content on structure and properties of steel, Shrinkage in welds& Residual stresses.	
	94	Concept of electrodes, filler rod and fluxes.	
	95	Welding defects- Detection, causes & remedy	
	96	Soldering, brazing, gas welding: Soldering, Brazing,	
	97	Gas Welding: Principle, oxy-Acetylene welding, oxy-hydrogen welding, air-acetylene welding, Gas cutting, powder cutting.	
	98	Inspection methods: Methods used for inspection of casting and welding.	
	99	Visual, magnetic particle, fluorescent particle,	
	100	ultrasonic, Radiography, eddy current, holography methods of inspection	

12.0 Assignments, Pop Quiz, Mini Project, Seminars

Sl.No.	Title	Outcome expected: students able to	Allied study	Week No.	Individual / Group activity	Reference: book/website /Paper
1	Assignments will be given at the end of the each module covering all the important and (un)covered portions.					

12.0 QUESTION BANK

Sample Questions	Questions
1	**MODULE 1** 1. Define casting. Enumerate different steps involved in producing a component by casting process. 2. Mention the advantages of casting in comparison with other manufacturing processes. 3. Explain the terms pattern, core, mould and casting in casting process. 4. With neat sketches explain different types of patterns and mention their applications 5. Define a pattern. Differentiate between a casting and pattern. 6. What are the common materials used for pattern making? Discuss their relative merits and demerits. 7. What are the factors which govern the selection of a proper material for pattern making? 8. Enumerate and briefly explain various pattern allowances. 9. Define a pattern. Differentiate between a casting and pattern. 10. What are the common materials used for pattern making? Discuss their relative merits and demerits. 11. What are the factors which govern the selection of a proper material for pattern making? 12. Enumerate and briefly explain various pattern allowances. 13. Explain match plate pattern with sketch. 14. Write explanatory note on no bake sands. 15. Sketch and exlain sand slinger machine. 16. With neat sketch explain shell moulding process. 17. Draw gating system and show all the elements. 18. Explain cement bonded mould 19. Explain method of making core 20. Discuss functions and types of gating system.
2	**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. With a sketch explain the operation of a high frequency induction furnace. 4. What are the differences between core type and coreless type induction furnaces? 5. With a neat sketch explain the operation of an indirect arc furnace. How does it differ from a direct arc furnace? 6. With a neat sketch explain the operation of cupola furnace. 7. Draw the neat sketch of a cupola showing the constructional details. Mark the different zones clearly and discuss the importance of each zone. 8. Draw a simple sketch and write a brief note on cupola charge. 9. Write the different reactions taking place in various zones of a cupola. 10. With neat sketch explain constructional and working features of electrical resistance furnace.
3	**MODULE 3** 1. Define solidification process; explain with sketches solidification of pure metals. 2. Explain nucleation – homogeneous nucleation, heterogeneous nucleation. 3. What is degassing, explain the need. 4. What are the methods for degassing? 5. Explain sources of degassing in liquid metals. 6. What is fettling & explain basic steps involved in cleaning of casting? 7. Explain aluminum casting. 8. How casting defects are are classified? 9. Explain the advantages and disadvantages of aluminum castings. 10. Explain drossing gas absorption.

4	**MODULE 4** 1. What is the working principle of arc welding? 2. Explain clearly the functions of flux in welding 3. Explain straight polarity and reverse polarity 4. Write a note on the classification of electrodes 5. Write a brief note on weld pattern used in arc welding 6. Explain with a neat sketch submerged arc welding process, mentioning its advantages and limitations. 7. Explain with a neat sketch flux-cored arc welding process, and bring out its advantages and limitations. 8. What is inert gas welding? Explain with a neat sketch the TIG welding process. Mention its advantages and limitations. 9. How is the MIG welding different from the TIG welding? Explain. 10. Briefly explain the atomic hydrogen welding process. 11. With a neat sketch explain the principle, process and applications of plasma arc welding process. 12. Differentiate between soldering and brazing.
5	**MODULE 5** 1. Define weld ability. Classify different welding tests. 2. What is weld ability? How is it assessed? Explain. 3. Briefly explain the factors that affect the weld ability of materials. 4. Draw a neat sketch to show the various regions (zones) of a welded joint, along with the grain structure. 5. With a neat sketch explain the metallurgical aspects of welding highlighting changes in the structure of the weld at different zones. 6. What process of welding would you recommend for welding (i) cast iron, (ii) steel 7. With a neat sketch explain the solidification of the weld and the resulting structure of the low carbon steel. 8. Write notes on: (i) solidification of the weld. (ii) HAZ in the weld 9. What is NDT? Give a brief classification of NDT methods. 10. With a neat sketch explain the various steps involved in the liquid dye penetrant testing of components & list the advantages and applications. 11. With a neat sketch explain the x-ray radiographic inspection method. Also list its advantages and disadvantages? 12. Briefly explain x-ray radiographic technique of non-destructive testing. 13. With a neat sketch explain the ultrasonic inspection for castings. Also list its advantages, disadvantages and applications. 14. With a neat sketch explain the magnetic inspection method. What are its advantages and disadvantages? 15. With a neat sketch explain the eddy current inspection method. What are its limitations and applications? 16. With a neat sketch explain the holographic inspection method. What are the applications?

13.0 University Result

Examination	FCD	FC	SC	% Passing
2017/18	13	17	29	90.77
2016/17	27	14	26	95.89

Prepared by	Checked by		
Prof. S. R. Kulkarni	Prof. G A Naik	HOD	Principal

17ME36A- Computer Aided Machine Drawing

Subject Title	COMPUTER AIDED MACHINE DRAWING		
Subject Code	17ME36A	IA Marks	40
Number of Lecture Hrs / Week	05	Exam Marks	60
Total Number of Lecture Hrs	50	Exam Hours	03
		CREDITS – 04	

FACULTY DETAILS:		
Name: Prof.Mahantesh Tanodi	**Designation:** Asst.Professor	**Experience:**06
No. of times course taught: 07	**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

1. To acquire the knowledge of CAD software and itsfeatures.
2. To inculcate understanding of the theory of projection and make drawings using orthographic projections and sectionalviews
3. To familiarize the students with Indian Standards on drawing practices.
4. To impart knowledge of thread forms, fasteners, keys, joints andcouplings.
5. To make the students understand and interpret drawings of machine components so as to prepare assembly drawings either manually and using CADpackages.
6. To acquire the knowledge of limits fits and tolerance pertaining to machine drawings.

3.0 Course Outcomes

Having successfully completed this course, the student will be able to draw and use modeling software's to generate

CO	Description
C206A.1	Have hands on experience on mechanical modeling software.
C206A.2	Draw true shape of sections of polyhedrons.
C206A.3	Visualize and draw orthographic views of simple machine components.
C206A.4	Understand and draw various thread forms.
C206A.5	Understand and draw orthographic views of assembly of fasteners as per BIS.
C206A.6	Understand and draw orthographic views of various riveted joints, cotter/knuckle joints and couplings as per BIS.
C206A.7	Visualize and prepare models of given detailed parts of machine component and its assembly with bill of materials and specifications.

4.0 Course Content

PART A

INTRODUCTION TO COMPUTER AIDED SKETCHING

Review of graphic interface of the software. Review of basic sketching commands and navigational commands. **(2 Hours)**

Sections of Solids: Sections of Pyramids, Prisms, Cubes, Tetrahedrons, Cones and Cylinders resting only on their bases (No problemson, axis inclinations, spheres and hollow solids), True shape of section. **(4 Hours)**

Orthographic views: Conversion of pictorial views into orthographic projections of simple machine parts with or without section.(Bureau of Indian Standards conventions are to be followed for the drawings), Hidden line conventions, Precedence of lines. **(4 Hours)**

Thread forms: Thread terminology, sectional views of threads. ISO Metric (Internal & External), BSW (Internal and External),square, Acme and Sellers thread, American Standard thread.
Fasteners: Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly) simpleassembly using stud bolts with nut and lock nut. Flanged nut, slotted nut, taper and split pin for locking, counter sunk head screw, grubscrew, Allen screw. **(8 Hours)**

PART B

Keys and Joints: Parallel, Taper, Feather Key, Gib head key and Woodruff key
Riveted joints: Single and double riveted lap joints, Butt joints with single/double cover straps (Chain and zigzag using snap head riveters).
Joints: Cotter joint (socket and spigot), Knuckle joint (pin joint) for two rods. **(8 Hours)**

Couplings: Split muff coupling, Protected type flange coupling, Pin (bush) type flexible coupling, Oldham's coupling and Universal coupling (Hook's Joint). **(6 Hours)**

PART C

Limits, Fits and Tolerances: Introduction, Fundamental tolerances, Deviations, Methods of placing limit dimensions, Types of fits with symbols and applications, Geometrical tolerances on drawings, Standards followed in industry. **(3 Hours)**

Assembly Drawings: (Part drawings shall be given)
1. Plummer block (Pedestal Bearing)
2. Rams Bottom Safety Valve
3. I.C. Engine connecting rod
4. Screw jack (Bottle type)
5. Tailstock of lathe
6. Machine vice
7. Lathe square tool post **(15 Hours)**

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

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. 'A Primer on Computer Aided Machine Drawing-2007', Published by VTU, Belgaum. 2. 'Machine Drawing', N.D.Bhat&V.M.Panchal, Published by Charotar Publishing House, 1999. 3. 'Machine Drawing', N.Siddeshwar, P.Kannaih, V.V.S. Sastri, published by Tata Mc.Grawhill, 2006.
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. "Machine Drawing", K.L.Narayana, P.Kannaiah and K. Venkata Reddy, 3rd Edition, New Age Publishers, 2007. 2. "Machine Drawing", N D Bhatt, 44th Edition, Charotar Publishers, 2009. 3. "Machine Drawing", Dhawan, S.Chand Publications, 2005. 4. "Machine Drawing" ,P.S.Gill, S.Chand Publications, 2005.

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

Website and Internet Contents References
https://hareeshang.wordpress.com/tutorials/camd/ http://m.noteboy.in/vtuflies/machine%20drawing.pdf https://www.edx.org/school/iitbombayx?utm_source=bing&utm_medium=cpc&utm_term=iit-bombay&utm_campaign=partner-iit-bombay http://www.vlab.co.in/

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

11.0 Examination Note

Internal Assessment: 20 Marks
Sketches shall be in sketch books and drawing shall through use of software on A3/A4 sheets. Sketch book and all the drawing printouts shall be submitted.

Scheme of Evaluation for Internal Assessment (40 Marks)
(a) Class work (Sketching and Computer Aided Machine drawing printouts in A4/A3 size sheets): 20 Marks.
(b) Internal Assessment test in the same pattern as that of the main examination: 20 marks.

Scheme of Examination:
Two questions to be set from each Part A, part B and Part C.
Student has to answer one question each from Part A, Part B for 25 marks each and one question from Part C for 50 marks.
Part A 1 x 25 = 25 Marks
Part B 1 x 25 = 25 Marks
Part C 1 x 50 = 50 Marks
Total = 100 Marks

INSTRUCTION FOR COMPUTER AIDED MACHINE DRAWING (15ME36A/46A) EXAMINATION
1. No restriction of timing for sketching/ computerization of solutions. The total duration is 3 hours.
2. It is desirable to do sketching of all the solutions before computerization.
3. Drawing instruments may be used for sketching.
4. For Part A and Part B, 2D drafting environment should be used.
5. For Part C 3D part environment should be used for parts assembly drawing and extract 2D views.

12.0 Course Delivery Plan

Module	Lecture No.	Content of Lecturer	% of Portion
		PART - A	
MODULE 1	1	**INTRUDUCTION TO COMPUTER AIDED SKETCHING:** Review of graphic interface of the software. Review of basic sketching commands and navigational commands.	3.84%
	2	Starting a new drawing sheet. Sheet sizes. Naming a drawing, Drawing units, grid and snap.	
	3	**Sections of Solids:** Sections of Pyramids, Prisms, Cubes, Tetrahedrons, Cones and Cylinders resting only on their bases (No problems on, axis inclinations, spheres and hollow solids). True shape of sections	15.38%
	4		
	5		
	6		
	7	**Orthographic Views:** Conversion of pictorial views into orthographic projections. of**simple machine parts** with or without section. (Bureau of Indian Standards conventions are to be followed for the drawings) Hidden line conventions. Precedence of lines.	
	8		
	9		
	10		
MODULE 2	11	**Thread Forms:** Thread terminology, sectional views of threads. ISO Metric (Internal & External) BSW (Internal & External) square and Acme. Sellers thread, American Standard thread.	15.38%
	12		
	13		
	14		
	15	**Fasteners:** Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly) simple assembly using stud bolts with nut and lock nut. Flanged nut, slotted nut, taper and split pin for locking, counter sunk head screw, grub screw, Allen screw.	
	16		
	17		
	18		
		PART – B	
MODULE 3	19	**Keys & Joints :** Parallel key, Taper key, Feather key, Gibhead key and Woodruff key	15.38%
	20		
	21		
	22		
	23	**Riveted Joints:** Single and double riveted lap joints, butt joints with single/double cover straps (Chain and Zigzag, using snap head rivets). Cotter joint (socket and spigot), knuckle joint (pin joint) for two rods.	
	24		
	25		
	26		
MODULE 4	27	**Couplings:** Split Muff coupling, Protected type flanged coupling, pin (bush) type flexible coupling, Oldham's coupling and universal coupling (Hooks' Joint)	15.38%
	28		
	29		
	30		
	31		
	32		
	33		

	34		
		PART-C	
MODULE 5	35	**Limits, Fits and Tolerances**: Introduction, Fundamental tolerances, Deviations, Methods of placing limit dimensions, Types of fits with symbols and applications, Geometrical tolerances on drawings, Standards followed in industry	34.61%
	36		
	37	1. Plummer blocks (Pedestal Bearing).	
	38		
	39	2 Rams bottom safety valve.	
	40		
	41	3. I.C. Engine connecting rod	
	42		
	43	4. Screw jack (Bottle type).	
	44		
	45	5. Tailstock of lathe.	
	46		
	47	6. Machine vice.	
	48		
	49	7. Tool Head of a shaper	
	50		

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 Section of solids and Orthographic views	Students study the Topics and write the Answers. Get practice to solve university questions.	Unit 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: University Questions on Thread forms and fasteners	Students study the Topics and write the Answers. Get practice to solve university questions.	Unit 2 of the syllabus	4	Individual Activity. Printed solution expected.	Book 1, 2 of the reference list. Website of the Reference list
3	Assignment 3: University Questions on Keys, Joints and Riveted joints	Students study the Topics and write the Answers. Get practice to solve university questions.	Unit 3 of the syllabus	6	Individual Activity. Printed solution expected.	Book 1, 2 of the reference list. Website of the Reference list
4	Assignment 4: University Questions Couplings	Students study the Topics and write the Answers. Get practice to solve university questions.	Unit 4 of the syllabus	8	Individual Activity. Printed solution expected.	Book 1, 2 of the reference list. Website of the Reference list
5	Assignment 5: University Questions on Assembly Drawings	Students study the Topics and write the Answers. Get practice to solve university questions.	Unit 5 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	Syllabus with Real World Mapping	12	Group Activity. Student Group need to perform Project and do a	All Books / paper Resources / Study Material. All Internet / Web

		Knowledge of Rivets Applications.			brief Report	resources.

14.0 QUESTION BANK

MODULE 1: SECTIONS OF SOLIDS

Section of pyramids

1. An equilateral triangular pyramid of base side, 40 mm and height 70 mm rests with its base on the HP such that one of its slant edges parallel to VP. A section plane perpendicular to VP and inclined at 63° to HP cuts the pyramid by passing through one of its lateral faces at a height of 9mm above the HP. Draw the FV, sectional top view and sectional side view along with the cut solid.
2. An equilateral triangular pyramid of 30mm side of base and axis 60mm long rests with its base on HP such that one of the base edges is inclined at 45° to the VP and nearer to it. It is cut by a section plane inclined at 60° to the HP and perpendicular to the VP, intersecting the axis at 40mm from the vertex. Draw the FV, sectional views from the top and right side along with the cut solid. Also project the true shape of section.
3. Fig p2.3 shows the sectional side view of an equilateral triangular truncated pyramid. Determine the true shape of section. Also find the inclination of the section plane with reference plane and size of the pyramid.
4. A triangular pyramid of base sides 50mm and axis 80mm long stands vertically with its base on the HP, such that one of the base edges is perpendicular to VP. A sectional plane perpendicular to VP and parallel to one of the slant edges of the pyramid passes at distances of 25mm from it. Draw the sectional top view and true shape of section. Also determine the inclination of the section plane with the reference plane.
5. A triangular pyramid of50mm side of base and axis length 80mm rests on its base on the HP with one of its base edges perpendicular to the VP.A section plane perpendicular to the VP and parallel to one of the lateral faces of the pyramid passes through at a distance of 25mm from the apex. Draw the front view, sectional top view and true shape of section. Determine the inclination of the section plane with the reference plane.
6. A triangular pyramid base 50mm sides and axis 80mm long, resting on its base on the ground with one of its base edges perpendicular to VP, is cut by two section planes, both perpendicular to the VP and are inclined at 45° to the HP, meet the axis at its mid-height. Both the section planes lie on either side of the axis and lean towards the base of the pyramid. Draw the front view, sectional top view and the combined true shape of section.
7. A triangular pyramid of base sides 50mm and 80mm long, resting on its base on the ground with one of its base edges perpendicular to the VP, is cut by two section planes, both perpendicular to the VP and are inclined at 45° to the HP, meet the axis at its mid-height. Both the section planes lie on either side of the axis and lean upwards. Draw the front view, sectional top view and the combined true shape of section.
8. A triangular pyramid, base 40mm sides and axis 60mm long, resting on its base on the HP with one of its base edges parallel to the VP. A section plane passing through one of the base corners of the pyramid and the two slant edges at 20mm and 30mm above the HP cuts the pyramid. Draw the front view, sectional top view and true shape of section. Determine the inclination of the section plane with the reference plane.
9. A triangular pyramid of base sides40mm and axis length 60mm is resting on its base on the ground with one of its base edges parallel to the VP and nearer to it. It is cut by two section planes both perpendicular to the VP and inclined to HP and meet at one of the base corners of the of the pyramid which is at equidistant from the other two base corners. One of the section planes is inclined at 45° to the HP and cuts the left slant edge while the other section plane is inclined at 60° to the HP and cuts the right end slant edge. Draw the front view, sectional top view and true shape of section.
10. A triangular pyramid of base sides 50mm and axis 65mm long rest vertically on its base with one of the base edges inclined at 30° to the VP and from it is such a way that the apex will be at 35mm in front of the VP. A HT inclined at 45° to XY line cuts the pyramid at 10mm in front of the axis. Both the section plane and the reference base edge of the pyramid lean towards right side. Draw the resulting sectional view the true shape section.
11. A square pyramid of base side 45mm and axis length 70mm rests on its base on the HP in such way that all of its base edges are equally inclined to the VP. It is cut by a section plane perpendicular to the VP, inclined at 45° to the HP and bisecting the axis. Draw the sectional top view sectional side view and true shape of section.
12. A square pyramid side of base 40mm and altitude 60mm has its base on the HP with an edge of base inclined at 30° to the VP. It is cut by a VT, passing through one of the extreme base corners and the center of gravity of the pyramid. Draw the sectional top view and true shape of section.
13. A square pyramid of base side 35mm and axis length 65mm is resting on the HP on its base with a side of base inclined at 30° to the VP. It is cut by a plane perpendicular to both the HP and VP and is 10mm away from the axis. Draw its top view, front view and true shape of section.

14. A hexagonal pyramid side of base 30mm and altitude 70mm is rests with its base on the HP and with a side of base parallel to the VP. It is cut by a cutting plane inclined at 35° to the HP and perpendicular to the VP and is bisecting the axis. Draw the front view, the sectional view looking from the top and true shape 0f section.
15. A pentagonal pyramid side of base 40mm and altitude 70mm is rests with its base on the HP and with a side of base parallel to the VP and 25mm from it. It is cut by a horizontal cutting plane and is bisecting the axis. Draw the front view and the sectional view looking from the top.

Sections of tetrahedrons

1. A tetrahedron of sides 60mm is resting on the HP on one of its faces, with an edge perpendicular to the VP and the nearest base corner is 25mm in front of it. A VT, whose angle of inclination 55° with the reference line XY cuts solid by passing through the axis at a height of 40mm above the base. Draw the resulting sectional view and true shape of section.
2. Fig p.16 shows two concentric equilateral triangles. It is the resulting sectional view of a tetrahedron resting on its base on the HP which is cut by a VT. Complete the projections of the cut solids. Determine the height of the full solid and the position of the section plane.

Sections of cones

1. A cone of base diameter 50mm and axis length 65mm rests with its base on the HP. Draw the true shape of section made by a section plane perpendicular to the VP and inclined to the HP at 50° and passing through an end point on the circumference of the base circle of the cone.
2. A cone of base diameter 50mm is resting on its base on the HP. It is cut by section plane perpendicular to the VP, so that the true shape of cut section is a triangle of base 40mm and altitude 63mm. locate the section plane and determine the angle of inclination of the VT with the reference line XY. Draw the front view. Determine the height of the cone. Also draw the apparent section and true shape of section.
3. A cone of base diameter 50mm and height 60mm stands with its base on the HP. It is cut by a VT inclined at 70° to the reference line XY and is passing through the apex of the cone. Draw its front view, sectional top view and true shape of section.
4. A cone of diameter of base 60mm and axis length 70mm is resting on its base on the ground. It is cut by two section planes. One is parallel to contour generator and 10mm away from it, while the other is parallel to the opposite contour generator. Both the cutting planes lean towards the base, intersecting each other on the axis of the cone. Draw the sectional plan, elevation and the left side view. Also draw the true shape of section with respect to any one of the section planes. Name the curve thus obtained.
5. A cone of diameter of base 50mm and axis length 70mm is standing with its base on the HP. It is cut by a section plane inclined at 40° to the VP and perpendicular to the HP cut s the cone at a distance 10mm in front of its axis. Draw the top view, sectional front view and true shape of section.

Sections of cubes

1. A cube of 45mm edge rests on one of its faces on the ground with its base edges equally inclined to the VP. A VT perpendicular to one of the solid diagonals cuts the solids through one of its base corners. Draw the sectional top view, true shape of section and determine the inclination of the section plane with the reference plane.
2. A hexahedron of 50mm side rests with a face on the HP such that one of its vertical faces is inclined is 30° to the VP. A section plane parallel to the VP and perpendicular to the HP cuts the cube at a distance of 20mm from the farthest vertical edge from the observer. Draw its top view, sectional front view and true shape of section.
3. The true shape of section of a hexahedron is an equilateral triangle of side 50mm. Position the cube of suitable size on the HP and locates the VT. Determine the inclination of section plane with HP and size of the cube. Also draw the sectional top view and true shape of section.
4. A cube of 40mm side is cut by a VT, so that the true shape of section is an equilateral triangle of sides of maximum length. Draw the sectional top view and true shape of section. Determine the inclination plane to HP and measure the length of the sides of the equilateral triangle.
5. The true shape of the section of a cube is a rhombus having diagonals of 60mm and 50mm. Draw the projections of the cube keeping it on base using a suitable position. Determine the size of the cube and the inclination of AIP with the HP. Also check the true shape of section.
6. A hexahedron of 40mm sides is cut by a section plane, so that the true shape of section is a rhombus of sides of maximum length. Draw the sectional top view and the true shape of section. Also find the inclination of the section lane with the reference plane and the size of the rhombus.

Sections of prisms

1. A Rectangular prism of height 75mm and cross section 60X37.5mm is resting on its base on the HP with one of its shorter base edges parallel to VP.A VT whose width between its ends is equal to the longer base edge cuts the

prism through one of the extreme base edges and pass through the lateral face opposite to that base edge. Draw the front view and true shape of the section. Measure the inclination of the section plane and sides of the true shape.

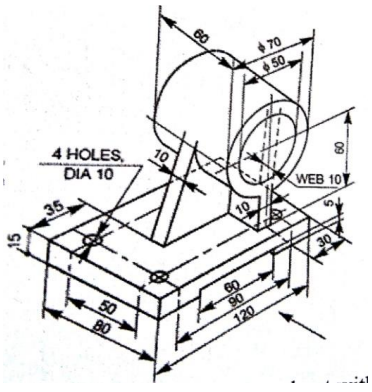
2. A rectangular prism of height 80mm and cross section 48X32mm is resting on the HP with its base. It is cut by a section plane in such a way that the true shape of section is a square of sides of maximum dimension. Draw the front view and determine the inclination of section plane to the reference plane. Also draw the sectional top view and true shape of section.
3. A square prism, sides of square faces 40mm and height 80mm rests with its base on the HP with a vertical face inclined at 30° to the VP. It is cut by a plane inclined at 50° to the VP and perpendicular to the HP and is 15mm from axis nearer to the observer. Both that inclined faces and the section plane lean towards the same direction. Draw its top view, sectional front view and true shape of section.
4. An equilateral triangular prism of 60mm base side and axis length 100mm is resting on the HP with its axis vertical and one of its base edges parallel to the VP and nearer to it. It is cut by an inclined section plane perpendicular to the HP and 60° to the VP and 10mm in front of the axis. Draw the sectional front view and true shape of section.

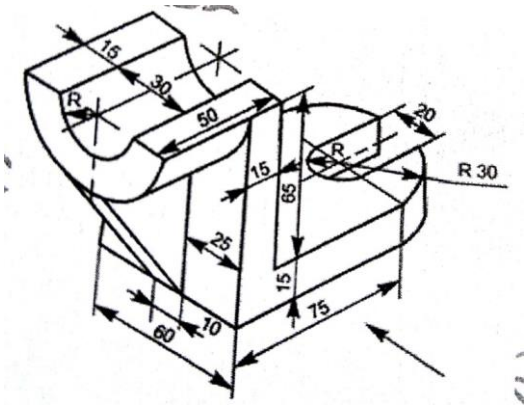
Sections of cylinders

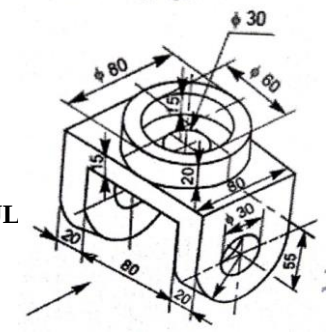
1. A cylinder of base diameter 50mm and 70mm is resting with its base on the HP. A section plane inclined at 50° to the VP and perpendicular to the HP cuts the solid at 10mm in front of it. Draw its top view, sectional front view and true shape of section.
2. A cylinder of base diameter 50mm and axis 70mm is resting on the HP with its axis vertical. A section plane perpendicular to both the HP and the VP cuts the cylinder at 15mm right of the axis. Draw the projections of the cylinder showing the true shape of section.
3. A cylinder of diameter of base 45mm and height 70mm long rests on its base on the HP. It is cut by a plane perpendicular to the VP and inclined at 30° to the HP and meets the axis at a height of 30mm above the base. Draw the front view, sectional top view and true shape of section.
4. A cylinder, 60mm diameter of base and axis 80mm long rests with its base on the HP. A section plane passing through one of its extreme end points on the circumference of its base circle and a point on the axis at 49mm from the base cuts the cylinder. Determine the inclination of the section plane with reference plane. Also draw the sectional top view and the sectional side view.
5. A cylinder of dbase diameter 50mm and axis 100mm long rests on its base on the HP. A VT cuts the cylinder to the HP through the mid point of the axis. Draw the front view, sectional plan and true shape of section.
6. A triangle of base 60mm and height 75mm is the front view3 of a cut cylinder of base diameter 60mm and height 75mm sectioned by two cutting planes. Draw the sectional views looking from the top and right sides. Also project one of the true shapes of section and determine the inclinations of the section planes.

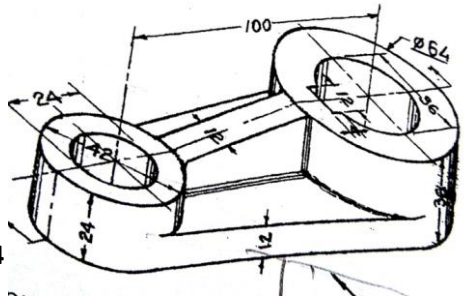
ORTHOGRAPHIC VIEWS

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









1. Draw neat sketches to indicate conventional represe3ntaion of the following:
   i) BSW thread having pitch 50mm.ii) Acme thread pitches 60mm. Show at least 3 threads in section.
2. i) Draw proportionate sketch of the locking device for a nut, use 20mm diameter Bolt using split pin.
   ii) Sketch any one type of Grub screw.
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
   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.

PART-B

MODULE 3: KEYS AND JOINTS:

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.

RIVEGTED JOINTS:

1. Draw the top view and sectional front view of double rivets butt joint with cover plates with zigzag riveting. The thickness of plate is 14mm. Show at least three rivets in on one row and two rivets in the adjoining rows. Indicate all the dimensions. Use snap head rivets and show all calculation on the drawing sheet.
2. Draw free hand proportionate sketch of a double riveted butt joint with double cover plates and zigzag riveting as indicated below.
3. Sectional front-view, ii) Top view. Take a plate thickness=10mm and indicate clearly all dimensions on the drawing. Use a scale of full size.
4. Prepare free hand sketch of two views of double riveted butt joint with single cover plate to connect two plates of 9mm thick. Adopt chain riveting. Use snap head rivets. Show three rivets in a row. Mark all proportions on the views.
5. Draw to 1:1 scale, top and sectional front views of a double riveted chain lap joint. The thickness of the plate is 9mm. Show at least three rivets. Use snap rivets. Indicate all the dimensions.
6. Draw a neat sketch of a double riveted butt joint with single strap. The rivets are to be arranged in a zigzag fashion. Assume and indicate the dimensions and show the calculations.
7. Draw the sectional front view and top view of a double riveted lap joint with zigzag riveting to connect two plates of 12mm thickness.
8. Draw the following views of a SOCKET and SPIGOT COTTER JOINT used for joining two rods of diameter 20mm: i) Sectional front view. ii) A view looking from socket end.

9. Make a neat and proportionate free hand sketch of a socket and spigot type cotter joint showing sectional front view and side view from socket end. When the diameter of the rods is to be 20mm.
10. Sketch proportionately the half sectional front view of socket and spigot cotter joint assuming diameter of rods=20mm. Indicate all proportions with dimensions. Prepare parts list.
11. Sketch neat and proportioned sectional front view of Knuckle joint to connect two round rods of 25mm diameter. Indicate all proportions with dimensions. Show the parts list.
12. Sketch the sectional front view of a cotter joint with sleeve to connect two rods of diameter 25mm. Indicate all proportions with dimensions. Add a parts list.
13. Sketch neat and proportionate figure of Knuckle joint showing sectional front view and top view. Take diameter of rods as 25mm.
14. Sketch a neat proportional front view of a socket and spigot cotter joint indicating all proportions to connect rods of 25mm.

MODULE 4: 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.
   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.

15. 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.
16. 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.
17. Sketch half sectional front view of a flange coupling unprotected type to connect two shafts 20mm diameter. Indicate all proportions. Add parts list.
18. Sketch sectional front view of a **Universal** coupling to connect two rods of diameter 30mm. indicates all dimensions, add parts lists.
19. 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.
20. Sketch the sectional front view of a flexible coupling to connect two shafts of 25mm dia with all dimensions.

PART-C

MODULE 5 : LIMITS, FITS AND TOLERANCES

1. Define Limits, Fits and Tolerances
2. Explain with neat sketch Types of fits with symbols and applications

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 "SCREW JACK". Assemble the parts and draw the following views i) Sectional Front view and ii) Top view.
4. 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.
5. 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.
6. 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.
7. Fig. shows the details of a Tail-Stock of a Lathe. Assemble the parts and draw.i) Sectional Front view.ii) Top view.
8. Fig. shows the details of a "CONNECTING ROD". Assemble the parts and draw the following views. Dimension the drawings.i) Front view andii) Top view.

16.0 University Result

Examination	S+	S	A	B	C	D	E	F	% Passing
Dec 2017	12	19	12	13	10	12	00	01	100%
Dec 2016	16	17	09	05	11	12	02	00	100%

Prepared by	Checked by		
Prof. Mahantesh Tanodi	Prof.Santosh Awade	HOD	Principal

17MEL37A- Material Testing Laboratory

Subject Title	**MATERIAL TESTING LAB**		
Subject Code	17MEL37A	**CIE Marks**	40
No of Lecture Hrs + Practical Hrs/ Week	01+02	**Exam Marks**	60
Total No of Lecture+Practical Hrs	50	**Exam Hours**	03
CREDITS – 02			

FACULTY DETAILS:		
Name: Prof.A.M.Biradar	**Designation:** Asst. Professor	**Experience:**10 Years
No. of times course taught:02Times	**Specialization:** Machine Design	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Mechanical Engineering	I	MES
02	Mechanical Engineering	III	Mechanics of Materials

2.0 Course Objectives

1. To learn the concept of the preparation of samples to perform characterization such as microstructure, volume fraction of phases and grain size.
2. To understand mechanical behavior of various engineering materials by conducting standard tests.
3. To learn material failure modes and the different loads causing failure.
4. To learn the concepts of improving the mechanical properties of materials by different methods like heat treatment, surface treatment etc.

3.0 Course Outcomes

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

CO	Course Outcome	RBT Level	POs
CO1	Determine the hardness of the various materials by different hardness test methods.	L1,L2,L3	PO1,PO2,PO3,PO4,PO6,
CO2	Evaluate the impact strength of materials by Izod and Charpy test.	L1,L2,L3	PO1,PO2,PO3,PO4,PO6, PO9
CO3	Evaluate the strength of different materials on universal testing machine.	L1,L2,L3	PO1,PO2,PO3,PO4,PO6, PO9
CO4	Determine the tensional strength of the given mild steel specimen on tensional test rig.	L1,L2,L3	PO1,PO2,PO3,PO4,PO6,
CO5	Identify the metals based on their microstructure.	L1,L2,L3	PO2,PO3,PO4
CO6	Modify the properties of metal specimens by heat treatment processes.	L1,L2,L3	PO2,PO3,PO4
CO7	Evaluate the Progressive loss of the material & coefficient of friction on wear	L1,L2,L3	PO1,PO2,PO3,PO4,PO6,
CO8	Conduct non destructive tests on given metal specimens.	L1,L2,L3	PO1,PO2,PO3,PO4,PO6, PO9,PO10
Total Hours of instruction		**52**	

4.0 Course Content

PART A

1. Preparation of specimen for Metallographic examination of different engineering materials. To report microstructures of plain carbon steel, tool steel, gray C.I, SG iron, Brass, Bronze & composites.
2. Heat treatment: Annealing, normalizing, hardening and tempering of steel. Metallographic specimens of heat treated components to be supplied and students should report microstructures of furnace cooled, water cooled, air cooled, tempered steel. Students should be able to distinguish the phase changes in a heat treated specimen

compared to untreated specimen.

3. Brinell, Rockwell and Vickers's Hardness tests on untreated and heat treated specimens.
4. 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.

PART B

5. Tensile, shear and compression tests of steel, aluminum and cast iron specimens using Universal Testing Machine
6. Torsion Test on steel bar.
7. Bending Test on steel and wood specimens.
8. Izod and Charpy Tests on Mild steel and C.I Specimen.
9. To study the wear characteristics of ferrous and non-ferrous materials under different parameters.
10. Fatigue Test (demonstration only).

5.0 Relevance to future subjects

SL. No	Semester	Subject	Topics / Relevance
01	III / IV	Machine Shop Lab	Provides basics of materials to be used in Machine Shop Lab
02	V/VI	Design of Machine Elements	Design of materials
02	VIII	Project work	Generation of components for project

6.0 Relevance to Real World

SL.No	Real World Mapping
01	Testing of Materials by using various equipments
02	Heat treatment procedure

7.0 Books Used and Recommended to Students

Text Books
1. Smith, Foundations of Materials Science and Engineering, 4th Edition, McGraw Hill, 2009. 2. William D. Callister, Material science and Engineering and Introduction, Wiley, 2006.
Reference Books
1. V.Raghavan, Materials Science and Engineering, , PHI, 2002 2. Donald R. Askland and Pradeep.P. Phule, The Science and Engineering of Materials, Cengage Learning, 4lh Ed., 2003. 3. George Ellwood Dieter, Mechanical Metallurgy, McGraw-Hill. 4. ASM Handbooks, American Society of Metals.
Additional Study material & e-Books
A text book of Materials Science and Engineering by William Callister

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

Website and Internet Contents References
http://www.nptel.ac.in
Materials Science - Qualify Gate Exam qualifygate.com/download/s%20k%20mondal/**Material**%20**Science**%20IISc.**pd**

9.0 Magazines/Journals Used and Recommended to Students

Sl. No.	Magazines/Journals	website
1	Materials Today - Journal - Elsevier	https://www.journals.elsevier.com/**materials-today**/
2	Journal of Materials Engineering and Performance - Springer	www.springer.com › Home › Materials › Characterization & Evaluation of Materials

10.0 Examination Note

Internal Assessment:
Theoretical aspects as well as relevant sketches should be drawn neatly for questions asked in Internal Assessments
Scheme of Evaluation for Internal Assessment (40 Marks)
Internal Assessment test in the same pattern as that of the main examination.

SCHEME OF EXAMINATION:

ONE question from part -A:	30 Marks
ONE question from part -B:	50 Marks
Viva -Voice:	20 Marks
Total :	100 Marks

11.0 Course Delivery Plan

Expt No	Hour	Name of the Experiment	% Of Portion
1	3	Preparation of specimen for Metallographic examination of different engineering materials. Identification of microstructures of plain carbon steel, tool steel, gray C.I,.	42.85
2	3	Preparation of specimen for Metallographic examination of different engineering materials. Identification of microstructures of SG iron, Brass, Bronze & composites.	
3	3	Heat treatment: Annealing, normalizing, hardening and tempering of steel.	
4	3	Hardness studies of heat-treated samples.	
5	3	To study the wear characteristics of ferrous, non-ferrous and composite materials for different parameters.	
6	3	Non-destructive test experiments like, (a). Ultrasonic flaw detection, to study the defects of Casted and Welded Specimens.	
7	3	Non-destructive test experiments like, Magnetic crack detection and Dye penetration testing, to study the defects of Casted and Welded Specimens.	57.15
8	3	Tensile tests of metallic and non metallic specimens using a Universal Testing Machine	
9	3	shear tests of metallic and non metallic specimens using a Universal Testing Machine	
10	3	compression tests of metallic and non metallic specimens using a Universal Testing Machine	
11	3	Torsion tests	
12	3	Bending Test on metallic and nonmetallic specimens.	
13	3	Izod and Charpy tests on M.S. Specimen.	
14	3	Brinell Hardness test	
15	3	Rockwell Hardness test	
16	3	Fatigue Test.	

12.0 QUESTION BANK

1. What are the objectives of testing materials?
2. Define stress and strain. In what unit it measures.
3. State hooks law
4. Is this applicable to all materials.
5. Define the terms a) elastic limit b) proportional limit c) yield point d) yield strength e) resilience f) toughness.
6. Does all material have yield point? Give example.
7. What is the use of tensile test?
8. What factor should be considered in selecting the gauge length?
9. Which property in tension test is an indication of stiffness of material?
10. What are the difference between proportional limit and elastic limit?
11. Distinguish between the yield point and yield strength?
12. Distinguish between resilience and toughness.
13. Describe the events that occur when a specimen under goes tension test.
14. How is stress calculated?
15. What additional measurement must be made to determine the true stress?
16. Describe the difference between brittle and ductile materials.
17. Give reasons as why the working stress must be less than the ultimate strength of the material.
18. What is UTM? Describe the mechanism
19. Describe the different types of strain measuring apparatus.
20. List some uses of compression test.
21. Explain compression fractures of the following materials a) cast iron b) wood) c) steel.
22. Define the following terms a) neutral axis b) centroidal axis.
23. Are torsion specimens subjects to other than shearing stress during the test? If so what are these stresses.
24. What physical property of the material is determined by means of an impact test?
25. In what unit is the results of impact test are given.
26. For impact test why are the notch specimen used.
27. What is the difference between charpy and izod test.
28. Define hardness. Why hardness test is conducted instead of tension test.
29. What physical properties of a material can be estimated from hardness test?
30. What is the unit of brinnel hardness number?
31. What is stress concentration?
32. Why is minor load applied? Before setting the Rockwell measuring dial.
33. What is meant by term Fatigue of the metals?
34. Define the following terms. In discussing fatigue tests, stress cycle, maximum stress range of stress minimum stress normal stress, alternating stress, amplitude, mean stress, fatigue life, fatigue limit, stress ratio, SN diagram, cycle ratio, fatigue strength, fatigue ratio.
35. If a material endurance limit how would you estimate its fatigue life.
36. State the resemblance and difference between creep and slip.
37. Does wood creep. State evidence for your answer.
38. Define wear of the material.
39. Name different types of wear.
40. Define micrography.
41. Describe the various steps involved in preparation of specimen for micrographic examination.
42. Why it is necessary to wash specimen thoroughly between each stage of the processes during grinding and polishing.
43. What is a function of an etchant?
44. Describe the features of phase diagram.
45. What is the difference between eutectic and eutectoid?
46. Explain the cury point on iron. Iron carbide equilibrium diagram.
47. What is allotropy?
48. Sketch structure and describe the characteristics of ferrite austenite, cementite and martensite and binite.
49. What is annealing? What is the purpose of annealing the steel?
50. How normalizing differ from annealing as applied to steel.
51. What are the advantages of the normalizing process in respect to the final properties?
52. Describe the hardening process. Where does the effect occur after hardening of steel?
53. Explain what happens in steel when it is quench hardened.
54. Name several quenching media.

55. What is age hardening

13.0 University Result

Examination	S+	S	A	B	C	D	E	% Passing
2016-17	-	25	28	09	08	03	-	100
2017-18	6	55	3	01	--	--	--	100

Prepared by	Checked by		
Prof.A.M.BIRADAR	Prof.G.A.NAIK	HOD	Principal

17MEL38A- Foundry and Forging Laboratory

Subject Title	**FOUNDRY AND FORGING LABORATORY**		
Subject Code	17MEL38A	**IA Marks**	40
No of Lecture Hrs + Practical Hrs / Week	01+02	**Exam Marks**	60
Total No of Lecture + Practical Hrs	52	**Exam Hours**	03
CREDITS – 02			

FACULTY DETAILS:		
Name: Prof. S.R.Kulkarni	**Designation:** Asst. Professor	**Experience:** 11Years
No. of times course taught: 03 Times	**Specialization:** Production Management	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Mechanical Engineering	I	Elements of Mech Engineering
02	Mechanical Engineering	III / IV	Metal Casting and Welding
03	Mechanical Engineering	III / IV	Manufacturing Process II

2.0 Course Objectives

- To provide an insight into different sand preparation and foundry equipments.
- To provide an insight into different forging tools and equipments.
- To provide training to students to enhance their practical skills.
- To practically demonstrate precautions to be taken during casting and hot working.
- To develop team qualities and ethical principles.

3.0 Course Outcomes

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

CO	Course Outcome	Cognitive Level	POs
CO1	Demonstrate various skills of sand preparation, molding.	A	PO1, PO6, PO9
CO2	Demonstrate various skills of forging operations.	A	PO1, PO6, PO9
CO3	Work as a team keeping up ethical principles.	U	PO1, PO6
Total Hours of instruction		**52**	

4.0 Course Content

PART A

1. Testing of Molding sand and Core sand

Preparation of sand specimens and conduction of the following tests:

1. Compression, Shear and Tensile tests on Universal Sand Testing Machine.
2. Permeability test
3. Sieve Analysis to find Grain Fineness Number(GFN) of Base Sand
4. Clay content determination in Base Sand.

PART B

2. Foundry Practice

1. Use of foundry tools and other equipment's.
2. Preparation of molding sand mixture.
3. Preparation of green sand molds using two molding boxes kept ready for pouring.
   - Using patterns (Single piece pattern and Split pattern)
   - Without patterns.

- Incorporating core in the mold. (Core boxes).
- Preparation of one casting (Aluminum or cast iron-Demonstration only)

PART C

3. Forging Operations :

Use of forging tools and other equipment's

- Calculation of length of the raw material required to prepare the model considering scale loss.
- Preparing minimum three forged models involving upsetting, drawing and bending operations.
- Demonstration of forging model using Power Hammer.

5.0 Relevance to future subjects

SL. No	Semester	Subject	Topics / Relevance
01	III / IV	Machine Shop Lab	Provides basics of materials to be used in Machine Shop Lab
02	VIII	Project work	Generation of components for project

6.0 Relevance to Real World

SL. No	Real World Mapping
01	Casting of raw material in to variety components by foundry process
02	Forming of components for various applications by forging process

7.0 Books Used and Recommended to Students

Text Books
1. Workshop Technology by Hazra Chaudhary vol I & vol II. 2. A Textbook of Foundry Technology eBook By O P Khanna PDF.
Reference Books
1. Fundamentals of Metal Forming by Robert Wagoner 2. Green sand Casting by Lindsay Publications
Additional Study material & e-Books

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

Website and Internet Contents References
http://www.foundrymagazineindia.com http://foundrymag.com http://www.foundrytradejournal.com/ http://www.nptel.ac.in

9.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	Website
1	Indian Foundry Journal	www.indianfoundry.org/indian-foundry-journal.php
2	International Journal of Metalcasting | AFS - American Foundry Society	www.afsinc.org › Technical & Management › International Journal of Metalcasting
3	International Journal of Metalcasting - Springer	www.springer.com › Home › Materials › Special types of Materials
4	Metal, Metallurgy & Foundry Periodicals, Magazines, Journals	www.castingarea.com/research/magazines.htm

10.0 Examination Note

Internal Assessment:
Theoretical aspects as well as relevant sketches should be drawn neatly for questions asked in Internal Assessments
Scheme of Evaluation for Internal Assessment (20 Marks)
(c) Internal Assessment test in the same pattern as that of the main examination (Better of the two Tests):25marks.

SCHEME OF EXAMINATION:
One question is to be set from Part-A 15 Marks One question is to be set from either Part-B or Part-C 35 Marks
Calculation of length of the raw material required for forging model is compulsory irrespective of the student preparing part-B or part-C model

Calculation of length for Forging	10 Marks
Viva – Voce	20 Marks
Total	**80 Marks**

11.0 Course Delivery Plan

Expt No	Lecture / Practical No	Name of the Experiment	% Of Portion
1	1	Introduction to Sand Preparation experiments.	47.61
2	2	To conduct an experiment to find out the compression strength of given sand specimen	
3	3	To conduct shear strength test on a standard sand test specimen and to derive the results.	
4	4	To conduct an experiment to find out the tensile strength of given sand specimen.	
5	5	To determine the permeability number of given green sand specimen.	
6	6	To find the grain fine number of given sand sample .	
7	7	To determine percentage of clay in the given sand sample	
8	8	Introduction to Foundry and tools details	26.19
9	9	To cut an ellipse of given dimensions.	
10	10	To make a hexagonal and square cavity as per sketch.	
11	11	To make equilateral triangle core in a circle	
12	12	Introduction to Forging and tools details	26.19
13	13	To make the square bar from round bar of 10mm dia.	
14	14	To make eye hook from round bar of 10 mm dia.	
15	15	To make round headed bolt from round bar of 12 mm dia.	

12.0 Question Bank

1. List the characteristics of Foundry sand.	23. For large iron and steel castings which type of foundry sand is used?
2. Explain Refractoriness of foundry sand?	24. What is the purpose of adding Binders to the foundry sand?
3. Define Permeability of foundry sand.	25. Name the common binders used in foundry?
4. What do you mean by Flow ability or plasticity	26. List the commonly used Organic binders.
5. What is Adhesiveness of foundry sand?	27. List the commonly used inorganic binders
6. Define Cohesiveness of foundry sand?	28. Which is the most widely used inorganic binders?
7. What is collapsibility of foundry sand?	29. What are Additives related to foundry?
8. What is Green sand?	30. List commonly used Additives.
9. What is Dry sand?	31. Where Coal dust additives are used?
10. What is the use of Facing sand?	32. Mention the main purpose of using coal dust additives?
11. What is Parting sand?	33. What is Sea coal?
12. What do you mean by Baking sand?	34. What is the nature of Sea coal?
13. What is Core sand?	
14. What is Molasses sand?	

15. Mention the advantage of Molasses sand. 16. Which sand is called as Fat sand? 17. What is the effect of sand grains on foundry sand? 18. Mention the types of sand grain surfaces. 19. Why the Smooth sand grain surface is preferred? 20. What are the different shapes of sand grains? 21. For light castings which type of foundry san d is preferred? 22. For bench work which type of foundry sand is preferred?	35. What are Pitch additives? 36. What is the role of Water on foundry sand? 37. Mention the quantity of water added to foundry sand. 38. What necessitates testing Foundry sand? 39. Name the Sand testing Equipments used in foundry laboratory. 40. Name the commonly performed tests on foundry test. 41. Why Grain fineness test is conducted? 42. Mention the methods used to test grain fineness? 43. Why Moisture content test is necessary?

13.0 University Result

Examination	FCD	FC	SC	% Passing
Jan 2016-17	6	1	1	100
Jan 2015-16	61	0	0	100

Prepared by	Checked by		
Prof. S R Kulkarni	Prof. G A Naik	HOD	Principal