Department of Mechanical Engineering

COURSE PLAN 2018-19

IV Semester ''B'' division

CONTENTS

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.

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 4th A to 8th B)	Prof. M.I.Tanodi Prof. G.V.Chiniwalar Prof. M.M.Shivashimpi Prof. A.M.Biradar Prof.S.R.Kulkarni Prof. G.A.Naik	
4	Department Association Coordinator	Prof. M. M. Shivashimpi/ Prof. M. R. Ingalagi	Shri.M.B.Badiger
5	Students Activities Coordinator	Prof. Jagadeesh A.	
6	Extra-Curricular Activities/ Induction/ Robo Vidya	Prof. T. S. Vandali / Prof. A.M.Biradar/Prof.N.M.Ukkali	
7	Dept.TP Cell Coordinator	Prof. R. V. Nyamagoud	Shri S. R. Nakadi
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.S.B.Awade/Prof. A. M. Biradar	Shri S. C. Jotawar Shri R. M. Hunachyali
12	Choice of Electives	Prof. S. N. Toppannavar Prof. D. N. Inamdar Prof. T. S. Vandali	---
13	Department Library Coordinator	Prof. Mahantesh 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	Prof. Mahesh Hipparagi	
17	Project & Technical Seminar Coordinators	Prof. Mahantesh Tanodi	Shri R. B. Kumbar / Shri.M.S.Kurni
18	Dispensary	Dr. Arun G. Bullannavar	Cell No. 9449141549
Institute Level			
01	Student Welfare Convener	Prof. R.R.Patil(9845455422)	
02	TP Cell Coordinator	Prof. Santosh Sajjan (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. S.S.Kamate (9008696825)	
06	Grievance Redressal Convener	Prof. S.S.Tabaj (9901398134)	
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

S J P N Trust's
Hirasugar Institute of Technology, Nidasoshi.
Inculcating Values, Promoting Prosperity
Approved by AICTE, Recognized by Govt. of Karnataka, Affiliated to VTU, Belagavi &
Recognized Under Section 2(f) of UGC Act, 1956.

IQAC
File I-11
2018-19 (Even)
Rev: 0

CALENDAR OF EVENTS FOR THE ACADEMIC YEAR 2018-19 (Even)

Date	Events
01-02-2019	Commencement of IV/VI/VIII Semester Classes
22-02-2019	EDP Activities
25-02-2019	Commencement of II Semester Classes
02-03-2019	Annual Sports Meet
14-03-2019 to 16-03-2019	First Internal Assessment of IV/VI/VIII Semester
20-03-2019	Feed Back-1, Display of First Internal Assessment Marks & Submission of Feedback-1 report to office
21-03-2019	HIT Quest - 2019
22-03-2019	HIT SAMBHRAMA-2019
23-03-2019	Techno-Vision 2019
11-04-2019 to 13-04-2019	Second Internal Assessment of IV/VI/VIII Sem. First Internal Assessment of II Sem.
15-04-2019	Feed Back-2
18-04-2019	Display of Internal Assessment Marks & Submission of Feedback-1 report to office
23-04-2019	Technical Activities under Professional Bodies
26-04-2019	NSS/Red Cross activities
16-05-2019 to 18-05-2019	Third Internal Assessment of IV/VI/VIII Sem. Second Internal Assessment of II Sem.
22-05-2019	Display of Internal Assessment Marks
20-05-2019 & 21-05-2019	Lab Internal Assessment of IV/VI/VIII Semester
22-05-2019	Graduation Day - 2019
23-05-2019	Project Exhibition of VIII Sem.
23-05-2019	Last Working Day of IV/VI/VIII Semester
27-05-2019 to 07-06-2019	Practical Exams of IV/VI/VIII Semester
10-06-2019 to 16-07-2019	Theory Exams of IV/VI/VIII Semester
10-06-2019 & 11-06-2019	Lab Internal Assessment of II Sem.
11-06-2019 to 17-06-2019	Project Viva-Voce of VIII Sem.
13-06-2019 to 15-06-2019	Third Internal Assessment of II Sem.
17-06-2019	Last Working Day of II Semester
19-06-2019 to 29-06-2019	Practical Exams of II Semester
01-07-2019 to 16-07-2019	Theory Exams of II Semester

February-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		

March-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						

04- Maha Shivaratri 05- Maha Dasoha 21- Holi

April-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				

06- Chandramana Ugadi 14-Dr. B. R. Ambedkar Jayanti
17-Mahaveer Jayanti 19-Good Friday

May-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	

01- Labours Day, 07- Basava Jayanthi

June -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						

05- Qutub-E-Ramazan

30/1/19
Dr. Shilpa Shrigiri
IQAC Co-ordinator

Hirasugar Institute of Technology, Nidasoshi Pin-591236

30/1/19
Dr. S C Kamate
Principal
PRINCIPAL
Hirasugar Institute of Technology
NIDASOSHI-591 236

DEPARTMENT CALENDAR OF EVENTS FOR THE ACADEMIC YEAR 2018-19 (Even)

Date	Events
01-02-2019	Commencement of IV/VI/VIII Semester Classes
22-02-2019	Technical Seminar
23-02-2019	Industrial Visit (VIII Semester)
14-03-2019 to 16-03-2019	First Internal Assessment of IV/VI/VIII Semester
09-03-2019	Industrial Visit (VI Semester)
21-03-2019	HIT Quest - 2019
30-03-2019	Expert Talk By Industrialist
05-04-2019	Hobby Project Exhibition
11-04-2019 to 13-04-2019	Second Internal Assessment of IV/VI/VIII Sem.
27-04-2019	ED Cell Activity
16-05-2019 to 18-05-2019	Third Internal Assessment of IV/VI/VIII Se
20-05-2019 & 21-05-2019	Lab Internal Assessment of IV/VI/VIII Semester
23-05-2019	Project Exhibition of VIII Sem.
23-05-2019	Last Working Day of IV/VI/VIII Semester
27-05-2019 to 07-06-2019	Practical Exams of IV/VI/VIII Semester
10-06-2019 to 16-07-2019	Theory Exams of IV/VI/VIII Semester
11-06-2019 to 17-06-2019	Project Viva-Voce of VIII Sem.

February-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		

March-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						

04- Maha Shivaratri 05- Maha Dasoha 21- Holi

April-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				

06- Chandraman Ugadi 14-Dr. B. R. Ambedkar Jayanti 17-Mahaveer Jayanti 19-Good Friday

May-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	

01- Labours Day

June -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						

05- Qutub-E-Ramazan

7/2/19
AIMSS Coordinator
Prof. M. M. Shivashimpi

7/2/19
HOD
Dr. B. M. Shrigiri

HOD
Mechanical Engg.
HIT, Nidasoshi

Scheme of Teaching and Examination

4th Semester "B"

VTU Scheme

Sl. No.	Subject Code	Title	Teaching Hours per week			Examination				Credits
			Lecture	Tutorial	Practical	Duration (hours)	SSE marks	CIE marks	Total marks	
1	17MAT41	Engineering Mathematics-IV	04			03	60	40	100	4
2	17ME42	Kinematics of Machines	03	02		03	60	40	100	4
3	17ME43	Applied Thermodynamics	03	02		03	60	40	100	4
4	17ME44	Fluid Mechanics	03	02		03	60	40	100	4
5	17ME45A	Metal Casting and Welding	04			03	60	40	100	4
6	17ME46A	Computer Aided Machine Drawing	01		04	03	60	40	100	3
7	17MEL47A	Material Testing Lab	03		02	03	60	40	100	2
8	17MEL47A	Foundry and Forging Lab	01		02	03	60	40	100	2
9	17KL49	Kannada	01			01	30	20	50	1
10	17MATDIP41	Additional Mathematics-II	03	--	--	03	60	--	60	--
11	AUDIT COURSE	English	01	--	--	--	--	--	--	--
		Total	**27**	**06**	**08**		**570**	**340**	**910**	**28**

Subject Title	**Engineering Mathematics-IV**		
Subject Code	17MAT41	**IA Marks**	40
Number of Lecture Hrs / Week	04	**Exam Marks**	60
Total Number of Lecture Hrs	50	**Exam Hours**	03
CREDITS – 04			

FACULTY DETAILS:		
Name: 1) Prof. S L Patil 2) Prof. S A Patil 3) Prof. S I Shivamoggimath	**Designation:** Asst. Professor	**Experience:** 1) 10 2) 8.5 3) 6.5
No. of times course taught: 1) 9 2) 6 3) 4	**Specialization:** Mathematics	

1.0 Prerequisite Subjects:

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

2.0 Course Objectives

The purpose of this course is to make students well conversant with numerical methods to solve ordinary differential equations, complex analysis, sampling theory and joint probability distribution and stochastic processes arising in science and engineering.

3.0 Course Outcomes

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

	Course Outcome	POs
CO1	Use appropriate single step and multi-step numerical methods to solve first and second order ordinary differential equations arising in flow data design problems.	1,2,3,12
CO2	Explain the idea of analyticity, potential fields residues and poles of complex potentials in field theory and electromagnetic theory.	1,2,3,12
CO3	Employ Bessel's functions and Legendre's polynomials for tackling problems arising in continuum mechanics, hydrodynamics and heat conduction.	1,2,3,12
CO4	Describe random variables and probability distributions using rigorous statistical methods to analyze problems associated with optimization of digital circuits, information, coding theory and stability analysis of systems.	1,2,3,12
CO5	Apply the knowledge of joint probability distributions and Markov chains in attempting engineering problems for feasible random events.	1,2,3,12
Total Hours of instruction		**50**

4.0 Course Content

MODULE-I

Numerical Methods:
Numerical solution of ordinary differential equations of first order and first degree, Taylor's series method, modified Euler's method, Runge - Kutta method of fourth order. Milne's and Adams-Bashforth predictor and corrector methods (No derivations of formulae). **(10 Hours)**

MODULE-II

Numerical Methods:
Numerical solution of second order ordinary differential equations, Runge-Kutta method and Milne's method.

Special Functions:
Series solution of Bessel's differential equation leading to Jn(x)-Bessel's function, Bessel orthogonality. Series solution of Legendre's differential equation leading to Pn(x)-Legendre polynomials. Rodrigue's formula, problems **(10Hours)**

MODULE-III

Complex Variables:
Review of a function of a complex variable, limits, continuity, differentiability. Analytic functions-Cauchy-Riemann equations in Cartesian and polar forms. Properties and construction of analytic functions. Complex line integrals-Cauchy's theorem and Cauchy's integral formula.Residue, poles, Cauchy's Residue theorem (without proof) and problems.

Transformations:
Conformal transformations, discussion of transformations: $w = z^2$, $w = e^z$, $w = z + 1/z$ and bilinear transformations-problems. **(10 Hours)**

MODULE-IV

Probability Distributions:
Random variables (discrete and continuous), probability mass/density functions. Binomial distribution, Poisson distribution. Exponential and normal distributions, problems.

Joint probability distribution:
Joint Probability distribution for two discrete random variables, expectation, covariance, correlation coefficient. **(10 Hours)**

MODULE-V

Sampling Theory:
Sampling, Sampling distributions, standard error, test of hypothesis for means and proportions, confidence limits for means, student's t-distribution, Chi-square distribution as a test of goodness of fit.

Stochastic process:
Stochastic processes, probability vector, stochastic matrices, fixed points, regular stochastic matrices, Markov chains, higher transition probability simple problems. **(10 Hours)**

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, Khanna Publishers, 43rd Ed., 2015. 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 Publishers, 7th Ed., 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 (30 Marks)
(a) Internal Assessment test in the same pattern as that of the main examination **30 Marks**.
(b) Assignments: **10 Marks**
Scheme of Examination:
Question paper pattern:
1. The question paper will have **ten** full questions carrying equal marks.
2. Each full question consisting of **20 marks.**
3. There will be **two** full questions.
4. Each full question will have sub question covering all the topics under a module.
5. 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
1	1	Numerical solution of ordinary differential equations of first order & first degree	20
	2	Taylor's series method & Problems.	
	3	Modified Euler's method	
	4	Problems	
	5	Runge -Kutta method of fourth order	
	6	Problems	
	7	Milne's predictor and corrector method	
	8	Problems	
	9	Adams-Bashforth predictor and corrector method	
	10	Problems.	
2	11	Numerical solution of second order ordinary differential equations	20
	12	Runge -Kutta method	
	13	Milne's method	
	14	Problems.	
	15	Series solution of Bessel's differential equation leading to Jn(x)	
	16	Properties of Bessel's functions.	
	17	$J_{\frac{1}{2}}(x) = \sqrt{\frac{2}{\pi x}}\sin x$ & $J_{-\frac{1}{2}}(x) = \sqrt{\frac{2}{\pi x}}\cos x$	
	18	Orthogonality of Bessel's functions.	
	19	Series solution of Legendre differential equation leading to Jn(x)-Legendre polynomials	
	20	Rodrigue's formula, problems	
3	21	Review of a function of a complex variable, limits, continuity, differentiability	20
	22	Analytic functions-Cauchy-Riemann equation in Cartesian form	
	23	Cauchy-Riemann equation in Polar form	
	24	Properties and construction of analytic functions	
	25	Complex line integrals-Cauchy's theorem	
	26	Cauchy's integral formula	
	27	Residue, poles, Cauchy's Residue theorem	
	28	Conformal Transformations and discussion of transformations of $w = z^2$, $w = e^z$	
	29	Discussion of Transformations: $w = z + (1 / z)$.	
	30	Bilinear transformations & Problems	
4	31	Random variables (discrete and continuous)	
	32	Probability mass/density functions	

	33	Binomial distribution.	20
	34	Poisson distribution.	
	35	Exponential distribution.	
	36	Normal distributions.	
	37	Problems.	
	38	Joint Probability distribution for two discrete random variables	
	39	Expectation, covariance.	
	40	Correlation coefficient	
5	41	Sampling & Sampling distributions	20
	42	standard error, test of hypothesis for means and proportions	
	43	confidence limits for means	
	44	student's t-distribution	
	45	Chi-square distribution as a test of goodness of fit.	
	46	Stochastic processes, probability vector	
	47	stochastic matrices, fixed points,	
	48	regular stochastic matrices	
	49	Markov chains	
	50	higher transition probability simple problems	

13.0 QUESTION BANK

MODULE-1

NUMERICAL METHODS

1. Solve $dy/dx = x^2y-1$ with y(0)=1 using Taylor's series method and find y(0.1) consider upto 4th degree terms.
2. Use Runge Kutta fourth order method to solve $dy/dx= y^2-x^2/y^2+x^2$ with y(0)=1 and find y for x=0.2 and 0.4 take h=0.2
3. Given $dy/dx = xy+ y^2$, y(0)=1, y(0.1)=1.1169 ,y(0.2)=1.2773, y(0.3)=1.5049 find y(0.4) accurate upto three decimal places using Milne's predictour corrector method.
4. Applying R-K method to find an approximate value of y for x=0.2 in steps of 0.1 of $dy/dx= x+ y^2$ given that y=1 when x=0.
5. Given $dy/dx= x^2(1+ y)$ & y(1)=1,y(1.1)=1.233, y(1.2)=1.548,y(1.3)=1.979. Evaluate y(1.4) by Adams Bash Fourth method
6. Employ Taylor's series method to find an approximate solution correct to fourth decimal places for the following initial value problem at x=0.1 & 0.2 $dy/dx=2y+3e^x$, y(0)=0.
7. Applying R-K method to find the approximate value of y for x=0.2 in step of x=0.1 given that $dy/dx= x+y^2$ with y(0)=1.
8. Using Milne's predictour corrector method find y where x=0.8 given $dy/dx= x-y^2$, y(0)=0, y(0.2)=0.02, y(0.4)=0.0795, y(0.6)=0.1762.Applying corrector formula twice.
9. Employ R-K method of 4rth order to solve the equation dy/dx = 3x+y/2, y(0)=1 at x=0.2 taking step lengthh=0.1
10. Solve the differential equation $dy/dx = x^2+y^2$ given y(0)=1 to find the value of y(0.1) by using Taylor's series method of order.
11. Using modified Euler's method ,solve the equation dy/dx = 1/x+y, y(0)=1 in steps of 0.5 at x=1
12. Using Adams Bash fourth predictor correct method find y when x=0.8 given $dy/dx = x- y^2$, y(0)=0, y(0.2)=0.02, y(0.4)=0.0795, y(0.6)=0.1762. Apply correct formula twice.
13. Using Taylor's series method to find y at the point x=0.1& x=0.2 given that $dy/dx= x^2+y^2$,y(0)=1
14. From the data given below find y at x=1.4 using Milne's predictour corrector method $y'= x^2+y/2$

x	1	1.1	1.2	1.3
y	2	2.2156	2.4649	2.7514

MODULE-2

NUMERICAL METHODS AND SPECIAL FUNCTIONS

1. Use R- K method to solve $xy'^2 - y^2$ for x = 0.2 correct to 4 decimal places. $= 1 \& y'(0) = 0$
2. Given y" + xy'+ y = 0, y(0)=1, y'(0)=0, obtain y for x=o(0.1)0.3Milne's method & calculate y(0.4).
3. Obtain the series solution of Bessel's differential equation $\frac{d^2y}{dx^2} + x\frac{dy}{dx} + (x^2 - n^2)y = 0$ in the form of

$AJ_n(x) + BJ_{-n}(x)$

4. If d β are two distict roots of $) = 0,$ then prove that $J_n(\alpha x)J_n(\beta x)dx = 0$ if $\alpha \neq \beta$.
5. Using R-K method of order four, solve y" = y+xy', y(0) = 1 , y'(0) to find y(0.2) & y'(0.2).
6. S.T. i) $J_{1/2} = \sqrt{2/\pi x}\ \sin x$, ii) $J_{-1/2} = \sqrt{2/\pi x}\ \cos x$.
7. Express $f(x) = x^4+3x^3-x^2+5x-2$ in terms of Legendary's polynomials.
8. Obtain the series solution of Bessel's differential equation in the form y = AJn(x) + BJn(x)
9. Establish the Rodrigue's formula for Legendre polynomials. S.T. i) Pn(1)=1, ii) $Pn(-1) = (-1)^n$
10. Express $f(x) = x^3+2x^2-x-3$ in terms of Legendre polynomials

MODULE-3
COMPLEX VARIABLES AND TRANSFORMATIONS

1. Derive Cauchy-Riemann equations in the Cartesian form.
2. Derive Cauchy-Riemann equations in the Polar form.
3. P.T if f(z)= u+iv is an analytic then the family of curves u(x,y)=C1 , v(x,y)= C2, C1 & C2 being Constants, intersect each other orthogonally
4. S.T w = log z, $z \neq 0$ is analytic & find dw/dz.
5. S.T $f(z) = z^n$, where n is a positive is analytic & hence find its derivative.
6. Find the analytic function f(z)= u+iv given $u-v= e^x(\cos y-\sin y)$
7. Find the analytic function f(z) as a function of z given that $u+ v = x^3-y^3+3xy(x-y)$
8. Discuss the conformal transformation of $w = z^2$
9. Discuss the conformal transformation of $w = e^z$
10. Find the bilinear transformation which map the points z= i, 1, -1on to the points w = 1, 0, ∞.
11. Find the bilinear transformation which maps z = ∞, i, 0 into w= -1, -i, 1. Also find the invariant points.
12. State & prove Cauchy integral Theorem.
13. Verify Cauchy's theorem for the function $f(z)= z^2$ where c is the square having vertices (0,0) ,(1,0),(1,1) & (0,1)
14. Evaluate $\int e^z / z+i\pi\, dz$ over each of the following contours C, a) $|z| =2\pi$, b) $|z| =\pi/2$, c) $|z-1|=1$
15. Evaluate $\int e^{2z}/(z+1)(z-2)\, dz$ where c is the circle $|z|=3$ using Residue Theorem.

MODULE-4
PROBABILITY DISTRIBUTIONS AND JOINT PROBABILITY DISTRIBUTIONS

1. Find the mean & variance of Binomial distribution.
2. The mark of 1000 students in an examination follows in a normal distribution with mean 70 & SD 5. Find the number of students whose marks will be i) less than 65 , ii) more than 75 & iii) between 65 & 75.
3. The probability mass function of a variate X is

$X = x_i$	-2	-1	0	1	2	3
p(x)	0.1	K	0.2	2k	0.3	k

4. Find i) The value of K, ii) ≤ 0), iii) > 1) iv) $2 < x \leq 1$)
5. If 10% of the rivets produced by a machine are defective, find the probability that, out of 12 rivets chosen at random.
6. S.T mean & standard deviation of exponential distribution are equal.

7. In a test of 2000 electric bulbs, it was found that the life of a bulb is a normal variable with average life of 2040 hours & standard deviation of 60 hours. Estimate the number of bulbs to burn for i) More than 2150 hours , ii) less than 1950 hours , Given that p[$0 \le z \le 1.83$] = 0.4664 & p[$0 \le z \le 1.33$] = 0.4082.
8. 2% of the fusion manufactured by a firm are found to be defective .Find the probability that a box containing 200 fuses contains i) no defective fuse , ii) 3 or more defective fuses.
9. In length of a telephone conversation is an exponential vitiate with mean 3 minutes. Find the probability that call i) ends in less than 3 minutes , ii) takes between 3 to 5 minutes.
10. Suppose that the student IQ scores form a normal distribution with average 100 & standard deviation 20. Find the percentage of students whose (i) score less than 80 (ii) score more than 120 (iii) score falls between 80 & 120 (G T P(1)=0.3413)
11. In a certain town the duration of a shower is exponentially distributed with mean 5 minutes what is

    the probability that a shower will least for i) 10 minutes or more, ii) less than 10 minutes, iii) betn 10 min & 12 min
12. The joint probability distribution for two random variables X and Y is as given below.

X \ Y	-2	-1	4	5
1	0.1	0.2	0	0.3
2	0.2	0.1	0.1	0

Find the marginal distributions of X, Y. Also find the covariance of X and Y.

13. The Joint probability distribution of two random variables X and Y is as follows

X \ Y	-4	2	7
1	1/8	1/4	1/8
5	1/4	1/8	1/8

14. Determine (i) Marginal distribution of X & Y (ii) E(X) , E(Y) and E(XY) (iii) Cov (XY) (iv) .
15. A fair coin is tossed 4 times. Let X denotes the number of heads occurring and let Y denotes the longest string of heads occurring. Find the joint distribution function of X and Y.

MODULE-5
SAMPLING THEORY AND STOCHASTIC PROCESS

1. Explain the following terms i) Null hypothesis , ii) Level of significance , iii) Type I & II errors , iv) Confidence limits.
2. A sample of 100 days is taken from meteorological records of certain districts & 10 of them are found

   to be fussy. Find the 99.73 % confidence interval of the % of fussy days in the distinct.
3. A certain stimulus administered to each of the 12 patients resulted in the following blood pressure

   5,2,8,-1,3,0,6,-2,1,5,0,4, can it be calculated that stimulus will increase the blood pressure ?

   [t 0.05 for 11d.f= 2.201]
4. A die was thrown 9000 times & a throw of 5 or 6 was obtained 3240 times. On the assumption of random throwing, do the data abdicate that the die is biased?
5. A random sample of 100 records deaths in past year showed an average life span of 71.8 years. Assuming a population standard deviation of 8.9 years, does the data indicated that average life span today is greater than 70 years? Use a 0.05 level of significance.
6. In 324 throws of a six faced die, an odd number turned up 181 times. Is it reasonable to think that the die is an unbiased one?
7. Four coins are tossed 100 times & the following results were obtained

No. of Heads	0	1	2	3	4
Frequencies	5	29	36	25	5

Fit a Binomial distribution for the data & test the goodness of fit given $\chi^2_{0.05} = 9.49$ for 4 d.f

8. Find the student's t distribution for the following variable values in a sample of eight -4,-2,-2,0,2,2,3,3 taking the mean of the universe to be zero.
9. A coin was tossed 400 times & the head turned up 216 times. Test the hypotheses that the coin is in biased at 5% level significance.
10. A die was thrown 1200 times & the number 6 was obtained 236 times. Can the die be considered fair at level of significance?
11. Explain i) Random sample ii) Sample mean iii) Population mean
12. Find the fixed probability vector of the regular stochastic matrix $\begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 1/2 & 0 \end{bmatrix}$
13. Explain i) Transient state ii) Recurrent state iii) absorbing state of Markov chain
14. Each year a man trades his car for a new car in 3 brands of the popular company Maruti Udyuog Limited. If he has a 'standard' he trades it for 'zen'. If he has a 'zen' he trades it for a 'Esteem'. If he has a 'Esteem' is just as likely to trade it for a new 'Esteem' or for a 'zen' or a 'standard'. In 1996 he bought his first car which was 'Esteem'. Find the probability that he has (i) 1999 Esteem (ii)1998 Standard (iii)1999 Zen
15. Define stochastic matrix. Find the unique fixed probability vector for the regular stochastic matrix

$$\begin{bmatrix} 0 & 1 & 0 \\ 1/2 & 0 & 1/2 \\ 1/2 & 1/4 & 1/4 \end{bmatrix}$$

16. Find the fixed probability vector of the regular stochastic matrix A= $\begin{bmatrix} 0.25 & 0.25 \\ 0 & 0.5 \\ 1 & 0 \end{bmatrix}$

14.0 University Result

Examination	S+	S	A	B	C	D	E	% Passing
July 2018	2	12	15	29	22	13	24	83.89
July 2017	1	10	13	27	20	11	22	84.55

Prepared by	Checked by		
Prof. S. A. Patil **Prof. S. I. Shivamoggimath**	**Prof. S. L. Patil**	**HOD**	**Principal**

Subject Title	**KINEMATICS OF MACHINES**		
Subject Code	17ME42	**IA Marks**	40
No of Lecture Hrs + Tutorial Hrs / Week	04+01	**Exam Marks**	60
Total No of Lecture + Practical Hrs	50	**Exam Hours**	03
CREDITS – 04			

FACULTY DETAILS:		
Name: Prof. G. V. Chiniwalar	**Designation:** Asst. Professor	**Experience: 18** Years
No. of times course taught: 02	**Specialization:** Machine Design	
Name: Prof. Mahantesh Tanodi	**Designation:** Asst. Professor	**Experience:** 06 Years
No. of times course taught: 06	**Specialization:** Machine Design	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
1	Mechanical Engineering	I/II	Elements of Mechanical Engineering
2	Mechanical Engineering	I/II/III/IV	Engg Mathematics
3	Mechanical Engineering	III	Mechanics of Materials

2.0 Course Objectives

1. Familiarize with mechanisms and motion analysis of mechanisms.
2. Understand methods of mechanism motion analysis and their characteristics.
3. Analysis motion of planar mechanisms, gears, gear trains and cams.

3.0 Course Outcomes

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

CO	Course Outcome	Cognitive Level	POs	PSOs
C216.1	Identify mechanisms with basic understanding of motion.	L2	PO1,PO2, PO6,PO8, PO12	PSO1,PSO2
C216.2	Comprehend velocity and acceleration analysis of planar mechanisms using graphical method, Instantaneous Center Method and Klein's Construction	L1,L2,L3	PO1,PO2, PO6,PO8, PO12	PSO1,PSO2
C216.3	Comprehend velocity and acceleration analysis of planar mechanisms using analytical method	L1,L2,L3	PO1,PO2, PO6,PO8, PO12	PSO1,PSO2
C216.4	Define gear terminology and identify types of gear, law of gearing, interference and examine gear trains for velocity ratio, tooth load and torque by algebraic and tabular column	L2	PO1,PO2, PO6,PO8, PO12	PSO1,PSO2
C216.5	Carry out motion analysis of cam profiles by analytical and graphical methods.	L2,L3	PO1,PO2, PO6,PO8, PO12	PSO1,PSO2
Total Hours of instruction		**50**		

4.0 Course Content

MODULE -1

Introduction: Definitions: Link, kinematic pairs, kinematic chain, mechanism, structure, degrees of freedom, Classification links, Classification of pairs based on type of relative motion, Grubler's criterion, mobility of mechanism, Groshoff's criteria, inversions of Grashoff's chain.

Mechanisms: Quick return motion mechanisms-Drag link mechanism, Whitworth mechanism and Crank and slotted lever Mechanism. Oldham's coupling, Straight line motion mechanisms Peaucellier's mechanism and Robert's mechanism. Intermittent Motion mechanisms: Geneva wheel mechanism, Ratchet and Pawl mechanism, toggle mechanism, pantograph, condition for correct steering, Ackerman steering gear mechanism.(**10 Hours)**

MODULE -2

Velocity and Acceleration Analysis of Mechanisms (Graphical Method): Velocity and acceleration analysis of four bar mechanism, slider crank mechanism. Mechanism illustrating Coriolis component of acceleration. Angular velocity and angular acceleration of links, velocity of rubbing.

Velocity Analysis by Instantaneous Center Method: Definition, Kennedy's theorem, Determination of linear and angular velocity using instantaneous center method.

Klein's Construction: Analysis of velocity and acceleration of single slider crank mechanism. (**10Hours)**

MODULE -3

Velocity and Acceleration Analysis of Mechanisms (Analytical Method): Velocity and acceleration analysis of four bar mechanism, slider crank mechanism using complex algebra method.

Freudenstein's equation for four bar mechanism and slider crank mechanism.

Function Generation for four bar mechanism.(1**0Hours)**

MODULE -4

Spur Gears: Gear terminology, law of gearing, path of contact, arc of contact, contact ratio of spur gear. Interference in involute gears, methods of avoiding interference, back lash, condition for minimum number of teeth to avoid interference, expressions for arc of contact and path of contact

Gear Trains: Simple gear trains, compound gear trains. Epicyclic gear trains:aAlgebraic and tabular methods of finding velocity ratio of epicyclic gear trains, torque calculation in epicyclic gear trains.(**10 Hours)**

MODULE -5

Cams: Types of cams, types of followers. displacement, velocity and acceleration curves for uniform velocity, Simple Harmonic Motion, Uniform Acceleration Retradation, Cycloidal motion. Cam profiles: disc cam with reciprocating / oscillating follower having knife-edge, roller and flat-face follower inline and offset.

Analysis of Cams: Analysis of arc cam with flat faced follower. (**10 Hours)**

5.0 Relevance to future subjects

SL. No	Semester	Subject	Topics / Relevance
01	VI	Design of machine element II	Gears/Cams
02	VII	Project Work	Kinematic analysis and synthesis of Mechanical parts

6.0 Relevance to Real World

SL. No	Real World Mapping
01	Kinematic analysis and synthesis of Mechanisms
02	Kinematic analysis and synthesis of Gears

7.0 Books Used and Recommended to Students

Text Books
1.Rattan S.S, Theory of Machines, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 4 th Edition, 2014.
2.Ambekar A. G., Mechanism and Machine Theory, PHI, 2009.
Reference Books
1.Michael M Stanisic, Mechanisms and Machines-Kinematics, Dynamics and Synthesis, Cengage Learning, 2016.
2.Sadhu Singh, Theory of Machines, Pearson Education (Singapore)Pvt. Ltd, Indian Branch New Delhi, 2nd Edi. 2006.
Additional Study material & e-Books
1.Nptel.ac.in
2.VTU, E- learning

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

Website and Internet Contents References
http://www.nptel.ac.in

9.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	Mechanism and Machine Theory - Journal - Elsevier	https://www.journals.elsevier.com/mechanism-and-machine-theory
2	Theory of Mechanisms and Machines: electronic journal	tmm.spbstu.ru/english.html
3	Mechanisms and robotics	http://mechanismsrobotics.asmedigitalcollection.asme.org/journal.aspx

10.0 Examination Note

Internal Assessment: 40 Marks

Scheme of Evaluation for Internal Assessment
Internal Assessment test in the same pattern as that of the main examination (Average of the Three Tests) 30 Marks and Assignments on each Module 10 Marks

SCHEME OF SEMESTER END EXAMINATION:
There are five modules, two questions from each module
Student has to answer any five question choosing at least one questions from each module.

Max. Marks: 60Marks

11.0 Course Delivery Plan

Module No.	Lecture No.	Content of Lecture	% of Portion
1		**INTRODUCTION:**	20
	1	DEFINITIONS: Link or element, kinematic pairs,	
	2	Kinematic chain, Mechanism, structure, degrees of freedom,	
	3	Classification links, Classification of pairs based on type of relative motion	
	4	Grubler's criterion, mobility of mechanism, Groshoff's criteria, inversions of Grashoff's	

		chain.	
		Mechanisms	
	5	Quick return motion mechanisms-Drag link mechanism	
	6	Single slider crank chain and Double slider crank chain.	
	7	Crank and slotted lever Mechanism. Oldham's coupling,	
	8	Straight line motion mechanisms Peaucellier's mechanism and Robert's mechanism.	
	9	Intermittent Motion mechanisms: Geneva wheel mechanism, Ratchet and Pawl mechanism,	
	10	Toggle mechanism, pantograph, and condition for correct steering, Ackerman steering gear mechanism.	
2		**Velocity and Acceleration Analysis of Mechanisms (Graphical Method)**	**20**
	11	Velocity and acceleration analysis of four bar mechanism,	
	12	slider crank mechanism	
	13	Mechanism illustrating Coriolis component of acceleration	
	14	Angular velocity and angular acceleration of links, velocity of rubbing.	
	15	Velocity Analysis by Instantaneous Center Method: Definition, Kennedy's theorem,	
	16	Velocity Analysis by Instantaneous Center Method: Definition, Kennedy's theorem,	
	17	Determination of linear and angular velocity using instantaneous center method.	
	18	Determination of linear and angular velocity using instantaneous center method.	
	19	Klein's Construction: Analysis of velocity and acceleration of single slider crank mechanism.	
	20	Klein's Construction: Analysis of velocity and acceleration of single slider crank mechanism.	
3		**Velocity and Acceleration Analysis of Mechanisms (Analytical Method):**	**20**
	21	Velocity and acceleration analysis of four bar mechanism,	
	22	Velocity and acceleration analysis of four bar mechanism,	
	23	slider crank mechanism using complex algebra method	
	24	slider crank mechanism using complex algebra method	
	25	Freudenstein's equation for four bar mechanism and slider crank mechanism.	
	26	Freudenstein's equation for four bar mechanism and slider crank mechanism.	
	27	Function Generation for four bar mechanism.	
	28	Function Generation for four bar mechanism.	
	29	Problems	
	30	Problems	
4		**Spur Gears:**	**20**
	31	Gear terminology, law of gearing	
	32	Path of contact, arc of contact, contact ratio of spur gear.	
	33	Interference in involute gears, methods of avoiding interference,	
	34	back lash, condition for minimum number of teeth to avoid interference	
	35	Expressions for arc of contact and path of contact	
	36	**Gear Train:** Simple gear trains, compound gear trains	
	37	Epicyclic gear trains:	
	38	Algebraic and tabular methods of finding velocity ratio of epicyclic gear trains,	
	39	Torque calculation in epicyclic gear trains.	
	40	Solving of related numerical.	
5		**Cams:**	**20**
	41	Types of cams, types of followers	
	42	Displacement, velocity and acceleration curves for uniform velocity	
	43	Simple Harmonic Motion	
	44	Uniform Acceleration Retardation, Cycloidal motion. Cam profiles	
	45	Problems	
	46	Disc cam with reciprocating / oscillating follower having knife-edge	
	47	Problems	
	48	Roller and flat-face follower inline and offset.	
	48	**Analysis of Cams**: Analysis of arc cam with flat faced follower.	
	49	Analysis of arc cam with flat faced follower.	
	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	*Assignment -1*: Questions on Introduction & Mechanisms	Explain Basic definitions and Mechanisms	Module 1	2	Individual Activity.	Text Book 1&2
2	*Assignment-2:* Questions on Velocity and Acceleration Analysis of Mechanisms (Graphical Method)	Analyses Velocity and Acceleration of Mechanisms by Graphical Method.	Module 2	4	Individual Activity.	Text Book 1&2
3	*Assignment-3:* Questions on Velocity and Acceleration Analysis of Mechanisms (Analytical Method)	Analyses Velocity and Acceleration of Mechanisms by Analytical Method.	Module 3	6	Individual Activity.	Text Book 1&2
4	*Assignment-4:* Questions on Spur gears & gear trains	Explain Gear terminology & types of gears	Module 4	8	Individual Activity.	Text Book 1&2
5	*Assignment-5:* Cams and Analysis of Cams	Explain types of cams their terminology & Analysis of cams	Module 5	8	Individual Activity.	Text Book 1&2

13.0 QUESTION BANK

MODULE-1:
INTRODUCTION:

1. Define kinematic link, kinematic pair, and kinematic chain.
2. Distinguish between a) mechanism and machine b) completely constrained motion and successful constrained motion.
3. What is an inversion? Explain various inversions of single and double slider crank chains.
4. Discuss various types of constrained motions.
5. What are quick-return mechanisms? Where are they used? Discuss the functioning of any one of them.
6. Explain briefly elliptical trammel and scotch yoke mechanism with neat diagram.
7. Define mobility of a mechanism with example.
8. What is the difference between exact and approximate straight line mechanism. Explain each with suitable example.
9. Explain the working of the following mechanisms with neat sketch a) pantograph b) toggle mechanism c) Ackermann's steering gear mechanism d) Geneva mechanism e) Ratchet and pawl mechanism.
10. Explain the following mechanisms with suitable sketches a) drag link mechanism b) whit worth mechanism c) crank and slotted link mechanism.

MODULE-2:
VELOCITY AND ACCELERATION ANALYSIS OF MECHANISMS (GRAPHICAL METHODS):

1. In mechanism shown in fig.2.1, crank2 rotates at 3000rpm.Find the acceleration of the point C in magnitude, direction and sense. Find also the angular acceleration of link 3.

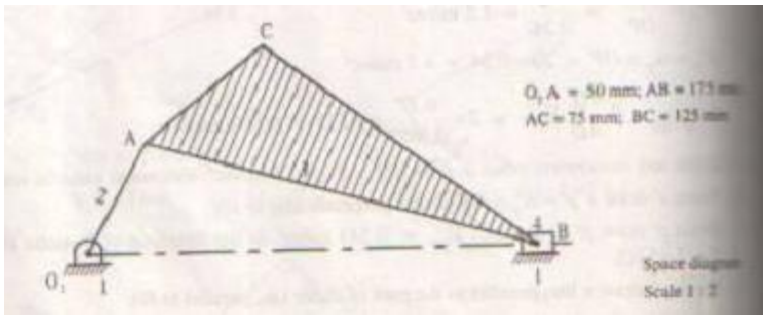


Fig. 2.1

2. The crank of a slider crank mechanism is 480mm long and rotates at 20 rad/sec in the counter clockwise direction. It has a connecting rod of 1600mm long. Determine the following when the crank is 60 degree from the inner dead centre, angular velocity of the connecting rod, the position and the velocity of a point P on the connecting rod having least absolute velocity shown in the fig.2.2

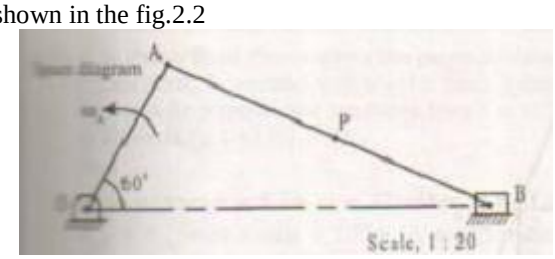


Fig. 2.2

3. The crank O2A of four bar mechanism shown in fig.2.3, is rotating clockwise at a constant speed of 100 rad/sec. Determine(a)The acceleration of the point C (b)The angular acceleration of the links 3&4.

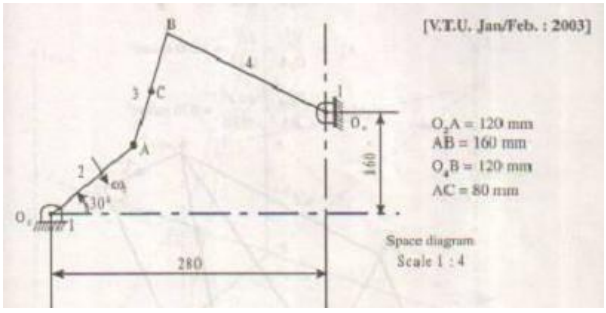


Fig. 2.3

4. A four bar mechanism ABCD is made up of four links, pin jointed at the ends. AD is fixed link which is 180 mm long. The links AB, BC, CD are 90 mm, 120mm and 120mm respectively. At certain instant, the link AB makes an angle of 60 degree with the link AD, if the link AB rotates at uniform speed of 100 rpm clockwise determine angular velocity of links BC and CD and angular acceleration of link CD and CB as shown in fig 2.4

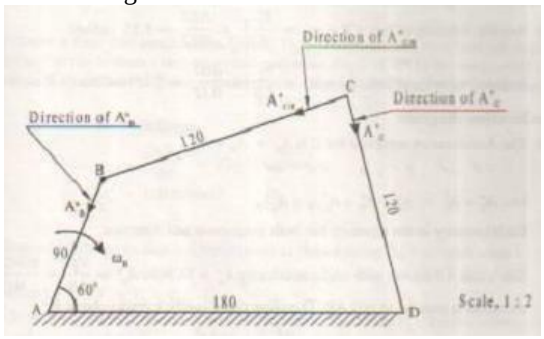


Fig. 2.4

5. In a slider crank mechanism, the crank OB = 30mm and the connecting rod BC=120mm. the crank rotates at uniform speed of 300rpm clockwise. Find the crank position shown in the figure in which the crank is turned 60 degree, find a) velocity of piston C and angular velocity of connecting rod BC b) acceleration of piston C and angular acceleration of connecting rod BC as shown in fig 2.5

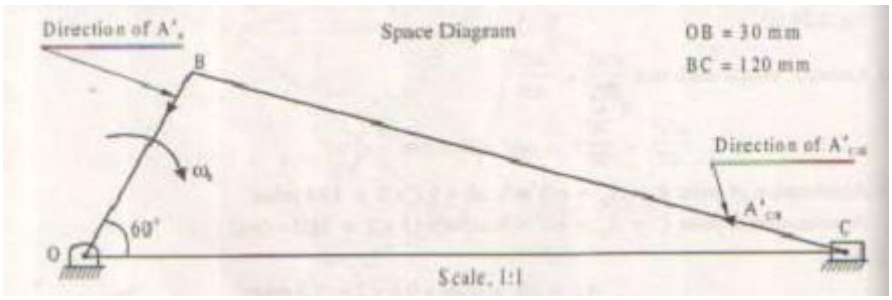


Fig. 2.5

VELOCITY ANALYSIS BY INSTANTANEOUS CENTER METHOD:

1. State and prove Arnold-Kennedy theorem of three centers or three centers inline theorem with a neat diagram.
2. Locate all the instantaneous centers for the four bar mechanism shown in the figure as shown in fig.2.6

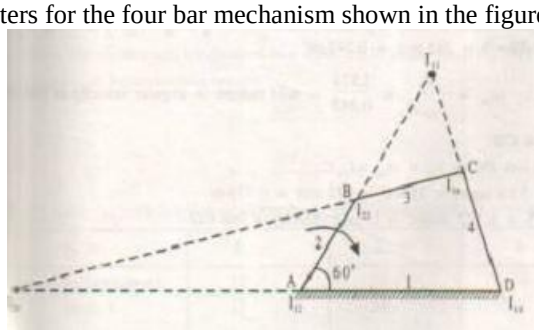


Fig. 2.6

3. Locate all the instantaneous centers for the slider and crank mechanism shown in the fig.2.7

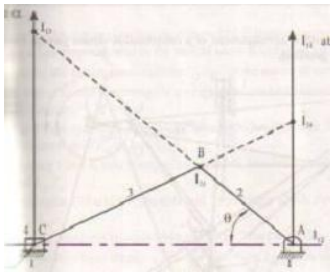


Fig. 2.7

4. In a four bar mechanism shown in fig 4.4,link 2 is rotating at angular velocity ω2.locate all the instantaneous centers of the mechanism &find a) the angular speeds of link 3 & 4, the linear velocity of links 3 & 4, the linear velocities of points E & F as shown in the figure 2.8

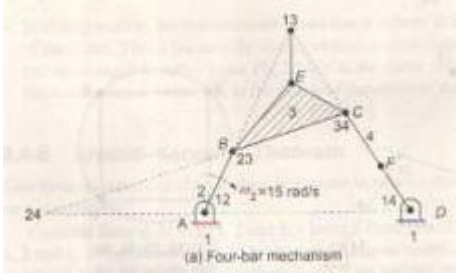


Fig. 2.8

5. Locate all the instantaneous centers of the mechanism shown in the figure 2.9

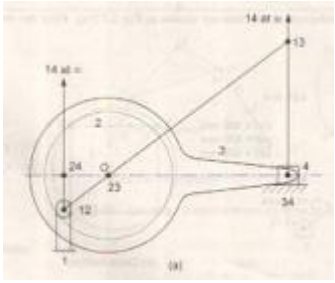


Fig. 2.9

1. A pin jointed four bar mechanism of link AB=150 mm, BC= 180 mm, CD= 180 mm and the fixed link AD= 300 mm. link AB makes 60 degree with the link AD and rotates uniformly at 100 rpm. Locate all the instantaneous centers and find the angular velocity of link BC and the linear velocity of link CD as shown in fig 2.10

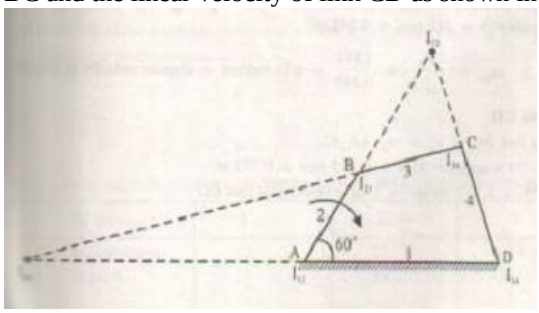


Fig. 2.10

2. In a slider crank mechanism, the crank OA=300 mm and connecting rod AB=1200 mm. the crank OA is turned 30 degree from inner dead centre locate all the instantaneous centers. If the crank rotates at 15 radian per second. Fin a) velocity of slider B and b) angular velocity of connecting rod AB as shown in fig 2.11

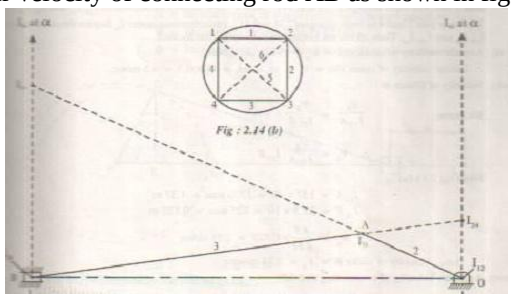


Fig. 2.11

3. Determine the velocity and acceleration of the piston by the Klein's construction to the following specifications: stroke=300 mm, ratio of connecting rod to crank length=4, speed of the engine=300 rpm, position of crank=45 degree with inner dead centre.

MODULE-3:

VELOCITY AND ACCELERATION ANALYSIS OF MECHANISMS (ANALYTICAL METHODS):

1. If the crank and connecting rod are 150 mm and 600 mm long respectively and the crank rotates at a constant speed of 100 rpm, determine a) velocity and acceleration of the piston b) angular velocity c) and angular acceleration of the connecting rod. The angle which the crank makes with the inner dead centre is 30 degrees.
2. The length of the connecting rod of a gas engine running at 340 rpm is 600mm and the crank is 120mm long. When the piston has moved one fourth stroke during out stroke determine a) then angular position of the crank b) the angular speed of connecting rod and c) the acceleration of the piston.
3. The length of the crank of a reciprocating engine is 120mm and its connecting rod length is 600mm it rotates at 360 rpm and at a particular instant it makes an angle of 50 degree with the inner dead center. Find a) velocity and

acceleration of the piston b) velocity and acceleration of the midpoint of the connecting rod c) angular velocity and angular acceleration of the connecting rod.

MODULE-4:

SPUR GEARS:

1. Two spur gears have 24 and 30 teeth of module =10mm, standard addendum=1 module, pressure angle=20 degrees find a) length of arc of contact b) contact ratio.
2. Two mating gears with module pitch 6mm have 20 and 50 teeth of pressure angle 20 degrees and addendum 6mm. Determine the number of pairs of teeth in contact.
3. A pinion of 24 teeth drives a gear of 60 teeth at a pressure angle of 20 degrees. The pitch radius of pinion is 38mm and outside radius is 41mm. The pitch radius of the gear is 95mm and the outside radius 98.5mm. Calculate the length of path of contact and contact ration.
4. Two 20 degrees involute gears in mesh have a gear ratio of 2 and 20 teeth on the pinion. The module is 5mm and the pitch line speed is 1.5 mtr per second. Assuming addendum to be equal to 1 module find a) angle turned through by pinion when one pair of teeth is in mesh and b) maximum velocity of sliding.
5. Two spur gears have 30 teeth each of involute shape. The circular pitch is 25mm. Pressure angle=20 degrees, determine the addendum of wheels if arc of contact is twice the circular pitch.
6. Two gear wheels mesh externally and are to give velocity ratio of 3. The teeth are of involute form of module 6mm and standard addendum=1module. Pressure angle=18 degrees, pinion rotates at 90 rpm. Find a) number of teeth on each wheel so that interference is just avoided b) length of path of contact c) maximum velocity of sliding between teeth.
7. Find the minimum number of teeth to avoid under cutting when the addendum for teeth is 0.84 module. Gear ratio is 3:1; find the length of arc of contact in terms of module. Pressure angle=20 degrees.
8. Two gears in mesh have a module of 8mm and a pressure angle of 20 degree. The larger gear has 57 teeth while pinion has 23 teeth. If the addenda on pinion and gear wheel are equal to 1module find a) the number of pairs of teeth in contact the angle of action of the pinion and the gear wheel.

GEAR TRAINS:

1. Two spur gears A & B of an Epicyclic gear train is shown in the figure 4.1 have 24 and 30 teeth respectively. The arm rotates at 100 rpm clockwise. Find the speed of gear B on its own axis when gear A is fixed. If instead of being fixed the wheel A rotates at 200 rpm in ccw direction, what will be the speed of gear B. (solve it by algaebraic method)

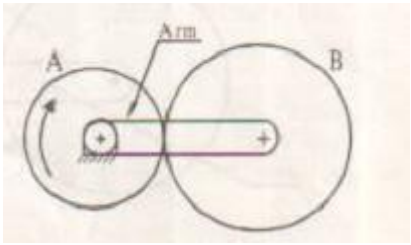


Fig. 4.1

2. In an Epicyclic gear train shown in the figure 4.2, the arm A is fixed to the shaft S the wheel B having 100 teeth rotates freely on the shaft S , wheel F 150 teeth is separately driven. If the arm A runs at 200 rpm, wheel F at 100 rpm in the same direction find a) number of teeth of gear C b) speed of the wheel B. (solve it by algebraic method)

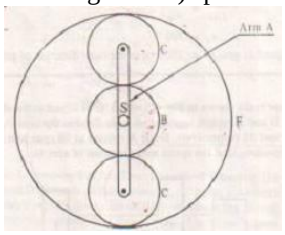


Fig. 4.2

3. A fixed annular wheel B has 92 teeth. Wheel C and D have 25 and 15 teeth respectively. Wheel E has 52 teeth, if the arm A rotates at 130 rpm, what is the speed of wheel E shown in the figure 4.3.(solve it by algaebraic method)

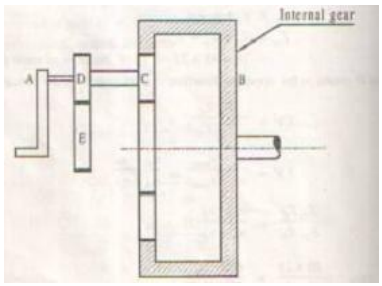


Fig. 4.3

4. The gear train shown in the fig.3.4.Gear A meshes with gear B.In the compound gear B-C, gear C meshes with gear D, Rotating relative to A around the same axis of A. If the gear A is fixed, arm F is used as the driving member, determine the speed ratio n_D/n_F. Number of teeth on wheels A,B,C&D are 61,61,62&60 respectively(solve it by graphical method.)

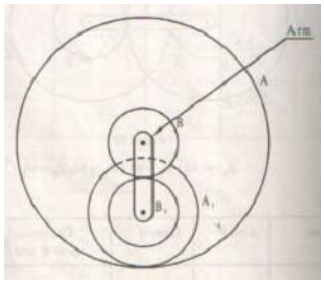


Fig. 4.4

5. An Epicyclic gear train is constructed as shown in fig 4.5.A fixed annular wheel A & a smaller concentric wheel B are connected by a compound wheel A_1-B_1.A_1 gearing with A. B_1 gearing with B. The compound wheel revolves on a stud which is carried around an arm which revolves about the axis A&B.A has 130 teeth,B1=80 teeth, pitch of A&A_1 being twice that of pitch of B&B_1.How many revolutions B will make for one revolution of the arm. (solve it by algebraic method)

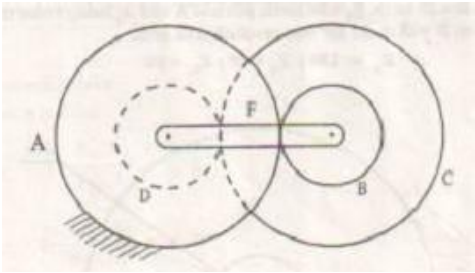


Fig. 4.5

6. An Epicyclic gear train is shown in the fig. 4.6.The wheel A is fixed& the input at the arm R is 3KW at 600rpm.Find the speed of wheel D and the torque required to hold the wheel A. Neglect frictional losses. (solve it by algebraic method)

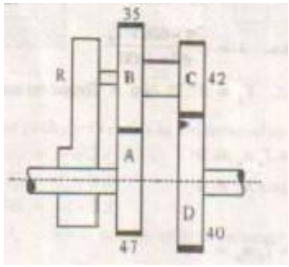


Fig. 4.6

7. In Epicyclic gear train shown in the fug 4.7, wheels A, D, E are free to rotate independently on the spindle O, while the compound wheel B-C rotates on the spindle P on the arm OP .If wheel A is given clockwise revolution of 60rpm, while gear D is given counterclockwise revolution at 300rpm,Determine the magnitude and direction of speeds of arm OP and wheel E.

Wheel	A	B	C	D	E
Teeth	12	30	14	?	?

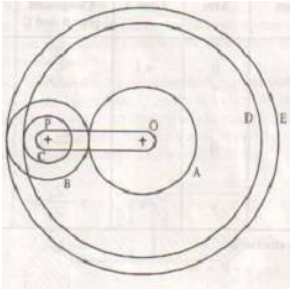


Fig. 4.7

8. Explain the term train value and velocity ratio used in gear trains.
9. Explain different types of gear trains with neat sketches and give examples where each one is used in practice.
10. Explain the sketches (a) Compound gear train (b) Reverted gear train (c) Epicyclic gear train.

MODULE-5:
CAMS:

1. Enumerate commonly used types of cams.
2. Discuss briefly the types of follower displacement diagrams
3. Define the following terms related to cam (a)Lift (b)Dwell (c)Pressure angle (d)Base circle
4. Explain the following types of cams (a)D-R-D cam (b)D-R-R-D cam (c)R-R-R cam.
5. Draw the profile of the cam operating a roller reciprocating follower with the following data: minimum radius of the cam==25mm,lift==30mm,roller diameter==15mm.The cam lifts the follower for 120degree with SHM followed by a dwell period of 30degree.Then the follower lowers down during 150degree of the cam rotation with uniform acceleration and deceleration followed by a dwell period .If the cam rotates at uniform speed of 150rpm,calculate the maximum velocity and acceleration of the follower during decent period.
6. A flat faced follower is raised through a distance of 25mm is 120degree rotation of the cam, remains at rest for the next 30degree and is lowered during further 120degree rotation of the cam. The raising of the follower takes place with cycloidal motion and the lowering with uniform acceleration and deceleration. However, the uniform acceleration is 2/3 of the uniform deceleration .The least radius of the cam is 25mm.Draw the cam profile assuming clockwise rotation of the cam.
7. Draw the profile of the cam to give the following motion to the follower: Follower to move through 30mm during 180degree of cam rotation with cycloidal motion .Follower to return with cycloidal motion during 180degree of cam rotation .Base circle radius of the cam is30mm&the roller diameter of the follower is 10mm.The axis of the roller is offset by 8mm to the right. .Determine the maximum velocity& acceleration of the follower during the out stroke, when the cam rotates at 2000rpm.

14.0 University Result

Examination	S+	S	A	B	C	D	E	% Passing
July 2017 (A&B)	00	01	12	50	38	27	20	87.81
July 2018 (A&B)	00	01	12	37	40	18	11	95.18

Prepared by	Checked by		
Prof.Mahantesh Tanodi	**Prof.G. V. Chinniwalar**	**HOD**	**Principal**

Subject Title	**APPLIED THERMODYNAMICS**		
Subject Code	17ME43	**IA Marks**	40
No of Lecture Hrs + Tutorials Hrs / Week	03 L+ 02 T	**Exam Marks**	60
Total No of Lecture + Tutorial Hrs	50	**Exam Hours**	03
CREDITS – 04			

FACULTY DETAILS:		
Name : Dr. B.M. Shrigiri	**Designation :** HOD	**Experience : 20**
No. of times course taught: 04Times	**Specialization:** Thermal Power Engineering	
Name: Prof. M. M. Shivashimpi	**Designation:** Assistant Professor	**Experience:** 11 Years
No. of times course taught: 09Times	**Specialization:** Thermal Power Engineering	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Mechanical Engineering	I, II & III	Engineering Mathematics
02	Mechanical Engineering	III	Basic Thermodynamics

2.0 Course Objectives

1. To have a working knowledge of basic performance of Gas power cycles.
2. To understand and evaluate the performance of steam power cycles their various Engineering applications.
3. To know how fuel burns and their thermodymic properties.
4. To Understand mechanism of power transfer through belt, rope, chain and gear drives in IC Engines.
5. To determine performance parameters of refrigeration and air-conditioning systems.
6. Evaluate the performance parameters of reciprocating air compressor as a function of receiver pressure.

3.0 Course Outcomes

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

CO	Course Outcome	Cognitive Level	POs
C215.1	Recall thermodynamic concepts to analyze the performance of I C engine and gas power cycles including propulsion systems.	**L1,L4**	PO1,P02,P04,PO6 .PO7,PO12
C215.2	Analyze Rankine cycle for the improvement in performance of steam power plant.	**L4**	PO1,P02,P04,PO7 ,PO12
C215.3	Perform the Combustion analysis of fuels or flue gases and Conduct the performance analysis of I. C. Engines.	**L4**	PO1,P02,P04,PO7 ,PO12
C215.4	Compare the working principles and applications of different refrigeration systems and evaluate the psychometric properties of air conditioning systems.	**L3**	PO1,P02,P04,PO6 .PO7,PO12
C215.5	Explain the thermodynamic analysis of reciprocating air compressors and function of steam nozzle.	**L2,L4**	PO1,P02,PO3,PO6 ,PO12
Total Hours of instruction		**50**	

4.0 Course Content

Module - I

Gas Power Cycles : Gas Power Cycles:Air standard cycles; Carnot, Otto, Diesel, Dual and Stirling cycles, p-v and T -s diagrams, description, efficiencies and mean effective pressures. Comparison of Otto and Diesel cycles. Gas turbine (Brayton) cycle; description and analysis. Regenerative gas turbine cycle. Inter-cooling and reheating in gas turbine cycles. Jet propulsion: Introduction to the principles of jet propulsion.**10 Hours**

Module –II

Vapour Power Cycles: vapour power cycle, drawbacks as a reference cycle. Simple Rankine cycle; description, T-s diagram, analysis for performance. Comparison of Carnot and Rankine cycles. Effects of pressure and temperature on Rankine cycle performance. Actual vapour power cycles. Ideal and practical regenerative Rankine cycles, open and closed feed water heaters. Reheat Rankine cycle. Characteristics of an Ideal working fluid in Vapour power cycles, Binary Vapour cycles. **10 Hours**

Module –III

Combustion Thermodynamics: Theoretical (Stoichiometric) air for combustion of fuels. Excess air, mass balance, Exhaust gasanalysis, A/F ratio. Energy balance for a chemical reaction, enthalpy of formation, enthalpy and internal energy of combustion. Combustion efficiency. Dissociation and equilibrium, emissions. **I.C.Engines:** Classification of IC engines, Combustion of SI engine and CI engine, Detonation and factors affecting detonation, Performance analysis of I.C Engines, heat balance, Morse test, IC Engine fuels, Ratings and Alternate Fuels.**10 Hours**

Module –IV

Refrigeration Cycles: Vapour compression refrigeration system; description, analysis, refrigerating effect. Capacity, power

required, units of refrigeration, COP, Refrigerants and their desirable properties, alternate Refrigerants. Any one case study on cold storage or industrial refrigerator. Air cycle refrigeration; reversed Carnot cycle, reversed Brayton cycle, Vapour absorption refrigeration system. Steam jet refrigeration. **Pscychrometrics and Air-conditioning Systems:** Properties of Atmospheric air, and Psychometric properties of Air, Psychometric Chart, Analyzing Air-conditioning Processes; Heating, Cooling, Dehumidification and Humidification, Evaporative Cooling. Adiabatic mixing of two moist air streams. Cooling towers.**10 Hours**

Module –V

Reciprocating Compressors: Operation of a single stage reciprocating compressors. Work input through p-v diagram and steady state steady flow analysis. Effect of Clearance and Volumetric efficiency. Adiabatic, Isothermal and Mechanical efficiencies. Multistage compressor, saving in work, Optimum intermediate pressure, Inter-cooling, Minimum work for compression. **Steam nozzles:** Flow of steam through nozzles, Shape of nozzles, effect of friction, Critical pressure ratio, Supersaturated flow **10 Hours**

5.0 Relevance to future subjects

SL. No	Semester	Subject	Topics / Relevance
01	VIII	Project work	Application of IC engine, turbine, Compressor, Refrigeration and air-conditioning
02	V	Turbo machines	Euler's turbine equation, Steam turbine, compressor, pump and hydraulic turbine
03	VI	Heat and Mass Transfer	Boiling and condensation, Heat Exchanger

6.0 Relevance to Real World

SL. No	Real World Mapping
01	Application of IC Engine, Power generation from Gas turbine and steam turbine.
02	Analysis of actual cycle with reference of ideal cycles.
03	Design of air conditioners, compressor.
04	Actual analysis of combustion process in the IC engine, steam turbines, Gas turbines.
05	To control the environmental pollution.

7.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
01	Tutorial	Solving the unsolved problems from the reference and text books and demonstration in laboratory
02	Nptel.ac.in	E- Learning
03	VTU, E- learning	E- Learning
04	MOOCS	E- Learning
05	Open courseware	E- Learning

8.0 Books Used and Recommended to Students

Text Books
1. Thermodynamics an engineering approach, by Yunus A. Cenegal and Michael A. Boles. Tata McGraw hill Pub. Sixth edition, 2008.
2. Basic and Applied Thermodynamics" by P .K. Nag, Tat a McGraw Hill, 2nd Edi. 2009
3. Fundamentals of Thermodynamics by G.J. Van Wylen and R.E. Sonntag, Wiley Eastern. Fourth edition 19993.
Reference Books
1.Thermodynamics for engineers, Kenneth A. Kroos and Merle C. Potter, Cengage Learning, 2016
2.Principles of Engineering Thermodynamics, Michael J,Moran, Howard N. Shapiro, Wiley, 8th Edition
3. An Introduction to Thermo Dynamics byY.V.C.Rao, Wiley Eastern Ltd, 2003.
4. Thermodynamics by Radhakrishnan. PHI, 2nd revised edition.
5. I.C Engines by Ganeshan.V. Tata McGraw Hill, 4rth Edi. 2012.
6. I. C. Engines by M.L.Mathur& Sharma. DhanpatRai& sons- India
Additional Study material & e-Books
1. Applied Thermodynamics by R.K Hedge and Niranjan Murthy
2. Thermal Engineering by R K. Rajput
3. Applied Thermodynamics by Kestur and Pravin

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

Website and Internet Contents References
1.Nptel.ac.in
2.VTU, E- learning
3.http://www.sjbit.edu.in/sjbit-downloads.html
4.http://auto.howstuffworks.com/

10.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	Applied Thermal Engineering	http://www.sciencedirect.com/science/journal/13594311
2	Case Studies in Thermal Engineering	http://www.sciencedirect.com/science/journal/2214157X
3	Auto car India Magazine	http://www.autocarindia.com/Magazine/
4	Low-Tech magazines	http://www.lowtechmagazine.com/
5	Thermal News	http://www.thermalnews.com/main/

11.0 Examination Note

Internal Assessment: (30 marks for I.A. + 10 marks for assignment) = 40 Marks

SCHEME OF EXAMINATION:

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		**Gas Power Cycles**	20
	1	Air standard cycles; Carnot, Otto, Diesel , p-v and T -s diagrams, description, efficiencies and mean effective pressures	
	2	Dual and Stirling cycles, p-v and T -s diagrams, description, efficiencies and mean effective pressures	
	3	Comparison of Otto and Diesel cycles and solving related numericals	
	4	Solving related numericals	
	5	Solving related numericals	
	6	Gas turbine (Brayton) cycle; description and analysis. Regenerative gas turbine cycle	
	7	Inter-cooling and reheating in gas turbine cycles.	
	8	Jet propulsion: Introduction to the principles of jet propulsion	
	9	solving related numericals	
	10	solving related numericals	
2		**Vapour Power Cycles**	40
	11	Carnot vapour power cycle, drawbacks as a reference cycle. Simple Rankine cycle; description, T-s diagram, analysis for performance	
	12	Comparison of Carnot and Rankine cycles. Effects of pressure and temperature on Rankine cycle performance.	
	13	Actual vapourpower cycles. Ideal and practical regenerative Rankine cycles,	
	14	Open and closed feed water heaters. Reheat Rankine cycle	
	15	Characteristics of an Ideal working fluid in Vapour power cycles, Binary Vapour cycles	
	16	Solving related numericals	
	17	Solving related numericals	
	18	Solving related numericals	
	19	Solving related numericals	
	20	Solving related numericals	
3		**Combustion Thermodynamics**	60
	21	Theoretical (Stoichiometric) air for combustion of fuels. Excess air, mass balance, Exhaust gas analysis, A/F ratio.	
	22	Energy balance for a chemical reaction, enthalpy of formation, enthalpy and internal energy of combustion. Combustion efficiency	
	23	Dissociation and equilibrium, emissions	
	24	Solving related numericals	
	25	Solving related numericals	
		I. C. Engines	
	26	Classification of IC engines, Combustion of SI engine and CI engine	
	27	Detonation and factors affecting detonation, Performance analysis of I.C Engines, heat balance, Morse test, IC Engine fuels	
	28	Ratings and Alternate Fuels.	
	29	Solving related numericals	
	30	Solving related numericals	
		Refrigeration Cycles	80

4	31	Vapour compression refrigeration system; description, analysis, refrigerating effect. Capacity, power required, units of refrigeration, COP	
	32	Refrigerants and their desirable properties, alternate Refrigerants. Any one case study on cold storage or industrial refrigerator. Air cycle refrigeration;	
	33	Reversed Carnot cycle, reversed Brayton cycle,Vapour absorption refrigeration system. Steam jet refrigeration	
	34	Solving related numericals	
	35	Solving related numericals	
		Pscychrometrics and Air-conditioning Systems	
	36	Properties of Atmospheric air, and Psychometric properties of Air, Psychometric Chart	
	37	Analyzing Air-conditioning Processes; Heating, Cooling, Dehumidification and Humidification	
	38	Evaporative Cooling. Adiabatic mixing of two moist air streams. Cooling towers	
	39	Solving related numericals	
	40	Solving related numericals	
5		**Reciprocating Compressors**	100
	41	Operation of a single stage reciprocating compressors. Work input through p-v diagram and steady state steady flow analysis	
	42	Effect of Clearance and Volumetric efficiency. Adiabatic, Isothermal and Mechanical efficiencies	
	43	Multi-stage compressor, saving in work, Optimum intermediate pressure, Inter-cooling, Minimum work for compression	
	44	Solving related numericals	
	45	Solving related numericals	
	46	Solving related numericals	
		Steam nozzles	
	47	Flow of steam through nozzles	
	48	Shape of nozzles, effect of friction	
	49	Critical pressure ratio, Supersaturated flow	
	50	Solving related numericals	

13.0 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	*Assignment -1*: Questions on Gas Power Cycles	Analyze the performance of I C engine and gas power cycles including propulsion systems.	Module 1	2	Individual Activity.	Text Book 2 and all the reference book
2	*Assignment-2:* Questions on vapor power cycles	Analyze Rankine cycle for the improvement in performance of steam power plant.	Module 2	4	Individual Activity.	Text Book 2 and all the reference book
3	*Assignment-3:* Questions on combustion thermodynamics and I.C engine	Perform the Combustion analysis of fuels or flue gases and Conduct the performance analysis of I. C. Engines.	Module 3	6	Individual Activity.	Text Book 2 and all the reference book

4	*Assignment-4:* Questions on Refrigeration Cycles and Pscychrometrics and Air-conditioning Systems	Compare the working principles and applications of different refrigeration systems and evaluate the psychometric properties of air conditioning systems.	Module 4	8	Individual Activity.	Text Book 2 and all the reference book
5	*Assignment-5:* Questions on Reciprocating Compressors and Steam nozzles	Explain the thermodynamic analysis of reciprocating air compressors and function of steam nozzle.	Module 5	8	Individual Activity.	Text Book 2 and all the reference book

14.0 QUESTION BANK

Module 1

Gas Power Cycles :

1. Derive the expression for the air standard efficiency of Diesel cycle with usual notations. State the assumptions made and represent the process on P-V and T-S diagram.
2. Show that the ideal Mean Effective Pressure of Otto cycle is given by P1 r (b -1) ($r^{(g-1)}$ –1) / (r-1) (g -1). Where, P1 = pressure at beginning of compression, r = compression ratio b = Ratio of maximum pressure to compression pressure g = Ratio of specific heat of the working fluids.
3. Compare Otto cycle and Diesel cycles, on the basis of the same compression ratio and same maximum pressure.
4. Compare Otto cycle and Diesel cycles, with help of PV and TS diagrams, based on the following conditions. i) When max. Cycle pressure and temp. are same. ii) When the compression ratio and heat addition are same.
5. With help of p-v and T-S diagrams, derive the expression for air standard efficiency of a semi diesel cycle in terms of C.R. Cut of ratio and expansion ratio.
6. Derive the expression for the air standard efficiency of Otto cycle with usual notations. State the assumptions made and represent the process on P-V and T-S diagram.
7. What do you understand by Air standard cycle?
8. Differentiate between open and closed gas turbines.
9. Explain the with neat sketches of Turbojet, turboprop, Ramjet and turbofan engines.
10. With neat T-S diagram explain the following i) inter cooling ii) reheating ii) regeneration.
11. Discuss the Jet propulsion and rocket propulsion.

Numericals:

1. A Carnot cycle using air as the working substance works between temperature limits of 900 K and 300 K. The pressure limits are 60 bars and 1 bar. Determine (i) pressure at salient points of the cycle, (ii) the heat supplied per unit mass of air, (iii) net work output per unit mass of air, (iv) mean effective pressure and (v) thermal efficiency of the cycle.
2. The maximum pressure and temperature in a Carnot gas power cycle are limited to 20 bar and 400^{o} C. The volumetric ratio of isentropic compression is 6 and volumetric ratio of isothermal expansion is 1.5. Assuming that air is the working substance and the volume of air at the beginning of isothermal expansion is 0.1 m^3, determine (i) the minimum temperature in the cycle, (ii) change in entropy during isothermal expansion process, (iii) thermal efficiency of the cycle, (iv) power output from the cycle if there are 200 cycles per minute and (v) mean effective pressure.
3. In an air-standard Carnot cycle, 110 kJ/kg of heat is transferred to the working fluid at 1110 K. Heat is rejected at 273 k. The minimum pressure in the cycle is 1bar. Find (i) thermal efficiency, (ii) mean effective pressure.
4. An ideal Otto cycle has a compression ratio of 8. The conditions at the beginning of compression stroke are 100 kPa and 17^{o} C. If the heat added during the cycle is 800 kJ/kg find (i) temperatures and pressures at salient points of the cycle, (ii) net work output per unit mass of air, (iii) thermal efficiency of the cycle, (iv) mean effective pressure, (v) compression ratio corresponding to maximum work output, (vi) maximum work output and (vii) thermal efficiency corresponding to maximum work output.
5. An air standard diesel cycle has a compression ratio of 14. The air-condition at the beginning of compression is 1 bar and 27 ^{o} C. The maximum temperature in the cycle is 2500 ^{o} C. Determine (i) temperature and pressure at

salient points of the cycle, (ii) net work output per unit mass of air, (iii) thermal efficiency, (iv) specific air consumption in kg/kWh, and (v) ME.

6. An air standard Bray ton cycle has air entering the compressor at 100kPa and 27 ^{o} C. The pressure ratio is 10 and the maximum allowable temperature in the cycle is 1350 K. Determine (i) temperatures at salient points of the cycle, (ii) compressor and turbine work per unit mass of air, (iii) net work output and work ratio, (iv) thermal efficiency of the cycle, (v) specific air consumption in kg/kWh, and (vi) improvement in the thermal efficiency of the cycle if a regenerator with 100 % effectiveness is incorporated in the cycle.
7. If the simple gas turbine cycle of example 3.17 is modified such that there are two stages of compression with inter cooling in between the stages, determine the net work output per unit mass of air and the thermal efficiency of the modified cycle. Assume the pressure ratio for each stage is such that the work output from the cycle is maximum. Assume the overall pressure ratio, the minimum cycle temperature and the maximum cycle temperature to be same as that in example 3.17.
8. An ideal gas turbine cycle has an overall pressure ratio Rp. The expansion takes place in two stages with reheating in between the stages. If R1 and R2 are the pressure ratios for the first and second stages of expansion show that for maximum work output from the cycleR1 = R2 = Rp. Also obtain expressions for the maximum net work output and for the corresponding thermal efficiency in terms of Rp and the maximum cycle temperature ratio 't'. Also draw the schematic and T-s diagrams for the cycle.
9. Determine the net work output and thermal efficiency of an ideal gas turbine cycle having two stages of compression with inter cooling in between the stages and two stages of expansion with reheating in between the stages. The overall pressure ratio for the cycle is 4 and the maximum cycle temperature is 900 ^{o} 0C Assume that the atmospheric temperature is 15 ^{o} C and the cycle is designed for maximum work output. Draw the schematic and T-s diagrams for the cycle. What would be the improvement in the thermal efficiency if an ideal regenerator is incorporated in the cycle?
10. The pressure ratio of an open cycle gas turbine cycle is 6. The compressor inlet conditions are 1 bar and 15 ^{o} C. The maximum temperature in the cycle is 800 ^{0}C. The isentropic efficiency of compressor is 85 % and that of the turbine is 90%. The combustion efficiency is 95 %. There is a pressure drop of 2 % of the inlet pressure in the combustion chamber. The calorific value of the fuel used is 42,000kJ/kg. Assuming that the values of Cp remain same throughout the cycle and equal to 1.4 and 1.005 kJ/(kg-K) respectively determine (i)net work output per unit mass of air,(ii) air-fuel ratio, (iii) thermal efficiency of the plant, (iv) specific fuel combustion in kg/kWh, and (v) power output from the plant for a mass flow rate of air of 1.0 kg/s.

Module 2

Vapour Power Cycles:

1. Sketch the flow diagram and corresponding temperature – entropy of a reheat cycle and derive an expression for reheat cycle efficiency. What are the advantages gained by the steam between stages?
2. Draw the line diagram and T-S diagram for vapor power cycle practical regenerative Rankine cycle with closed feed water heaters.
3. Draw the line diagram and T-S diagram for vapor power cycle practical regenerative Rankine cycle with open feed water heaters.
4. Explain with T-S diagrams, limitations of Carnot cycle and how we can overcome the same in Rankine cycle.
5. Explain clearly with help of a T-S diagram, the working of a Rankine cycle with regeneration using open feed water system. Also briefly comment upon the effect of pressure and temperature on performance.

Numericals :

1. In a simple Rankine cycle, dry saturated steam at 20 bars expands to pressure of 1 atmosphere. Determine (i) the pump work, (ii) turbine work, (iii) network output, (iv) thermal efficiency, (v) quality of steam entering the condenser, and (vi) specific steam consumption in kg/kWh. What would be the (i) network output, (ii) cycle efficiency, (iii) specific steam consumption in kg/kWh and (iv) quality of steam entering the condenser if the condenser pressure is reduced to 0.06 bars and compare the performance of the two cycles.
2. Compare the performance of simple Rankine cycle with boiler exit steam conditions of 20 bar and dry saturated with that of another simple Rankine cycle with boiler exit steam conditions of 30 bar and dry saturated in terms of (i) net work output, (ii) heat supply, (iii) thermal efficiency, (iv) steam rate and (v) quality of steam entering the condenser. Assume the condenser pressure to be 0.06 bars for both the cycles.
3. Compare the performance of an ideal reheat cycle with that of a simple Rankine cycle in terms of (i)net work output, (ii) thermal efficiency, (iii) steam rate, and iv) quality of steam entering the condenser assuming the following data. Boiler exit conditions are 15 bars and 300 C. Condenser pressure is 0.1 bars. Repeater pressure is 4bar. The steam is reheated at constant pressure back to its original temperature in the repeater.
4. In a simple Rankine cycle, steam conditions at the boiler exit are 10 bar and 300 ^{o} C. In the pipe line between the boiler exit and turbine inlet, there is an energy loss of 50 kJ/kg and a drop in pressure of 0.5 bars. The steam

expands in the turbine to a pressure of 0.09 bars. The isentropic efficiency of the turbine is 0.86 and that of the pump is 0.70. Determine (i) the condition of steam entering the turbine, (ii) actual pump work per unit mass of water, (iii) turbine work per unit mass of steam (iv) net work output and thermal efficiency of the cycle, and (v) quality of steam entering the condenser.

5. In a reheat steam cycle, the boiler exit conditions are 25 bar and 300 ^{o} C. The exit pressure of steam at the end of first stage is 5 bar. The steam is then reheated to300 ^{o} C before expanding in the second turbine to 0.05 bar. Assuming the high and low pressure turbines to have efficiencies of 87% and85 % respectively, find (i) the thermal energy input in the reheater, (ii) the cycle efficiency, (iii) specific steam consumption and(iv) power output for a mass flow rate of 2 kg/s.

Module 3

Combustion Thermodynamics, I. C. Engines:

1. Define the following a) Stoichimetric air b) Enthalpy of combustion c) Caloric value d) Adiabatic flame temperature e) Percentage of excess air .
2. With neat sketch, explain the analysis of exhaust gases by or sat apparatus.
3. Define heat of reaction and stiochiometric air fuel ratio.
4. Distinguish between I) Theoretical and excess air II) Higher heating value and lower heating value.
5. Balance the chemical equation for combustion of octane with theoretical amount of air, also find the theoretical air – fuel ratio.
6. Explain briefly the Morse test.
7. What do you understand by heat balance sheet? Enumerate the importance of the same.
8. Explain any three methods to measure indicate power of an IC engine in laboratory.
9. Explain the motoring test.
10. Differentiate between four stroke engine and two stroke engine.

Numericals :

1. Coal with following mass analysis is burnt with 100 % excess air C = 74 % , H_2 = 4.3 % , S= 2.7 % , N_2 = 1.5 % , 02= 5 % ,Ash = 7 % . Find the moles of gaseous products if 100 kg of fuel are burnt.
2. The products of combustion of hydrogen fuel of unknown composition have the following composition as measured on dry basis; $C0_2$ = 80 %; C0 = 0.9 %; 0_2 = 8.8 %, N_2= 82.3 %. Calculate: air fuel ratio, Composition of fuel on mass basis, the percentage of theoretical air on mass basis.
3. The volumetric composition of dry products of an unknown hydro carbon fuel CxHy, gives $C0_2$= 12.1 %, 0_2= 3.8 %, C0 =0.90 %, and N_2 = 83.4 % . Determine the chemical formula of fuel, air fuel ratio and percentage of excess air.
4. The sample of coal has following mass based analysis C = 80 %, H – 12 % and ash = 12 %. Compute the stoichiometric air fuel ratio and analysis of products by volume .
5. The fuel used in petrol engine contains 87 % carbon 13 % hydrogen. The air supply is 75 % of that theoretically required for complete combustion. Assuming that all hydrogen is burned and there is no free carbon left; find the volumetric analysis of dry exhaust gases.
6. The following observations have been made from the test of a four cylinder, two – stroke petrol engine. Diameter of the cylinder = 10 cm; stroke = 15 cm; speed = 1600 rpm; Area of indicator diagram = 5.5 cm2; Length of the indicator diagram = 55 mm; spring constant = 3.5 bar/cm; Determine the indicated power of the engine.
7. A gasoline engine (petrol engine) working on Otto cycle consumes 8 liters of petrol per hour and develops 25 kW. The specific gravity of petrol is 0.75 and its calorific value is 44, 000 kJ/kg. Determine the indicated thermal efficiency of the engine.
8. The bore and stroke of water cooled, vertical, single-cylinder, and four stroke diesel engines are 80 mm and 110 mm respectively. The torque is 23.5 Nm. Calculate the brake mean effective pressure. What would be the mean effective pressure and torque if the engine rating is 4 kW at1500 rpm?
9. A six cylinder, gasoline engine operates on the four stroke cycle. The bore of each cylinder is 80 mm and the stroke is 100 mm. The clearance volume in each cylinder is 70 cc. At a speed of 4000 rpm and the fuel consumption is 20 kg/h. The torque developed is 150 N-m. Calculate (i) the brake power, (ii) the brake mean effective pressure, (iii) brake thermal efficiency if the calorific value of the fuel is 43000 kJ/kg and(iv) the relative efficiency if the ideal cycle for the engine is Otto cycle.
10. An eight cylinder, four stroke engine of 9 cm bore, 8 cm stroke and with a compression ratio of 7 is tested at 4500 rpm on a dynamometer which has 54 cm arm. During a 10 minute test, the dynamometer scale beam reading was 42 kg and the engine consumed 4.4 kg of gasoline having a calorific value of 44,000 kJ/kg. Air at 27 ^{o} C and 1bar was supplied to the carburetor at a rate of 6 kg/min. Find (i) the brake power, (ii) the brake mean effective

pressure, (iii) the brake specific fuel consumption, (iv) the brake specific air consumption, (v) volumetric efficiency , (vi) the brake thermal efficiency and(vii) the air fuel ratio.

Module 4

Refrigeration Cycles, Pscychrometrics& Air-conditioning Systems:

1. Draw neat PV and TS diagram foe reversed Brayton cycle. And derive COP
2. Define COP.
3. What is one ton of refrigeration?
4. Distinguish between refrigeration and refrigerator.
5. Write note properties of refrigerants.
6. With a neat sketch, describe the clearly the working of a Bell – Coleman cycle.
7. Derive an expression for an Air refrigeration system.
8. Define a) Specific humidity b) degree of saturation c) relative humidity.
9. With neat sketch describe the a summer air condition system.
10. With neat sketch describe the a winter air condition system.
11. Represent the following processes on psychrometric chart a) Heating and humidifying b) sensible heating c) sensible cooling d) cooling and dehumidifying.

Numericals :

1. A reversed Carnot cycle is used for heating and cooling. The work supplied is 10 kW. If the COP is 3.5 for cooling determine (a) the ratio of maximum temperature to minimum temperature in the cycle , (b) refrigeration effect in tons and (c)COP if the cycle is used as a heat pump.
2. An ideal air refrigeration cycle has the following specifications: Pressure of air at compressor inlet = 101 kPa; Pressure of air at turbine inlet = 404 kPa; Temperature of air at compressor inlet = −6 ^{o} C; Temperature of air at turbine inlet = 27 ^{o} C; Determine (i) The COP of the cycle, (ii) Power required to produce 1 ton of refrigeration, and (iii) air circulation rate per ton of refrigeration.
3. In an air refrigerating machine, the compressor takes in air at 1 bar and10 ^{o} C. After compression to 5.5 bar, the air is cooled to 30 ^{o} C before expanding it back to 1bar. Assuming ideal conditions, determine (i) refrigeration effect per unit mass of air, (ii) heat rejected by air per unit mass in the intercooler, and (ii) COP of the cycle, In an actual plant using the above cycle, the air flow rate is 1700 kg / h and the relative COP of the actual plant is 0.65. Determine the power required for the actual plant for the same refrigerant.
4. An air refrigeration system is to be designed according to the following specifications: Pressure of air at compressor inlet = 101 kPa; Pressure of air at compressor exit = 404 kPa; Temperature of air at compressor inlet = − 6 ^{o} C; Temperature of air at turbine inlet = 27 ^{o} C; Isentropic efficiency of compressor = 85 %;Isentropic efficiency of turbine = 85 %;Relative pressure drop in each heat exchanger = 3 %Capacity of the plant = 1 ton Determine (a) COP of the cycle, (ii) Power required in kW, and (iii) air circulation rate.
5. In an ideal air refrigeration cycle, air after compression in the compressor is first cooled in an intercooler and then passed through a regenerative heat exchanger. It is then expanded in a turbine and after expansion the air flows through the regenerative heat exchanger where it exchanges heat with the air coming from the intercooler. Then the cold air is passed through the cold chamber before it enters the compressor.(a) Draw the schematic layout of the plant.(b) obtain an expression for the COP of the cycle in terms of the pressure ratio of the compressor and the temperature ratio of the compressor inlet temperature to the turbine inlet temperature.
6. Moist air at 35 ^{o} C has dew point of 15 ^{o} C. Calculate its relative humidity, specific humidity and enthalpy. Take Cp_v = 1.88 KJ /kg K. 7. 30 m ^{3} /min. of air at 15 ^{o} C DBT and 13 ^{o} C WBT is mixed 12 m ^{3} /min. of air at 25 ^{o} C DBT and 18 ^{o} C WBT. Calculate DBT, specific humidity of mixture. Take atm. Pressure as 760 mm of Hg . Calculate by calculation method only.

Module 5

Reciprocating Compressors, Steam nozzles:

1. Derive an expression for work done in a reciprocating air compressor a) without clearance b) with clearance.
2. What is the purpose of multi staging in reciprocating compressor? How does it affect a) Mechanical efficiency b) Volumetric Efficiency?
3. Derive an expression for work done for single stage, single acting reciprocating compressor with clearance volume.
4. Discuss the application of compressed air, and derive an expression for the volumetric efficiency of reciprocating air compressor.
5. State the advantages of multistage compression.
6. For perfect inter cooling obtain an expression for the intermediate pressure in terms of initial and final pressure. Hence show that pressure ratio per stage is equal.

Numericals:

1. An ideal compressor has a displacement volume (stroke volume) of 14litres and a clearance volume of 0.7 liter. It receives air at 100 KPa and discharges at500 KPa. The compression is polytrophic with index equal to 1.3 and expansion is isentropic. Assuming that air behaves as a perfect gas, determine (i) work done on air per cycle and (ii) the error involved in calculation of work done if the index for compression and for expansion are both equal to 1.3.
2. A double acting compressor, with a piston displacement of 0.05 m^3 per stroke, operates at 500 rpm. The clearance is 5 percent and it receives air at 100 KPa and discharges at 600 KPa. The compression is polytrophic according to the law $PV^{1.35}$ =constant. Determine the power required to drive the compressor and the mass of air delivered in kg/s if the suction temperature is 27 ^{o} C.
3. A single acting air compressor has a cylinder of bore 15 cm and the piston stroke is 25 cm. The crank speed is 600 rpm. Air is taken from atmosphere (1 bar and 27 C) and is delivered at 11 bars. Assuming polytrophic compression of the type $PV^{1.25}$ = C, find the power required to drive the compressor if its mechanical efficiency is 80%. The compressor has a clearance which is $1/20^{th}$ of the stroke volume. How long will it take to deliver 1 m^3 of air at the compressor inlet conditions? Also find the volumetric efficiency of the compressor.
4. A reciprocating compressor has a 5 % clearance with a bore and stroke of 25 x 30 cm. The compressor operates at 500 rpm. Air enters the cylinder at 27 ^{o} C and 95KPa and discharges at 2000 KPa. If the indices for both compression and expansion are equal to 1.3 Determine (i) volumetric efficiency, (ii) the volume of air handled at inlet conditions in m^3/s, (iii) the power required to drive the compressor if the mechanical efficiency is 90 %, (iv) the mass of air delivered in kg/s, (v) the mass of air in the clearance space.
5. A single cylinder single acting air compressor takes air from atmosphere (1.0315 bars and 25 ^{o} C) and delivers at 9 bar. The compressor running at 900 rpm, delivers1291 kg of air per minute. The compression index is 1.25. The stroke to bore ratio is 1.25 and the mechanical efficiency is 83 %. Calculate: (i) the cylinder dimensions, (ii) the power required to drive the compressor, and (iii) the heat transfer during compare assumptions needed to solve this problem.

15.0 University Result

Examination	S+	S	A	B	C	D	E	% Passing
May _June 2018	0	0	2	3	7	15	33	54.2
July 2017	0	0	0	4	18	26	37	62.78

Prepared by	Checked by		
Prof. M.M. Shivashimpi	**Dr. B.M. Shrigiri**	**HOD**	**Principal**

Subject Title	**FLUID MECHANICS**		
Subject Code	17ME44	**IA Marks**	40
No of Lecture Hrs + Tutorial Hrs / Week	03+02	**Exam Marks**	60
Total No of Lecture + Practical Hrs	50+0	**Exam Hours**	03
			CREDITS – 04

FACULTY DETAILS:		
Name: Prof. S.N.Topannavar	**Designation:** Asst. Professor	**Experience: 20** Years
No. of times course taught: 6 Times	**Specialization:** Thermal Power Engg.	
Name: Dr.R.M.Galagali	**Designation:** Assoc. Professor	**Experience:** 19Years
No. of times course taught: 5Times	**Specialization: Product Design & Manufacturing**	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
Mechanical Engineering	I/II/III/IV	Engg. Mathematics	Mechanical Engineering
Mechanical Engineering	III	Basic thermodynamics	Mechanical Engineering
Mechanical Engineering	IV	Applied thermodynamics	Mechanical Engineering

2.0 Course Objectives

- To have a working knowledge of the basic properties of fluids and understand the continuum approximation
- To Calculate the forces exerted by a fluid at rest on submerged surfaces and understand the force of buoyancy
- To understand the flow characteristic and dynamics of flow field for various Engineering applications
- To know how velocity changes and energy transfers in fluid flows are related to forces and torques and to understand why designing for minimum loss of energy in fluid flows is so important.
- To discuss the main properties of laminar and turbulent pipe flow and appreciate their differences and the concept of boundary layer theory.
- Understand the concept of dynamic similarity and how to apply it to experimental modeling
- To appreciate the consequences of compressibility in gas flow and understand the effects of friction and heat transfer on compressible flows

3.0 Course Outcomes

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

CO	Course Outcome	Cognitive Level	POs
CO1	Define and formulate the properties of fluids, fluid statics and effect of buoyancy.	L1, L2	PO1,PO2,PO6 ,
CO2	Interpret and apply the principles of fluid kinematics and dynamics, fluid flow measuring devices.	L3	PO1,PO2,PO4 ,
CO3	Formulate the correlations for the different fluid flows and analysis of different losses during the flow.	L4	PO1,PO2,PO4 , PO7,PO9,PO1
C04	Analyze the flow over bodies and dimensional analysis.	L4	PO1,PO2,PO3 ,
C05	Understand the basic concepts of compressible flow and CFD.	L2	PO1,PO2,PO6 ,
	Total Hours of instruction	**50**	

4.0 Course Content

MODULE -1

Basics: Introduction, Properties of fluids-mass density, weight density, specific volume, specific gravity, viscosity, surface tension, capillarity, vapour pressure, compressibility and bulk modulus. Concept of continuum, types of fluids etc, pressure at a point in the static mass of fluid, variation of pressure, Pascal's law, Absolute, gauge, atmospheric and vacuum pressures pressure measurement by simple, differential manometers and mechanical gauges.

Fluid Statics: Total pressure and center of pressure for horizontal plane, vertical plane surface and inclined plane surface submerged in static fluid. Buoyancy, center of buoyancy, meta-center and meta-centric height its application in shipping, stability of floating bodies. **10 Hours**

MODULE -2

Fluid Kinematics and Dynamics:

Fluid Kinematics: Types of Flow-steady, unsteady, uniform, non-uniform, laminar, turbulent, one,two and three dimensional, compressible, incompressible, rotational, irrotational, stram lines, path lines, streak lines, velocity components, convective and local acceleration, velocity potential, stream function, continuity equation in Cartesian co-ordinates. Rotation, vorticity and circulation, Laplace equation in velocity potential and Poisson equation in stream function, flow net, Problems.

Fluid Dynamics:

Momentum equation, Impacts of jets- force on fixed and moving vanes, flat and curved. Numericals. Euler's equation, Integration of Euler's equation to obtain Bernoulli's equation, Bernoulli's theorem, Application of Bernoulli's theorem such as venture meter, orifice meter, rectangular and triangular notch, pitot tube, orifices etc., related numerical**.** **12 Hours**

MODULE -3

Laminar and turbulent flow: Reynolds Number, Entrance flow and Developed flow,Navier-

Stokes Equation (no derivation),Laminar flow between parallel plates, Poiseuille equation – velocity profile, Couette flow, Fully developed laminar flow in circular pipes, Hagen - Poiseuille equation, related numericals.

Energy consideration in pipe flow, Loss of Pressure Head due to Fluid Friction, DarcyWeishach formula, major and minor losses in pipes, Commercial pipe, Colebrook equation, Moody equation/ diagram. Pipes in series, parallel, equivalent pipe, Related Numericals and simple pipe design problems**.** **10 Hours**

MODULE -4

Flow over bodies: Development of boundary layer**,** Prandtl's boundary layer equations, Blasius solution, laminar layer over a flat plate, boundary layer separation and its control. Basic concept of Lift and Drag, Types of drag, Co-efficient of drag and lift, streamline body and bluff body, flow around circular bodies and airfoils, Lift and drag on airfoil, Numericals.

Dimensional analysis: Need for dimensional analysis, Dimensions and units, Dimensional Homogeneity and dimensionless ratios, methods of dimensional analysis, Rayleigh's method, Buckingham Pi theorem, Similitude and Model studies. Numericals. **10 Hours**

MODULE -5

Compressible Flows: Introduction, thermodynamic relations of perfect gases, internal energy and enthalpy, speed of sound, pressure field due to a moving source, basic Equations for one- dimensional flow, stagnation and sonic Properties, normal and oblique shocks.

Introduction to CFD: Necessity, limitations, philosophy behind CFD, applications. **08Hours**

5.0 Relevance to future subjects

SL. No	Semester	Subject	Topics / Relevance
1	V	Turbo machines	Analysis, Design and Development of fluid machines
2	VI	Heat and Mass Transfer	Convection heat transfer
3	VII	Hydraulics and pneumatics	Design and Development of hydraulic and pneumatic valves
4	VIII	Power plant engineering	Fluid flow analysis in power plant equipments
5	V	Fluid Mechanics and Machinery Lab	Fluid properties and flow analysis

6.0 Relevance to Real World

SL. No	Real World Mapping
01	Design and Development of Fluid flow and heat transfer equipments in industries
02	Pipe net work design to distribute the fluid in industries, agriculture and society
03	Fluid flow analysis and system design for living organisms

7.0 Books Used and Recommended to Students

Text Books

1. Fluid Mechanics (SI Units), Yunus A. Cengel John M.Cimbala, 3rd Ed., Tata McGraw Hill, 2014.
2. Fluid Mechanics, F M White, McGraw Hill Publications Eighth edition. 2016
3. Mechanics of Fluids, Merle C. Potter, Devid C. Wiggerrt, Bassem H. Ramadan, Cengage learning, Fourth editions 2016.

Reference Books

1. Fundamentals of Fluid Mechanics by Munson, Young, Okiishi& Huebsch, John Wiley Publications.7th edition.
2. Fluid Mechanics, Pijush.K.Kundu, IRAM COCHEN, ELSEVIER, 3rd Ed. 2005.
3. Fluid Mechanics, John F.Douglas, Janul and M.Gasiosek and john A. Swaffield,Pearson Education Asia, 5th ed., 2006.
4. Introduction to Fluid Mechanics by Fox, McDonald, John Wiley Publications,8th edition.

Additional Study material & e-Books

1. Nptel.ac.in
2. VTU, E- learning
3. Fluid Mechanics related websites

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. Fluid Mechanics related websites

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 for IA Tests +10 Marks for Assignments
Theoretical aspects as well as relevant sketches should be drawn neatly for questions asked in Internal Assessments and assignments

Scheme of Evaluation for Internal Assessment
Internal Assessment test in the same pattern as that of the main examination (Average of 3 Tests):30marks.

SCHEME OF EXAMINATION:

- There are five modules two questions from each module
- Student has to answer any five question choosing at least one questions from each module.

Max. Marks: 60Marks

11.0 Course Delivery Plan

Module No.	Lecture No.	Content of Lecture	% of Portion
1		**Basics Properties of Fluids**	25
	1	Introduction, properties of fluids, viscosity	

	2	Thermodynamic properties, Surface tension and Capillarity	
	3	Vapour pressure and Cavitation.	
	4	Solving of related numericals.	
		Fluid Statics	
	5	Fluid pressure at a point, Pascal's law, pressure variation in a static fluid, Absolute, gauge, atmospheric and vacuum pressures	
	6	simple manometers, differential manometers	
	7	total pressure and center of pressure, vertical plane surface submerged in liquid,	
	8	horizontal plane surface submerged in liquid, inclined plane surface submerged in liquid curved surface submerged in liquid	
	9	Buoyancy, center of buoyancy, meta-center and meta-centric height, conditions of equilibrium of floating and submerged bodies. Introduction	
	10	Solving of related numericals.	
2		**Fluid Kinematics**	20
	1	Types of fluid flow,	
	2	continuity equation, continuity equation in 3 dimensions (Cartesian co-ordinate system only)	
	3	velocity and acceleration	
	4	velocity potential function and stream function	
	5	Solving of related numerical	
		Fluid Dynamics	
	6	Introduction, equations of motion, Euler's equation of motion	
	7	Bernoulli's equation from Euler's equation	
	8	Bernoulli's equation for real fluids	
	9	Momentum equation, Impacts of jets- force on fixed and moving vanes, flat and curved	
	10	Introduction, venturimeter, orifice meter	
	11	Pitot tube, V-Notch and rectangular notches.	
	12	Solving of related numerical	
3		**Laminar and Turbulent flow**	15
	1	Reynolds Number, Entrance flow and Developed flow, Navier- Stokes Equation (no derivation)	
	2	Laminar flow between parallel plates, Poiseuille equation – velocity profile,	
	3	Couette flow, Fully developed laminar flow in circular pipes, Hagen - Poiseuille equation.	
	4	Solving the related problems	
	5	Frictional loss in pipe flow.	
	6	Darcy- Equation for loss of head due to friction in pipes	
	7	Commercial pipe, Colebrook equation	
	8	Moody equation/ diagram. Pipes in series	
	9	parallel, equivalent pipe	
	10	Related Numericals and simple pipe design problems.	
4		**Flow over bodies:**	25
	1	Development of boundary layer, Prandtl's boundary layer equations,.	
	2	Blasius solution, laminar layer over a flat plate,	
	3	boundary layer separation and its control. Basic concept of Lift and Drag,	
	4	Types of drag, Co-efficient of drag and lift, streamline body and bluff body,	
	5	flow around circular bodies and airfoils, Lift and drag on airfoil, Numericals.	
	6	Dimensional analysis: Need for dimensional analysis,	
	7	Dimensions and units, Dimensional Homogeneity and dimensionless ratios,	
	8	methods of dimensional analysis, Rayleigh's method, Buckingham Pi theorem,	
	9	Similitude and Model studies. Numericals	
	10	Solving of related numericals.	
5		**Compressible Flows:**	15
	1	Introduction	
	2	thermodynamic relations of perfect gases	

	3	internal energy and enthalpy, speed of sound	
	4	pressure field due to a moving source	
	5	basic Equations for one- dimensional flow,	
	6	stagnation and sonic Properties, normal and oblique shocks	
		Introduction to CFD:	
	7	Necessity, limitations,	
	8	philosophy behind CFD, applications	

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	Assignment 1: Questions on Introductory concepts and definitions	Solve Numericals related to CO1	Module 1	3	Individual Activity.	Text Books
2	Assignment 2: Questions on Dynamics of flow	Derive expressions and Solve Numericals related to CO2	Module 2	6	Individual Activity.	Text Books
3	Assignment 3: Questions on One-Darcy Weishach	Derive expressions and Solve Numericals related to CO3	Module 3	8	Individual Activity.	Text Books
4	Assignment 4: Questions on flow over bodies	Derive expressions and Solve Numericals related to CO4	Module 4	10	Individual Activity.	Text Books
5	Assignment 5: Compressible flow Introduction to CFD	Derive expressions and Solve Numericals related to CO5	Module 5	11	Individual Activity.	Reference book s

13.0 Assignment question bank

ASSIGNMENT: 1 Date: ***27.2.18***

Module 1		
Q. No	**Description of Question**	**Marks**
1	Define fluid classify the same. Define (1) Fluid Mechanics, (2) Hydromechanics, (3) Fluid static, (4) Hydrostatic	**5**
2	Define Density, specific weight, sp.volume and sp. Gravity.	**5**
3	Explain capillarity and derive an expression for i) Capillary rise and ii) capillary fall depression.	**5**
4	State and prove Pascal's Law	**5**
5	Numericals: from F M White	**5**

ASSIGNMENT: 2 Date: ***20.3.18***

Module 2		
Q. No	**Description of Question**	**Marks**
1	What are the Types of fluid flow and explain laminar and turbulent flow.	**5**
2	Derive an expression for continuity equation in 3 dimensions (Cartesian co-ordinate system only)	**5**
3	Derive an expression for Bernoulli's equation from Euler's equation	**5**
4	Derive an expression for venturimeter	**5**
5	Numerical related to Bernoulli's equation, velocity potential function and stream function and flow rate measuring devices.	**5**

ASSIGNMENT: 3 Date: ***10.4.18***

Module 3		
Q. No	**Description of Question**	**Marks**
1	Derive an expression for Hagen - Poiseuille equation	**5**
2	Solving the related problems	**5**
3	Derive an expression for Darcy- Equation for loss of head due to friction in pipes	**5**
4	Solving the related problems	**5**
5	Derive an expression for Laminar flow between parallel plates.	**5**

ASSIGNMENT: 4 Date: ***27.4.18***

Module 4		
Q. No	**Description of Question**	**Marks**
1	State Buckingham's π theorem. The tip deflection δ of a cantilever beam is a function of tip load W, beam length l, second moment of area I and Young's modulus E. Perform a dimensional analysis of this problem.	**5**
2	Explain the following i) Drag ii) Lift	**5**
3	Explain the following i) Momentum thickness ii) Mach number iii) Mach cone	**5**
4	A flat plate 1.8m x1.8 m moves at 36 krn/hr in stationary air of density 1.2 kg/m3. If the coefficient of drag and lift are 0.15 and 0.75 respectively. Determine: i) The lift force ii) The drag force iii) The resultant; force iv) Power required to keepthe plate in motion.	**5**
5	Distinguish between i) Streamline body and bluff body ii) Friction drag and pressure drag.	**5**

ASSIGNMENT: 5 Date: ***15.5.18***

Module 5		
Q. No	**Description of Question**	**Marks**
1	Write a note on necessity of CFD.	**5**
2	Derive an expression for stagnation pressure	**5**
3	Derive an expression for stagnation density and temperature	**5**
4	Define stagnation density , temperature and pressure	**5**
5	Related numerical	**5**

14.0 QUESTION BANK

MODULE-1:

Basics Properties of Fluids and Fluid Statics

1. Define fluid classify the same. Define (1) Fluid Mechanics, (2) Hydromechanics, (3) Fluid static, (4) Hydrostatic, (5) Fluid kinematics, (6) Hydro kinematics, (7) Fluid dynamics, (8) Hydrodynamics, (9) Hydraulics.
2. What do you mean by continuum concept of fluid?
3. Define Density, specific weight, sp.volume and sp. Gravity.
4. What is viscosity? Explain in brief. Derive an equation for absolute or dynamic viscosity and write its unit in S.I. Also define kinematics viscosity. Write its equation and S.I. Unit. Relate poise, centipoises, stoke, Centistokes with units of viscosities in S.I
5. Describe in brief thermodynamic properties of fluids.
6. Explain capillarity and derive an expression for i) Capillary rise and ii) capillary fall depression.
7. Numericals: from books
8. What is static fluid?
9. Define pressure. Derive an expression for pressure at a point below free surface of liquid. Also derive a general form of equation for pressure variation in a static fluid. Define pressure head
10. State and prove Pascal's Law.
11. Describe guagepr ; atmospheric pr, vacuum pr and absolute pr.
12. Describe mechanical guage. Sketch and explain Bourdon tube pressure guage.
13. Describe monometer. Classify it. Explain in brief (1) Piezometer, U-Tube manometer single column manometer, Differential manometer, inverted U-Tube manometer and derive their respective equations.
14. Numericals Ref FM – Pijush.K.Kundu

15. Define total or resultant pressure force and center of pressure. Derive an expression for total pressure force & position of C.P for the following conditions I) vertical plane surface submerged in liquid ii) Horizontal plane surface submerged in liquid iii) Inclined plane surface submerged in liquid.
16. Define the term buoyancy and center of buoyancy.
17. Explain the term metacentre and meta centric height.
18. Derive an analytical expression for the metacentric height of a floating body.
19. Describe in brief experimental method of determing metacentric height.
20. What are the conditions of equilibrium of a floating body and a submerged body

MODULE-2:

Fluid Kinematics and Fluid Dynamics

1. Define kinematics of flow. What are the different methods of describing fluid motion.
2. Define the following types of line: i) Path line ii) stream line iii) Stream tube iv) Potential line, v) Streak or filament line.
3. Define the following types of fluid flow: 1) steady and unsteady flow 2) Uniform and non uniform flow 3) Laminar, transition and turbulent flow 4) Compressible and incompressible flow. 5) Rotational and irrigational Flow 6) One – Two and Three dimensional Flow.
4. Define continuity equation . Write its equation Derive the continuity equation for the three dimensional flow in Cartesian co-ordinates and modify it for two and one dimensional flow.
5. Describe velocity and Acceleration of fluid particles. Also explain local acceleration and concoctive acceleration.
6. Describe with sketches 4 important types of motion.
7. What do you mean by velocity potential function and stream function. Also write their proper ties.
8. Explain equipotential line and line of constant stream function. Also relate steam function and velocity potential Function.
9. Numerical:
10. Name the different forces present in a Fluid flow. For the Euler's equation of motion, which forces are taken into consideration?
11. What is Euler's equation? How will you obtain Bernoulli's equation form it?
12. State Bernoulli's theorem for steady flow of an incompressible fluid. Derive an expression for Bernoulli's theorem from the first principle and state the assumptions made for such a derive. Also write it applications.
13. Numericals
14. What is venturimeter? Derive an expression for the discharge through a venturimeter.
15. What is orificemeter. Derive an expression for discharge through an orificemeter.
16. What is pitot – tube? How will you determine the velocity at any point with the help of pitot – tube?
17. What is the difference between pitot tube and pitot – static tube?
18. Numericals :
19. What is V-notch? Derive an expression for discharge through a v-notch.
20. Numericals

MODULE-3:

Laminar and turbulent flow

1. What do you mean by 'Viscous flow'
2. Derive an expression for the viscosity distribution for viscous flow through a circular pipe. Also sketch the velocity distribution and shear stress distribution across a section of the pipe.
3. Prove that maximum velocity in a circular pipe for viscous flow is equal to two times the average velocity of the flow.
4. Find the expression for the loss of head of a viscous fluid through a circular pipe.
5. What is Hagen Poisenille's formula? Drive an expression for Hagen Poisenille's formula.
6. Prove that the velocity distribution for viscous flow between two parallel plates when both plates are fixed across a section is parabolic in nature. Also prove that maximum velocity is equal to one and a half times the average velocity. Also derive an expression for drop of head for a given length of pipes.
7. Numericals:
8. What do you understand by the terms: Major energy loss and minor energy losses in pipes?
9. How will you determine the loss of head due to friction in pipes by using I) Darcy formula and ii) Chezy's formula.

10. Derive an expression for loss of head due to i) Sudden expansion of pipe ii) Sudden contraction in pipe, iii) Bend in pipe, iv) pipe fittings and v) an obstruction in pipe.
11. What is a compound pipe? What will be loss of head when pipes are connected in series?
12. Explain the term pipes in parallel. How discharge through the main pipe is increased by connecting pipes in parallel.
13. Describe flow through branched pipes.
14. Numericals

MODULE-4:

Flow over bodies:

1. Define the term: drag and lift. Derive its expression.
2. Numericals.
3. What do you understand by the term boundary layer and boundary layer concept?
4. Define Laminal boundary Layer, Laminar sub Layer, boundary layer thickness. Derive an expression for displacement thickness and momentum thickness.
5. Numericals
6. Define the terms dimensional analysis.
7. What do you mean by fundamental Units and derived Units. Prepared a table for fundamental quantity, geometric quantity, kinematics quantity and dynamic quantity and write their symbol and dimensions. Explain the term dimensionally homogeneous equation.
8. What are the methods of dimensional analysis? Describe Rayleigh's method of dimensional analysis.
9. State Bucking ham's π Theorem. Why this theorem is considered superior over the Rayleigh's method for dimensional conalysis?
10. What do you mean by repeating variables? How are repeating variables are selected for dimensional analysis?.
11. Numericals:

MODULE-5:

Compressible Flows and Introduction to CFD:

1. Define Charl's law and boys law
2. Define Mach Number, Mach angle, Mach cone.
3. Explain pressure field due to moving source
4. Define stagnation property, normal shok, oblique shock.
5. Derive an expression for stagnation pressure, density and temperature.
6. Numericals
7. Write a note on necessity of CFD.

15.0 University Result

Examination	S+	S	A	B	C	D	E	% Passing
July 2017	00	00	03	10	22	29	27	65.51
July 2018	00	00	09	12	39	19	18	84.90

Prepared by	Checked by		
Prof. S.N.Topannavar	Dr.R.M.Galagali	**HOD**	**Principal**

Subject Title	**Metal Casting and Welding**		
Subject Code	17ME45A	**IA Marks**	20
No of Lecture Hrs + Practical Hrs / Week	04	**Exam Marks**	80
Total No of Lecture + Practical Hrs	50	**Exam Hours**	03
CREDITS – 04			

FACULTY DETAILS:		
Name: Prof. R.K. Chitgopkar	**Designation:** Asst. Professor	**Experience:28** Years
No. of times course taught: 04	**Specialization:** T.P. E	

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.	L2, L2	1,6,12
C205.2	Summarize the different casting process and select the melting furnace based on ferrous and non-ferrous alloys.	L2, L3	1,6,12
C205.3	Know the solidification, gasification, casting defects and different methods of directional solidification.	L2, L2, L3	1,2,5,6,12
C205.4	List and explain different types of conventional welding processes.	L2,L2,L3	1,2,3,6,12
C205.5	Explain different special types of welding, soldering, brazing and NDT.	L2,L3	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
1. Nptel.ac.in 2. VTU, E- learning 3. MOOCS 4. Open courseware

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

Website and Internet Contents References
1. http://www.nptel.ac.in 2. http://me.emu.edu.tr/me364/2.pdf 3. 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	1	Definition, Classification of manufacturing processes. Metals cast in the foundry-classification	20%
	2	Factors that determine the selection of a casting alloy. Introduction to casting process & steps involved.	
	3	Patterns: Definition, classification, materials used for pattern, various pattern allowances and their importance.	
	4	Sand molding: Types of base sand, requirement of base sand. Binder, Additives definition, need and types.	
	5	Preparation of sand molds: Molding machines- Jolt type, squeeze type and Sand slinger.	
	6	Study of important molding process: Green sand, core sand,	
	7	Dry sand, sweep mold, CO2 mold, shell mold, investment mold, plaster mold, cement bonded mold..	
	8	Cores: Definition, need, types. Method of making cores,	
	9	concept of gating (top, bottom, parting line, horn gate)	
	10	Risering (open, blind) Functions and types	
2	11	Melting furnaces: Classification of furnaces,	40%
	12	Gas fired pit furnace, Resistance furnace,	
	13	Coreless induction furnace, electric arc furnace,	
	14	Constructional features & working principle of cupola furnace.	
	15	Casting using metal molds: Gravity die casting,	

	16	Pressure die casting,	
	17	Centrifugal casting,	
	18	Squeeze casting,	
	19	Slush casting,	
	20	Thixocasting, continuous casting processes	
3	21	Solidification: Definition, Nucleation, solidification variables,	60%
	22	Directional solidification-need and methods. Degasification in liquid metals-Sources of gas, degasification methods	
	23	Fettling and cleaning of castings: Basic steps involved.	
	24	Sand Casting defects- causes, features and remedies	
	25	Advantages & limitations of casting process	
	26	Nonferrous foundry practice: Aluminum castings - Advantages, limitations,	
	27	Melting of aluminum using lift-out type crucible furnace.	
	28	Hardeners used, drossing, gas absorption,	
	29	Fluxing and flushing, grain refining, pouring temperature.	
	30	Stir casting set up, procedure, uses, advantages and limitations	
4	31	Welding process: Definition, Principles, Classification,	80%
	32	Application, Advantages & limitations of welding. Arc welding:	
	33	Principle, Metal arc welding (MAW), Flux Shielded Metal Arc Welding (FSMAW),	
	34	Inert Gas Welding (TIG & MIG)	
	35	Submerged Arc Welding (SAW) and Atomic Hydrogen Welding (AHW).	
	36	Special type of welding: Resistance welding principles,	
	37	Seam welding, Butt welding,	
	38	Spot welding and Projection welding.	
	39	Friction welding, Explosive welding,	
	40	Thermit welding, Laser welding and electron beam welding.	
5	41	Soldering, Brazing And Metallurgical Aspects In Welding Structure of welds, Formation of different zones during welding,	100%
	42	Heat Affected Zone (HAZ), Parameters affecting HAZ.	
	43	Effect of carbon content on structure and properties of steel, Shrinkage in welds& Residual stresses.	
	44	Concept of electrodes, filler rod and fluxes.	
	45	Welding defects- Detection, causes & remedy	
	46	Soldering, brazing, gas welding: Soldering, Brazing,	
	47	Gas Welding: Principle, oxy-Acetylene welding, oxy-hydrogen welding, air-acetylene welding, Gas cutting, powder cutting.	
	48	Inspection methods: Methods used for inspection of casting and welding.	
	49	Visual, magnetic particle, fluorescent particle,	
	50	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

I	**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.
II	**MODULE 2** 1. Mention the factors to be considered in the selection of a suitable melting furnace. 2. What are the different types of crucible furnaces? With a sketch explain the principle of operation of a gas fired pit furnace. 3. 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.
III	**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.

IV	**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.
V	**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. R.K.Chitgopkar	Prof. G A Naik	HOD	Principal

Subject Title	**COMPUTER AIDED MACHINE DRAWING**		
Subject Code	**17ME46A**	**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. S B Awade	**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 its features.
2. To inculcate understanding of the theory of projection and make drawings using orthographic projections and sectional views
3. To familiarize the students with Indian Standards on drawing practices.
4. To impart knowledge of thread forms, fasteners, keys, joints and couplings.
5. To make the students understand and interpret drawings of machine components so as to prepare assembly drawings either manually and using CAD packages.
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	Cognitive Level	POs
C207.1	Have hands on experience on mechanical modeling software.	L1,L2	PO1,PO3,PO5,PO8, PO10,PO12
C207.2	Draw true shape of sections of polyhedrons.	L1,L2	PO1,PO3,PO5,PO8, PO10,PO12
C207.3	Visualize and draw orthographic views of simple machine components, thread forms, fasteners, riveted, cotter, knuckle joints and couplings as per BIS.	L1,L2	PO1,PO3,PO5,PO8, PO10,PO12
C207.4	Visualize and prepare models of given detailed parts of machine component and its assembly with bill of materials and specifications.	L1,L2	PO1,PO3,PO5,PO8, PO10,PO12

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 problems on, 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) 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. **(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
1) https://hareeshang.wordpress.com/tutorials/camd/
2) http://m.noteboy.in/vtuflies/machine%20drawing.pdf
3) https://www.edx.org/school/iitbombayx?utm_source=bing&utm_medium=cpc&utm_term=iit-bombay&utm_campaign=partner-iit-bombay
4) 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, Gib head 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 Knowledge of Rivets Applications.	Syllabus with Real World Mapping	12	Group Activity. Student Group need to perform Project and do a brief Report	All Books / paper Resources / Study Material. All Internet / Web resources.

14.0 QUESTION BANK

MODULE 1

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.

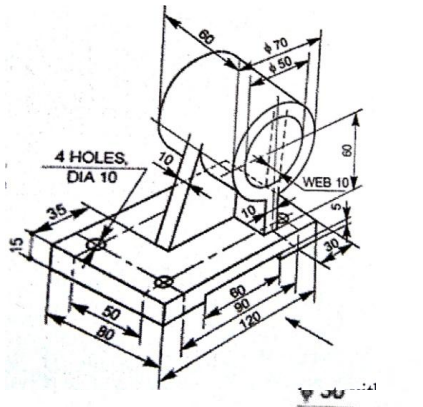
2. A rectangular prism of height 80mm and cross section 48X32mm is resting on the HP with its base. It is cut by a section plane in such a way that the true shape of section is a square of sides of maximum dimension. Draw the front view and determine the inclination of section plane to the reference 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.

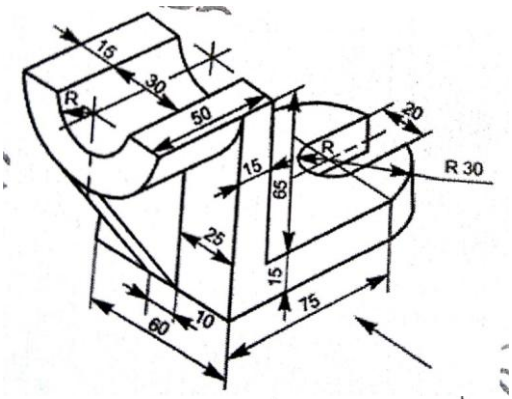
Sections of cylinders

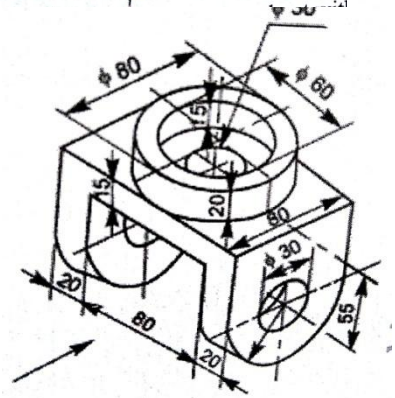
1. A cylinder of base diameter 50mm and 70mm is resting with its base on the HP. A section plane inclined at 50° to the VP and perpendicular to the HP cuts the solid at 10mm in front of it. Draw its top view, sectional front view and true shape of section.
2. A cylinder of base diameter 50mm and axis 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.

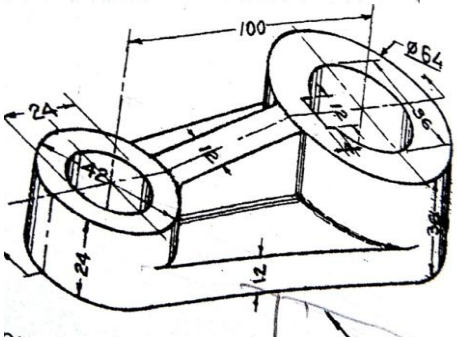
ORTHOGRAPHIC VIEWS

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









MODULE 2

THREAD FORMS:

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
2017-18 Even	14	15	10	4	10	4	00	00	100
Dec 2017	12	19	12	13	10	12	00	01	100

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

Subject Title	**MATERIAL TESTING LAB**		
Subject Code	17MEL47A	**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:03Times	**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
2. fraction of phases and grain size.
3. To understand mechanical behavior of various engineering materials by conducting standard tests.
4. To learn material failure modes and the different loads causing failure.
5. 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,PO 6,
CO2	Evaluate the impact strength of materials by Izod and Charpy test.	L1,L2,L3	PO1,PO2,PO3,PO4,PO 6,PO9
CO3	Evaluate the strength of different materials on universal testing machine.	L1,L2,L3	PO1,PO2,PO3,PO4PO 6,PO9
CO4	Determine the tensional strength of the given mild steel specimen on tensional test rig.	L1,L2,L3	PO1,PO2,PO3,PO4,PO 6,
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	L1,L2,L3	PO1,PO2,PO3,PO4,PO
CO8	Conduct non destructive tests on given metal specimens.	L1,L2,L3	PO1,PO2,PO3,PO4,PO 6,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 alifygate.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)
(c) Internal Assessment test in the same pattern as that of the main examination: 40marks.

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	Hours	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**

Subject Title	**FOUNDRY AND FORGING LABORATORY**		
Subject Code	17MEL 38A/ 48A	**IA Marks**	40
No of Lecture Hrs + Practical Hrs / Week	01+02	**Exam Marks**	100 (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 O6 Months
No. of times course taught: 04 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
C208.1	Demonstrate the applications of basic of Foundry and Forging processes.	L2	1,2,12
C208.2	Experiment with molding sand to determine tensile, compression and Shear	L3	1,2,3,4,5,6,8,12
C208.3	Evaluate the sand properties by conducting permeability, clay content and	L5	1,2,3,4,5,6,8,12
C208.4	Apply sand molding process through preparation of moulds using two molding	L3,L6	1,2,3,4,6,8,12
C208.5	Determine the length of the raw material required and create the forging	L5,L6	1,2,3,4,5,6,8,12
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
1. http://www.foundrymagazineindia.com
2. http://foundrymag.com
3. http://www.foundrytradejournal.com/
4. 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 (40 Marks)

SCHEME OF EXAMINATION:

One question is to be set from Part-A =30 Marks
One question is to be set from either Part-B or Part-C =50 Marks
Viva – Voce =20 Marks

Total = 100 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.
2. Explain Refractoriness of foundry sand?
3. Define Permeability of foundry sand.
4. What do you mean by Flow ability or plasticity
5. What is Adhesiveness of foundry sand?
6. Define Cohesiveness of foundry sand?
7. What is collapsibility of foundry sand?
8. What is Green sand?
9. What is Dry sand?
10. What is the use of Facing sand?
11. What is Parting sand?
12. What do you mean by Baking sand?
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?
23. For large iron and steel castings which type of foundry sand is used?
24. What is the purpose of adding Binders to the foundry sand?
25. Name the common binders used in foundry?
26. List the commonly used Organic binders.
27. List the commonly used inorganic binders
28. Which is the most widely used inorganic binders?
29. What are Additives related to foundry?
30. List commonly used Additives.
31. Where Coal dust additives are used?
32. Mention the main purpose of using coal dust additives?
33. What is Sea coal?
34. What is the nature of Sea coal?
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