Department of Mechanical Engineering

COURSE PLAN 2018-19

IV Semester ''A'' division

INSTITUTE VISION

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

INSTITUTE MISSION

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

DEPARTMENT OF MECHANICAL ENGINEERING

VISION

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

MISSION

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

Program Educational Objectives (PEOs)

The Graduates will be able to

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

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

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

Program Specific Outcomes (PSOs)

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

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

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

Program Outcomes (POs)

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

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

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

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

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

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

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

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

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

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

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

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

CONTENTS

Student Help Desk

S. N	Purpose	Contact Person	
		Faculty	**Instructor**
	Department Level		
1	Attestations	Dr. B. M. Shrigiri	
2	Online submission of exam form/revaluation form to VTU	Prof. S. B. Awade / Prof. N. M. Ukkali / Prof. M. R. Ingalagi	--
3	Students' Counseling & Discussion with parents (Class Teachers from 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- 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, 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 "A"

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	17ME45B	Machine Tools and Operations	04			03	60	40	100	4
6	17ME46B	Mechanical Measurements and Metrology	01		04	03	60	40	100	3
7	17MEL47B	Mechanical Measurements and Metrology Lab	03		02	03	60	40	100	2
8	17MEL48B	Machine Shop	01		02	03	60	40	100	2
9	17KL49	Kannada	01			01	30	20	50	1
		Total	**23**	**06**	**08**		**510**	**340**	**850**	**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	
	22	Analytic functions-Cauchy-Riemann equation in Cartesian form	

	23	Cauchy-Riemann equation in Polar form	20
	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)	20
	32	Probability mass/density functions	
	33	Binomial distribution.	
	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[$0 \leq z \leq 1.83$] = 0.4664 & p[$0 \leq z \leq 1.33$] = 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
C212.1	Identify mechanisms with basic understanding of motion.	L2	PO1,PO2, PO6, PO8, PO12	PSO1,PSO2
C212.2	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
C212.3	Comprehend velocity and acceleration analysis of planar mechanisms using analytical method	L1,L2,L3,	PO1,PO2, PO6, PO8, PO12	PSO1,PSO2
C212.4	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
C212.5	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)**
	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):**
	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:**
	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:**
	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.

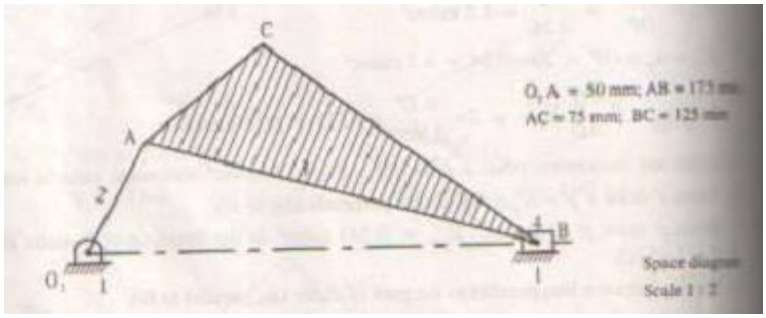

Fig. 2.1

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

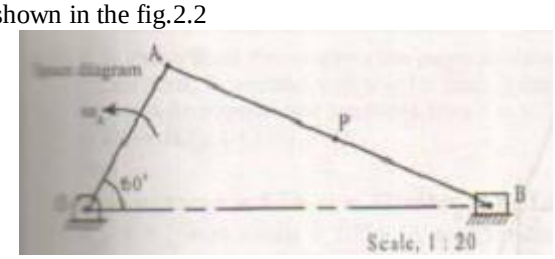

Fig. 2.2

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.

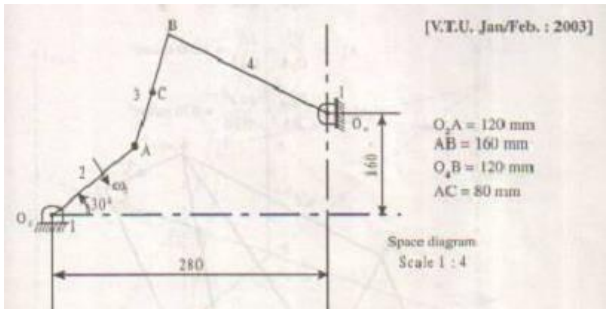

Fig. 2.3

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

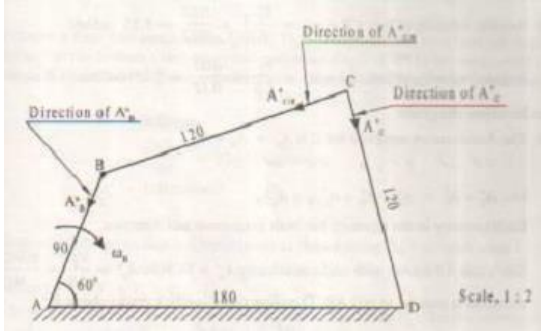

Fig. 2.4

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

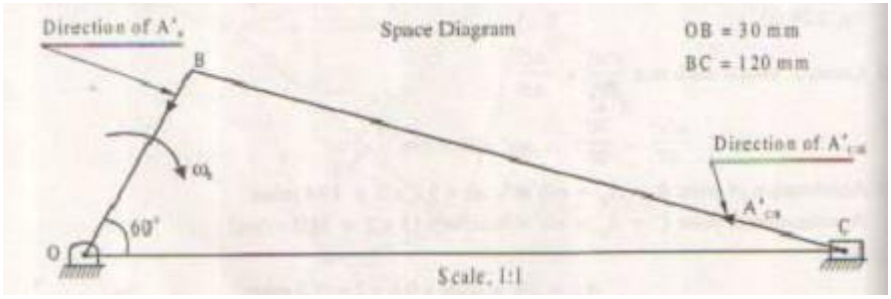

Fig. 2.5

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

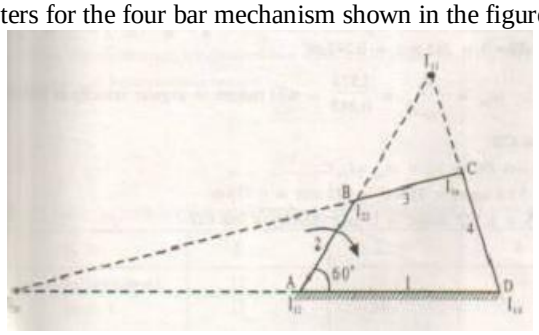

Fig. 2.6

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

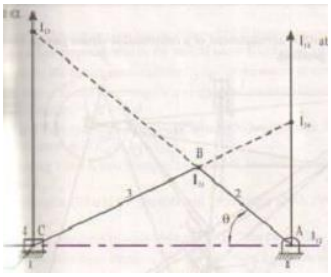

Fig. 2.7

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

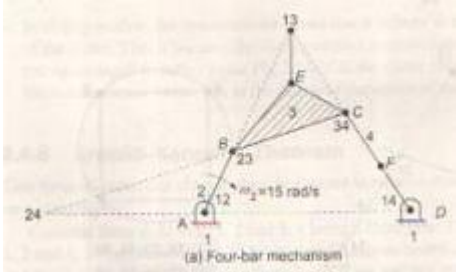

Fig. 2.8

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

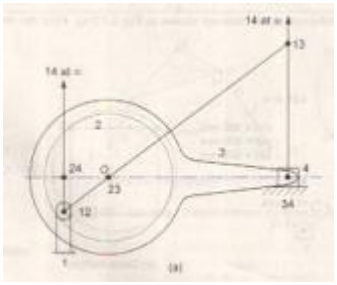

Fig. 2.9

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

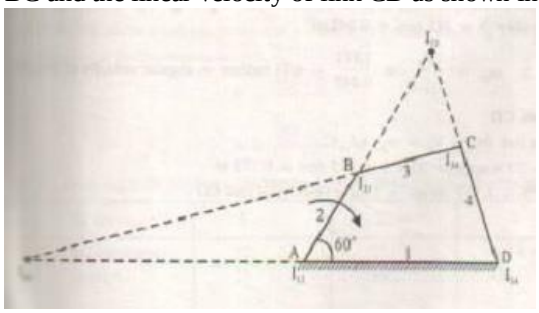

Fig. 2.10

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

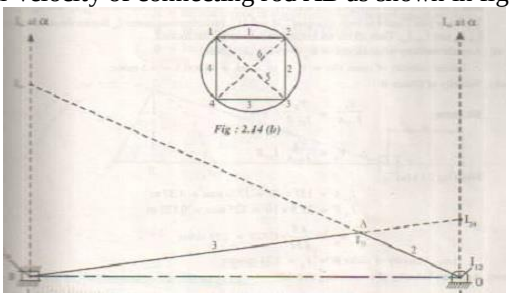

Fig. 2.11

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)

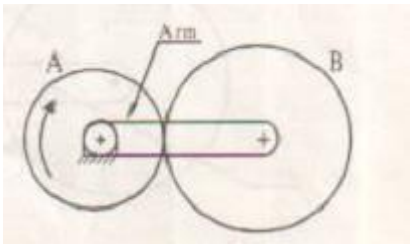

Fig. 4.1

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)

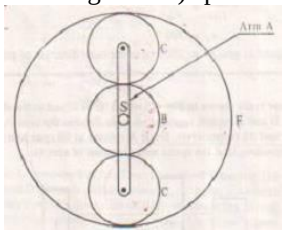

Fig. 4.2

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)

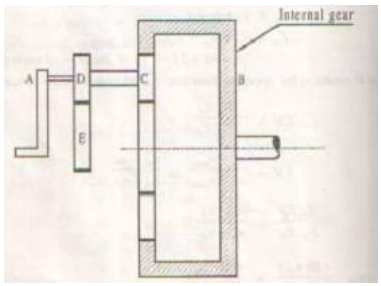

Fig. 4.3

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.)

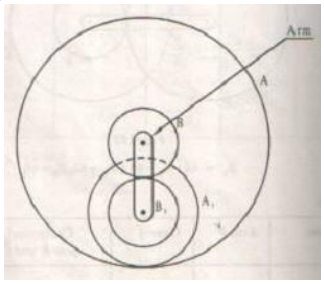

Fig. 4.4

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)

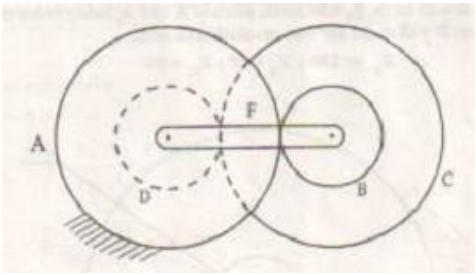

Fig. 4.5

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)

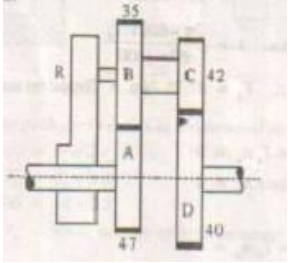

Fig. 4.6

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	?	?

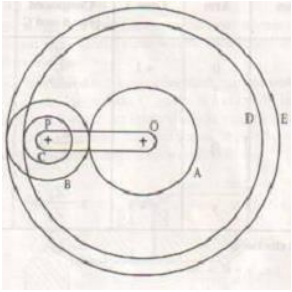

Fig. 4.7

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
I		**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	
II		**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	
III		**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

IV	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	
V		**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° 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° 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 ° C. The maximum temperature in the cycle is 2500 ° 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 ° 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 ° 0C Assume that the atmospheric temperature is 15 ° 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 ° 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 ° 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 ° C. The exit pressure of steam at the end of first stage is 5 bar. The steam is then reheated to300 ° 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 ° 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 ° C; Temperature of air at turbine inlet = 27 ° 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 ° C. After compression to 5.5 bar, the air is cooled to 30 ° 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 ° C; Temperature of air at turbine inlet = 27 ° 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 ° C has dew point of 15 ° 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 ° C DBT and 13 ° C WBT is mixed 12 m ^{3} /min. of air at 25 ° C DBT and 18 ° 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 ° 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 ° 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 ° 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	**MACHINE TOOLS AND OPERATIONS**		
Subject Code	17ME45B	**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: Prof. M A Hipparagi	**Designation:** Asst. Professor	**Experience:**10
No. of times course taught:05	**Specialization:** Production Technology	

1.0 Prerequisite Subjects

Sl. No	Branch	Semester	Subject
01	Mechanical Engineering	I	EME

2.0 Course Objectives

1. To introduce students to different machine tools in order to produce components having different shapes and sizes.
2. To enrich the knowledge pertaining to relative motion and mechanics required for various machine tools.
3. To develop the knowledge on mechanics of machining process and effect of various parameters on economics of machining.

3.0 Course Outcomes

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

CO	Course Outcome	RBT Level	POs
C206.1	Classify and demonstrate basic working of all the machine tools	L1	PO1,PO2 PO4,PO12
C206.2	Explain the different types of relative motions in machining process	L2	PO1,PO2 PO4,PO12
C206.3	Explain cutting tool materials, tool geometry, surface finish and make use of machining equations for cutting operations.	L2	PO1,PO2 PO4,PO12
C206.4	Analyze the different mechanics of machining process.	L4	PO1,PO2 PO4,PO12
C206.5	Appreciate the concept of tool wear, tool life and economics of machining processes with simple numerical	L2	PO1,PO2 PO4,PO12
	Total Hours of instruction	**50 Hours**	

4.0 Course Content

MODULE 1
MACHINE TOOLS
Introduction, Classification, construction and specifications of lathe, drilling machine, milling machine, boring machine, broaching machine, shaping machine, planing machine, grinding machine [**Simple sketches showing major parts of the machines**]**10 hours**

MODULE 2
MACHINING PROCESSES

Introduction, Types of motions in machining, turning and Boring, Shaping, Planing and Slotting, Thread cutting, Drilling and reaming, Milling, Broaching, Gear cutting and Grinding, Machining parameters and related quantities.
[Sketches pertaining to relative motions between tool and work piece only].10 Hours

MODULE 3
CUTTING TOOL MATERIALS, GEOMETRY AND SURFACE FINISH
Introduction, desirable Properties and Characteristics of cutting tool materials, cutting tool geometry, cutting fluids and its applications, surface finish, effect of machining parameters on surface finish.
Machining equations for cutting operations: Turning, Shaping, Planing, slab milling, cylindrical grinding and internal grinding, Numerical Problems.**10 Hours**

MODULE 4
MECHANICS OF MACHINING PROCESSES
Introduction, Chip formation, Orthogonal cutting, Merchants model for orthogonal cutting, Oblique cutting, Mechanics of turning process, Mechanics of drilling process, Mechanics of milling process, Numerical problems.**10 Hours**

MODULE 5
TOOL WEAR, TOOL LIFE: Introduction, tool wear mechanism, tool wear equations, tool life equations, effect of process parameters on tool life, machinability, Numerical problems
ECONOMICS OF MACHNING PROCESSES: Introduction, choice of feed, choice of cutting speed, tool life for minimum cost and minimum production time, machining at maximum efficiency, Numerical problems.**10 Hours**

5.0 Relevance to Future subjects

Sl. No.	Semester	Subject	Topics
01	VIII	Project work	Machining, Machining time calculations

6.0 Relevance to Real World

SL. No.	Real World Mapping
01	Machine tool operations.
02	Cutting tool materials and tool geometry.
03	Machining time calculations.

7.0 Books Used and Recommended to Students

Text Books

1. Fundamentals of metal cutting and Machine Tools, B.L. Juneja, G.S. Sekhon and Nitin Seth, New Age International Publishers 2nd Edition, 2003
2. All about Machine Tools, Heinrich Gerling, New Age International Publishers revised 2nd Edition, 2006

Reference Books

1. Fundamental of Machining and Machine Tools, Geoffrey Boothroyd and Winston A. Knight, CRC Taylor& Francis, Third Edition.
2. Metal cutting principles, Milton C. Shaw, Oxford University Press, Second Edition,2005.

Additional Study material & e-Books

1. "Workshop Technology vol II" .Hazra Choudary

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

Website and Internet Contents References
1. https://iitbmechdamp.wordpress.com/me338manufacturingprocessesii/
2. https://ec.europa.eu/.../sites/.../cross-cutting-kets-roadmap-innovation-fields-manufac*turing.*
3. https://www.kitaabdeal.com/Manufacturing-Processes---II.
4. *https://books.google.co.in/books/about/Manufacturing_Processes_Ii.html?id...*

9.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	Journal of manufacturing process	https://www.journals.elsevier.com/journal-of-manufacturing-processes/
2	Journal of manufacturing process	http://www.sciencedirect.com/science/journal/15266125
3	Journal of manufacturing science and engineering	https://journaltool.asme.org/home/JournalDescriptions.cfm?JournalID=11
4	International journal of advanced manufacturing technology	http://www.springer.com/engineering/production+engineering/journal/170

10.0 Examination Note

Internal Assessment: 40 Marks

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

Scheme of Evaluation for Internal Assessment (40 Marks)

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

(d) Assignments: **10** Marks

.

SCHEME OF EXAMINATION:

Question paper pattern:

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

INSTRUCTION FOR MACHINE TOOLS AND OPERATIONS (17ME35B)
EXAMINATION

1. Draw the neat sketches for relevant theory. The total duration is 3 hours.
2. Draw the flow charts required for some machining processes.

11.0 Course Delivery Plan

Module	Lecture No.	Content of Lecturer	% of Portion
1	1	**MACHINE TOOLS** Introduction , Classification	20%
	2	Construction and specifications of lathe	
	3	Construction and specifications of drilling machine	
	4	Construction and specifications of milling machine	
	5	Construction and specifications of boring machine,	
	6	Construction and specifications of broaching machine	

	7	Construction and specifications of shaping machine	
	8	Construction and specifications of planing machine	
	9	Construction and specifications of grinding machine	
	10	Overview of all the machines	
2	11	**MACHINING PROCESSES** Introduction, Types of motions in machining	40%
	12	Turning and Boring	
	13	Shaping	
	14	Planing and Slotting	
	15	Thread cutting	
	16	Drillingand reaming	
	17	Milling	
	18	Broaching	
	19	Cutting and Grinding	
	20	Gear, Machining parameters and related quantities	
3	21	**CUTTING TOOL MATERIALS, GEOMETRY AND SURFACE FINISH** Introduction	60%
	22	Desirable Properties and Characteristics of cutting tool materials	
	23	Cutting tool geometry	
	24	Cutting fluids and its applications	
	25	Surface finish, effect of machining parameters on surface finish	
	26	**Machining equations for cutting operations:** Turning, Shaping	
	27	Planing, slab milling	
	28	Internal grinding	
	29	Cylindrical grinding	
	30	Numerical Problems	
4	31	**MECHANICS OF MACHINING PROCESSES** Introduction	80%
	32	Chip formation	
	33	Orthogonal cutting,	
	34	Merchants model for orthogonal cutting	
	35	Oblique cutting	
	36	Mechanics of turning process	
	37	Mechanics of drilling process	
	38	Mechanics of milling process	
	39	Numerical problems	
	40	Numerical problems	
5	41	**TOOL WEAR, TOOL LIFE** Introduction	100%
	42	Tool wear mechanism	
	43	Tool wear equations	
	44	Tool life equations	
	45	Effect of process parameters on tool life, machinability	
	46	Numerical problems	
	47	**ECONOMICS OF MACHINING PROCESSES:** introduction	
	48	Choice of feed, choice of cutting speed	
	49	Tool life for minimum cost and minimum production time	
	50	Machining at maximum efficiency, Numerical problems	

12.0 Assignments, Pop Quiz, Mini Project, Seminars

Sl.No.	Title	Outcome expected	Allied study	Week No.	Individual / Group activity	Reference: book/website /Paper
1	Assignment 1: Study of basic concepts about machine tools	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 1	3	Individual Activity.	Book 1, of the reference list. Website of the Reference list
2	Assignment 2:Can able to Study different machining operations	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 2	6	Individual Activity.	Book 1,2 of the reference list. Website of the Reference list
3	Assignment 3: Understand different cutting tool materials, its geometry	Students study the Topics and write the Answers. Get practice to solve university questions.	Module3	12	Individual Activity.	Book 1, of the reference list. Website of the Reference list
4	Assignment 4: Can able to Study mechanics of machining processes	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 1	15	Individual Activity.	Book 1,2 of the reference list. Website of the Reference list
5	Assignment 5: Basics of Economics of Machining Process	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 1	18	Individual Activity.	Book 1,2, of the reference list. Website of the Reference list

13.0 QUESTION BANK

MODULE 1

INTRODUCTION TO MACHINE TOOLS

1.Explain the construction and specifications of lathe
2. Explain the construction and specifications of drilling machine
3. Explain the construction and specifications of milling machine
4. Explain the construction and specifications of boring machine,
5. Explain the construction and specifications of broaching machine
6. Explain the construction and specifications of shaping machine
7. Explain the construction and specifications of planing machine
8. Explain the construction and specifications of grinding machine

MODULE 2

MACCHINING PROCESS

1. Explain Planing and Slotting with neat sketch
2. Explain Thread cutting with neat sketch
3. Explain Drilling and reaming with neat sketch
4. Explain Milling with neat sketch
5. Explain Broaching with neat sketch
6. Explain cutting and Grinding with neat sketch
7. Explain Gear, Machining parameters and related quantities

MODULE 3

CUTTING TOOL MATERIALS,GEOMETRY AND SURFACE FINISH

1.What are the desirable Properties and Characteristics of cutting tool materials
2.Explain the cutting tool geometry with neat sketch
3.Explain the cutting fluids and its applications
4.Briefly explain the surface finish, effect of machining parameters on surface finish
5.Derive the machining equation for Turning, Shaping
6. Derive the machining equation Planing, slab milling
7. Derive the machining equation Internal grinding
8. Derive the machining equation cylindrical grinding
9.A cast iron plate measuring 300x100x40mm is to be rough shaped along its wider face.calculate the machining time taking approach=25mm, over travel =25mm, cutting speed =12m/min, return speed =20m/min, allowance on either side of the plate width=5mm and feed per cycle=1mm.

MODULE 4

MECHANICS OF MACHINING PROCESS

1.Explain with neat sketch Chip formation mechnism
2.Expain in brief Orthogonal cutting & Oblique cutting
3.Explain the Merchants model for orthogonal cutting
4.Explain the Mechanics of turning process
5.Explain the Mechanics of drilling process
6.Explain the Mechanics of milling process
7. In an orthogonal cutting, the following data were observed : depth of cut=0.25mm,horizontal force=1135N,thrust force=110N,rake angle=200,width of cut=4mm,cutting velocity=30m/min,chip thickness ratio=0.47.Determine friction angle, shear plane angle, resultant cutting force & the power required

MODULE 5

TOOL LIFE, TOOL WEAR ECONOMICS OF MACHINING PROCESS

1.Explain the tool wear mechanism
2.Explain tool wear equations for the cutting tool
3.Explain the tool life equations
4.Briefly describe the effect of process parameters on tool life, machinability
5.Explain the importance of choice of feed, choice of cutting speed
6.Describe the tool life for minimum cost and minimum production time
7.machining at maximum efficiency,
8. A certain tool during rough turning gave a tool life of 1 hr at a cutting speed of 30 m/min. what will be the life of the tool when it is used at the same cutting speed for finish turning. Take n=0.125 for rough cut, and n=0.1 for finish cut.

15.0 University Result

Examination	FCD (S+, S, A)	FC (B)	SC (C, D, E)	% Passing
June 2018	35	21	7	100
Jan 2018	19	33	10	100

Prepared by	Checked by		
Prof.M A Hipparagi	Prof.M A Hipparagi	HOD	Principal

Subject Title	**MECHANICAL MEASUREMENTS AND METROLOGY**		
Subject Code	17 ME 46 B	**CIE**	40
Number of Lecture Hrs / Week	04	**SEE**	60
Total Number of Lecture Hrs	50	**Exam Hours**	03
			CREDITS – 04

FACULTY DETAILS:		
Name: Prof. G A Naik	**Designation:** AP	**Experience:23 years**
No. of times course taught:10	**Specialization:** Production Technology	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Mechanical Engineering	I	Mechanical Engineering Science
02	Mechanical Engineering	III	Mechanical measurements and Metrology

2.0 Course Objectives

Students are expected to –

- Understand metrology, its advancements & measuring instruments.
- Acquire knowledge on different standards of length, calibration of End Bars, linear and angular measurements, Screw thread and gear measurement & comparators.
- Equip with knowledge of limits, fits, tolerances and gauging.
- Acquire knowledge of measurement systems and methods with emphasis on different transducers, intermediate modifying and terminating devices.
- Understand the measurement of Force, Torque, Pressure, Temperature and Strain.

3.0 Course Outcomes

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

CO	Description	CL	POs
C208.1	Illustrate the principle of operation and calibration of an instrument and Compare engineering measuring instruments for a particular application	L1, L2	PO1, PO2, PO3, PO6, PO7, PO12
C208.2	Understand the concepts of limits, fits, tolerance and make use of measuring instruments.	L2	PO1, PO2, PO3, PO6, PO7, PO12
C208.3	Make use of concepts of interferometer and screw thread measurement methods.	L3	PO1, PO2, PO3, PO6, PO7, PO12
C208.4	Explain the concepts of measurement, measurement systems and intermediate modifying devices	L2	PO1, PO2, PO3, PO6, PO7, PO12
C208.5	Interpret the working of force, torque, pressure, strain and Temperature measuring devices	L2	PO1, PO2, PO3, PO6, PO7, PO12
Total Hours of Instructions			**50**

4.0 Course Content

MODULE -1

Introduction to Metrology: Definition, objectives and concept of metrology, Need of inspection, Principles, process, methods of measurement, Classification and selection of measuring instruments and systems. Accuracy, precision and errors in a measurement, System of measurement, Material Standard, Wavelength Standards, Subdivision of standards, Line and End standards, Classification of standards and Traceability, calibration of End bars (Numerical), standardization.

Linear Measurement and angular measurements:

Slip gauges- Indian standards on slip gauge, method of selection of slip gauge, stack of slip gauge, adjustable slip gauge, wringing of slip gauge, care of slip gauge, slip gauge accessories, problems on building of slip gauges (M87, M112).

Measurement of angles- sine bar, sine center, angle gauges, optical instruments for angular measurements, Auto collimator-applications for measuring straightness and squareness.**10 Hours**

MODULE -2

System of Limits, Fits, Tolerance and Gauging:

Definition of tolerance, Specification in assembly, Principle of interchangeability and selective assembly, limits of size, Indian standards, concept of limits of size and tolerances, definition of fits, hole basis system, shaft basis system, types of fits and their designation (IS 919-1963), geometric tolerance, position-tolerances.

Classification of gauges, brief concept of design of gauges (Taylor's principles), Wear allowance on gauges, Types of gauges-plain plug gauge, ring gauge, snap gauge, limit gauge and gauge materials.

Comparators:

Functional requirements, classification, mechanical- Johnson Mikrokator, sigma comparators, dial indicator, electrical- principles, , LVDT, Pneumatic- back pressure gauges, solex comparators and optical comparators-Zeiss ultra-optimeter.**10 Hours**

MODULE -3

Measurement of screw thread and gear:

Terminology of screw threads, measurement of major diameter, minor diameter, pitch, angle and effective diameter of screw threads by 2-wire and 3- wire methods, best size wire. Screw thread gauges, Tool maker's microscope. Terminology, tooth thickness measurement using constant chord method, addendum comparator method and base tangent method, measurement of pitch, concentricity, run out, and involute profile. Gear roll tester for composite error.

Advances in metrology:

Basic concepts of lasers, advantages of lasers, laser interferometers, types, applications. Basic concepts of Coordinate Measuring Machines-constructional features, applications.**10 Hours**

MODULE -4

Measurement systems and basic concepts of measurement methods:

Definition, significance of measurement, generalized measurement system, definitions and concept of accuracy, precision, calibration, threshold, sensitivity, hysteresis, repeatability, linearity, loading effect, system response-time delay. Errors in measurement, classification of errors. Transducers, transfer efficiency, primary and secondary transducers, electrical, mechanical and electronic transducers, advantages of each type of transducers.

Intermediate modifying and terminating devices: Mechanical systems, inherent problems, electrical intermediate modifying devices, input circuitry, ballast circuit, electronic amplifiers. Terminating devices, Cathode ray oscilloscope, Oscillographs.**10 Hours**

MODULE -5

Force, Torque and Pressure Measurement:

Direct methods and indirect method, force measuring inst. Torque measuring inst, Types of dynamometers, Absorption dynamometer, Prony brake and rope brake dynamometer, and power measuring instruments. Pressure measurement, principle, use of elastic members, Bridgeman gauge, McLeod gauge, Pirani gauge.

Measurement of strain and temperature:

Theory of strain gauges, types, electrical resistance strain gauge, preparation and mounting of strain gauges, gauge factor, methods of strain measurement. Temperature Compensation, Wheatstone bridge circuit, orientation of strain gauges for force and torque, Strain gauge based load cells and torque sensors.

Resistance thermometers, thermocouple, law of thermocouple, materials used for construction, pyrometer, optical pyrometer.**10 Hours**

5.0 Relevance to future subjects

SL. No.	Semester	Subject	Topics / Relevance
01	III / IV	Mechanical measurements and Metrology Lab	Provides basics of measurement process and different measurement systems and measuring instruments to be used in MMM Lab
02	VIII	Project work	Generation of components for project

6.0 Relevance to Real World

SL. No.	Real World Mapping
01	Measuring a physical quantity like Length, Angle using different measuring devices
02	Operation of different measuring devices like Tool makers microscope for measurement of diameter of screw threads, Gear nomenclatures, surface alignments etc.

7.0 Books Used and Recommended to Students

Text Books

1. Mechanical measurements and Metrology by Dr. T Chandrashekar, Subhas Stores publishers

Reference Books

1. **Engineering Metrology and Measurements,** Bentley, Pearson Education.
2. **Theory and Design for Mechanical Measurements,III edition,** Richard S Figliola, Donald E Beasley, WILEY India Publishers.
3. **Engineering Metrology,** Gupta I.C., Dhanpat Rai Publications.
4. **Deoblin's Measurement system**, Ernest Deoblin, Dhanesh manick, McGraw –Hill.
5. **Engineering Metrology and Measurements,**N.V.Raghavendra and L.Krishnamurthy, Oxford University Press.

Additional Study material & e-Books

1. **Mechanical measurements by Beckwith maragoni and Lienhard, Pearson Education,**

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

Website and Internet Contents References

1. http://www.tatynerds.com/mechanical-metrology-metrology
2. http: //www.vturesource.com/2011/01/mechanical-measurements
3. http://www.nptel.ac.in
4. http://www.sapnaonline.com/shop/Author/t-chandrashekar

9.0 Magazines/Journals Used and Recommended to Students

Sl. No	Magazines/Journals	website
1	International Journal of measurement Technologies and Instrumentation Engineering	http://www.igi-global.com/journal/international-journal-measurement-technologies-instrumentation/43483
2	International Journal of Metrology and Quality Engineering	http://www.metrology-journal.org/
3	Springer Handbook of Metrology and Testing	http://www.springer.com/us/book/9783642166402
4	Measurement Techniques	http://www.springer.com/physics/applied+%26+technical+physics/journal/11018

10.0 Examination Note

Internal Assessment: 30 Marks

Theoretical aspects as well as relevant sketches should be drawn neatly for questions asked in Internal Assessments

Scheme of Evaluation for Internal Assessment

Internal Assessment test in the same pattern as that of the main examination (Average of three tests and Assignment):40marks

SCHEME OF EXAMINATION:

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

Max. Marks: 60Marks

11.0 Course Delivery Plan

Module	Lecture No.	Content of Lecturer	% of Portion
1	51	Definition, objectives and concept of metrology	20%
	52	Need of inspection, Principles, process,	
	53	methods of measurement, Classification and selection of measuring instruments and systems	
	54	Accuracy, precision and errors in measurement	
	55	System of measurement, Material Standard, Wavelength Standards, Subdivision of standards,	
	56	Line and End standards, Classification of standards and Traceability, calibration of End bars(Numerical), standardization	
	57	Slip gauges- Indian standards on slip gauge, method of selection of slip gauge, stack of slip gauge, adjustable slip gauge, wringing of slip gauge,	
	58	care of slip gauge, slip gauge accessories, problems on building of slip gauges (M87, M112)	
	59	Measurement of angles- sine bar, sine center, angle gauges	
	60	Auto collimator-applications for measuring straightness and squareness.	
2	61	Definition of tolerance, Specification in assembly, Principle of interchangeability and selective assembly	40%
	62	Limits of size, Indian standards, concept of limits of size and tolerances,	

	63	definition of fits, hole basis system, shaft basis system, types of fits and their designation (IS 919-1963),	
	64	Geometric tolerance, position-tolerances. Classification of gauges, brief concept of design of gauges (Taylor's principles),	
	65	Wear allowance on gauges, Types of gauges-plain plug gauge, ring gauge, snap gauge, limit gauge and gauge materials.	
	66	Functional requirements, classification	
	67	mechanical- Johnson Mikrokator, sigma comparators	
	68	Dial indicator, electrical principles, ,	
	69	LVDT, Pneumatic- back pressure gauges, solex comparators	
	70	Optical comparators- Zeiss ultra-optimeter.	
3	71	Terminology of screw threads, measurement of major diameter	60%
	72	minor diameter, pitch, angle and effective diameter of screw threads by 2-wire and 3- wire methods,	
	73	Best size wire. Screw thread gauges, Tool maker's microscope. Gear tooth terminology, tooth thickness measurement using constant chord method,	
	74	Addendum comparator method and base tangent method, measurement of pitch	
	75	Concentricity, run out, and involutes profile. Gear roll tester for composite error	
	76	Basic concepts of lasers, advantages of lasers	
	77	Laser interferometers, types	
	78	Applications. Basic concepts of Coordinate Measuring Machines	
	79	constructional features, applications	
	80	constructional features, applications	
4	81	Definition, significance of measurement, generalized measurement system	80%
	82	Definitions and concept of accuracy, precision, calibration,	
	83	Threshold, sensitivity, hysteresis, repeatability, linearity, loading effect, system response-time delay. Errors in measurement,	
	84	Classification of errors. Transducers, transfer efficiency, primary and secondary transducers,	
	85	Mechanical, electronic transducers, advantages of each type transducers.	
	86	Mechanical systems, inherent problems	
	87	Electrical intermediate modifying devices	
	88	input circuitry, ballast circuit	
	89	Electronic amplifiers. Terminating devices	
	90	Cathode ray oscilloscope, Oscillographs	
5	91	Direct methods and indirect method	100%
	92	Force measuring inst. Torque measuring inst., Types of dynamometers, Absorption dynamometer	
	93	Prony brake and rope brake dynamometer, and power measuring instruments.	
	94	Pressure measurement, principle, use of elastic members	
	95	Bridgeman gauge, McLeod gauge, Pirani gauge.	
	96	Theory of strain gauges, types, electrical resistance strain gauge, preparation and mounting of strain gauges,	
	97	Gauge factor, methods of strain measurement. Temperature Compensation, Wheatstone bridge circuit,	
	98	Orientation of strain gauges for force and torque, Strain gauge based load cells and torque sensors.	
	99	Resistance thermometers, thermocouple, law of thermocouple	
	100	materials used for construction, pyrometer, optical pyrometer	

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 to Metrology and Linear Measurement and angular measurements	Basic definitions	Module 1	2	Individual Activity.	Text Book 1
2	Assignment 2: Questions on System of Limits, Fits, Tolerance and Gauging and comparators	Derivations and numerical on System of Limits, Fits, Tolerance and Gauging n	Module 2	4	Individual Activity.	Text Book 1
3	Assignment 3: Questions o Measurement of screw thread and gear and Advances in metrology	Derivations	Module 3	6	Individual Activity..	Text Book 2
4	Assignment 4: Measurement systems and basic concepts of measurement methods	Derivations of different governing equations	Module 4	8	Individual Activity.	Text Book 2
5	Assignment 5: Force, Torque and Pressure Measurement and Measurement of strain and temperature	Limitations & Applications	Module 5	8	Individual Activity.	Reference book 1

12.0 QUESTION BANK

Module I

Introduction to Metrology and Linear Measurement and angular measurements

1. Distinguish between line standards and end standards.
2. How are end standards derived from line standards? Give examples of these two types of standards.
3. Explain the role of light wave standard in the future of precision measurements.
4. What is the difference between line standards and end standards? How will you compare an end gauge with a line standard?

5. An NPL type level comparator has vial radius of 210 m, divisions 2.5mm apart and contact feet 25mm centre distance. Calculate the difference in length of two gauges under comparison. If the total bubbles displacement is 6 divisions.
6. Briefly describe the different types of standards for liner measurements.
7. Explain with neat figure the Standards of length - International prototype meter, Imperial standard yard, and Wave length standard,
8. Three 100mm end bars are measured on a level comparator by first wringing them together and comparing with a 300 mm bar and then inter comparing them. The 300 mm bar has a known error of +42 micrometer and the three bars together measure 64 micrometer less than the 300 mm bar. Bar A is 18 micrometer longer than bar B and 23 micrometer longer than bar C. find the actual length of each bar.
9. A calibrated meter end bar has an actual length of 1000.0005mm it is to be used in the calibration of two bars, A and B each having a basic length of 500 mm. When compared with the meter bar LA+LB was found to be shorter by 0.003mm. in comparing A with B it was found that A was 0.0006 mm longer than B. find the actual length of A and B.
10. Four length bars of basic length 100mm are to be calibrated using a calibrated length bar of 400 mm. whose actual length is 399.9992mm. it was also found that lengths of bars B C and D in comparison to A are +0.0002mm, +0.0004mm and -0.0001mm respectively and length of all the four bars put together in comparison to standard calibrated bar is +0.0003mm longer. Determine the actual dimensions of all the four end bars.
11. What is meant by Wringing of slip gauges?

Module II

System of Limits, Fits, Tolerance and Gauging and comparators

1 Define Fits
2 Define Basic size
3 Define Fundamental deviation
4 Define Allowances
5. Explain the principle if interchangeability and selective assembly.
6. What are compound tolerances? Explain
7. What is tolerance accumulation? Explain.
8. What is meant by geometrical tolerance?
9. Explain hole basis system and shaft basis of system.
10. Give the classification of gauges.
11. Explain the concept of design of gauges (Taylor's principles)?
12. What is wear allowance on gauges?
13. Write a note on gauge materials.
14. Calculate the dimensions of plug and ring gauges to control the production of 50 mm shaft and hole pair of H7d8 as per IS specifications. The following assumptions may be made: 50mm lies in diameter range of 30 and 50 mm and the upper deviation for the 'd' shaft is given by $-16D^{0.44}$ and lower deviation for hole H is zero. Tolerance factor and IT6=10i and above IT6 grade the tolerance magnitude is multiplied by 10 at each fifth step.
15. Determine the dimensions and tolerances of shaft and hole having size of 30 H7h8. Also determine the allowances and maximum clearances.
17. What is a comparator? Classify the different types of comparators.
18. Describe the mechanical comparator and clearly explain the magnification method adopted in it.
19. Explain how pneumatic comparator works.
20. What is projection comparator? Show a sketch to illustrate the principle and give the type of works for which this instrument is specially suitable.
21. Explain with neat sketch the Johnson Mikrokator.
22. Explain with neat sketch Sigma Comparators.
23. What is dial indicator?
24. Explain the working principle of Optical Comparators.
25. With a neat figure explain the construction and working principle of LVDT.
26. Explain Solex Comparators.

Module III

Measurement of screw thread and gear and Advances in metrology

1. Explain the Principle of interferometery?
2. Explain the working of autocollimator?
3. What are Optical flats? Explain

4. With a neat figure give the terminology of screw threads?
5. Explain the 2-wire and 3-wire methods,
6. Derive an expression for Best size wire.
7. With a neat sketch explain the use of Toolmakers microscope?
8. With a neat figure give gear terminology?
9. Explain the use of use of gear tooth vernier caliper and gear tooth micrometer.
10. What are the advances in Metrology

Module IV

Measurement systems and basic concepts of measurement methods

1. Define measurement and explain the generalized measurement system with neat block diagram.
2. Define
   a) Accuracy b) precision c) calibration d) threshold e) sensitivity f) hysteresis g) repeatability h) linearity i) loading effect j) system response-times delay.
3. Classify Errors.
4. What is Transducers? Explain Primary and Secondary transducers.

a. Write short notes on : Electrical transducer, Mechanical transducer, Electronic transducer.

6. Write the advantages and disadvantages for the transducer in previous question.
7. List the inherent problems mechanical systems.
8. What are the Electrical intermediate modifying devices? Explain any one
9. Explain the ballast circuit.

Module V

Force, Torque and Pressure Measurement and Measurement of strain and temperature

1. With a neat figure explain the working of analytical balance?
2. Explain the platform balance with neat figure?
3. What is proving ring? Explain.
4. List the torque measurement methods.
5. What is hydraulic dynamometer? Explain
6. Explain the Principle of pressure measurement with elastic members.
7. What is Bridgeman gauge? Explain with neat figure.
8. Explain the working of Mcloed gauge and Pirani Gauge.
9. Explain the principle of resistance thermometers.
10. Describe the law of thermocouple?
11. What materials are used for construction of thermocouple?
12. Write note on a) pyrometer b) optical pyrometer
13. What is Strain gauge? Explain with example.

13.0 University Result

Examination	S+	S	A	B	C	D	E	F	% Passing
Jan 2018	2	3	11	16	17	1	7	4	93.44
June 2018	--	3	4	16	25	9	3	1	96.97

Prepared by	Checked by		
Prof.G A Naik	Prof.B M Dodamani	HOD	Principal

Subject Title	**Mechanical measurements and Metrology Laboratory**		
Subject Code	17MEL47B	**CIE**	40
No of Lecture Hrs + Practical Hrs/ Week	01+02	**SEE**	60
Total No of Lecture +Practical Hrs	50	**Exam Hours**	03
CREDITS – 02			

FACULTY DETAILS:		
Name: Prof. G A Naik	**Designation:** Asst. Professor	**Experience:** 23Years
No. of times course taught: 12 Times	**Specialization:** Production Technology	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Mechanical Engineering	I	Mechanical Engineering Science
02	Mechanical Engineering	III	Mechanical measurements and Metrology

2.0 Course Objectives

1. To learn various measuring methods, Principles of operation of instruments and different aspects of measurement systems
2. To know the different measuring instruments for measuring a physical quantity like length, Angle, Surface flatness
3. To know the specification, part details and their functions of measuring instruments

3.0 Course Outcomes

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

CO	Course Outcome	Cognitive Level	POs
C210. 1	Select the set of combination of slip gauge height based on given dimensions.	**L1**	PO1, PO2, PO4 PO6, PO12
C210. 2	Calibrate the Thermocouple, Load cell and LVDT to measure physical quantities.	**L1,L2**	PO1, PO2, PO4 PO6, PO12
C210. 3	Find major and minor diameters using Two or Three wire method and Angle of screw thread using Toolmaker's microscope.	**L1,L2**	PO1, PO2, PO4 PO6, PO12
C210. 4	Measure slope or angle of the given work piece using Sine bar, Sine center and Bevel protractor.	**L1,L2**	PO1, PO2, PO4 PO6, PO12
C210. 5	Measure width and height of gear tooth at pitch circle diameter using Gear tooth vernier calipers	**L3**	PO1, PO2, PO4 PO6, PO12

4.0 Course Content

PART A

1. Calibration of Pressure Gauge
2. Calibration of Thermocouple
3. Calibration of LVDT
4. Calibration of Load cell
5. Determination of modulus of elasticity of a mild steel specimen using strain gauges.

PART B

1. Measurements using Optical Projector / Toolmaker Microscope.
2. Measurement of angle using Sine Center / Sine bar / bevel protractor
3. Measurement of alignment using Autocollimator / Roller set
4. Measurement of cutting tool forces using

a) Lathe tool Dynamometer OR

b) Drill tool Dynamometer.

5. Measurements of Screw thread Parameters using two wire or Three-wire methods.
6. Measurements of Surface roughness, Using Tally Surf/Mechanical Comparator
7. Measurement of gear tooth profile using gear tooth Vernier /Gear tooth micrometer
8. Calibration of Micrometer using slip gauges
9. Measurement using Optical Flats

5.0 Relevance to future subjects

SL. No	Semester	Subject	Topics / Relevance
01	III / IV	Mechanical measurements and Metrology Lab	Provides basics of measurement process and different measurement systems and measuring instruments to be used in MMM Lab
02	VIII	Project work	Generation of components for project

6.0 Relevance to Real World

SL.No	Real World Mapping
01	Measuring a physical quantity like Length, Angle,etc using different measuring devices
02	Operation of different measuring devices like Tool makers microscope for measurement of diameter of screw threads, Gear nomenclatures, surface alignments etc.

7.0 Books Used and Recommended to Students

Text Books
Mechanical measurements and Metrology by Dr. T Chandrashekar, Subhas Stores publishers
Reference Books
1. Engineering Metrology by R. K. Jain,Khanna Publishers 2. Mechanical metrology by I. C. Gupta Dhanapat Rai Publications, Delhi
Additional Study material & e-Books
1. Mechanical measurements by Beckwith maragoni and Lienhard, Pearson Education,

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

Website and Internet Contents References
http://www.tatynerds.com/mechanical-metrology-metrology http: //www.vturesource.com/2011/01/mechanical-measurements http://www.nptel.ac.in http://www.sapnaonline.com/shop/Author/t-chandrashekar

9.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	International Journal of measurement Technologies and Instrumentation Engineering	http://www.igi-global.com/journal/international-journal-measurement-technologies-instrumentation/43483
2	International Journal of Metrology and Quality Engineering	http://www.metrology-journal.org/
3	Springer Handbook of Metrology and Testing	http://www.springer.com/us/book/9783642166402
4	Measurement Techniques	http://www.springer.com/physics/applied+%26+technical+physics/journal/11018

10.0 Examination Note

SCHEME OF EXAMINATION:

One question is to be set from

Part-A	30
Part-B	50
Viva–Voce	20
Total	100 Marks

11.0 Course Delivery Plan

Expt. No	Lecture/Practical No	Name of the Experiment	% Of Portion
1	1	To study slip gauges and build up a slip gauge for given dimension	47.61
2	2	To calibrate the given vernier caliper.	
3	3	To calibrate the given micrometer	
4	4	To measure the angle using sine bar	
5	5	To measure the angle of tapered work using sine center	
6	6	To study Toolmaker's microscope and measure angle of screw thread using Toolmaker's microscope.	
7	7	To study the use of bevel protractor & to measure the angle	
8	8	To calibrate given load cell (load transducer) with help of fulcrum weights	26.19
9	9	To determine strain of a cantilever beam (AL) using strain gauges	
10	10	Measurement of effective diameter of screw thread using three-wire method	
11	11	To measure width & height of gear tooth at pitch circle diameter of a given gear.	
12	12	Calibration of LVDT with respect to micrometer by spring core method.	26.19
13	13	Calibration of thermocouple using glass thermometer	
14	14	To determine the straightness & flatness of the surface by using Autocollimator	
15	15	To study the flatness of the surfaces (Concave, Convex & Flat) by using the optical flats.	

12.0 QUESTION BANK

1. Define pressure?
2. Explain the bourdon tube pressure gauge
3. List the different pressure measuring instruments.
4. What is temperature?
5. List the different types of temperature measuring instruments.
6. Explain the principle of thermocouple.
7. What is calibration of thermocouple?
8. Different ways of displacement measurement.
9. Explain the working of LVDT.
10. What is strain gauge?
11. What is load cell?
12. Discuss the arrangement of strain gauges in load cell.
13. What is tool maker's microscope
14. Discuss the use of tool maker's microscope for thread measurement.
15. What are the different methods of measuring angles?
16. What is sine centre?
17. What is sine bar?
18. What is bevel protractor?
19. What are angle gauges?
20. Explain the working principle of autocollimator.
21. List the screw thread parameters.
22. What are different types of threads?
23. What is least count?
24. Calculate the least count of screw gauge, vernier caliper.
25. What are optical flats?
26. Explain the working principle of optical flats.
27. When bright fringes are formed?
28. When dark fringes are formed?
29. What is the function
30. What are optical flats?
31. Definf effective diameter of screw thread
32. What is gear?
33. What is Autocollimator?
34. Define Pitch?
35. What is the function of collimator lens?

13.0 University Result

Examination	S^+	S	A	B	C	D	E	F	% Passing
Jan 2018	21	31	8	--	--	--	--	--	100
June 2018	24	36	3	1	--	--	--	--	100

Prepared by	Checked by		
Prof.G A Naik	Prof.B M Dodamani	HOD	Principal

Subject Title	**MACHINE SHOP LABORATORY**		
Subject Code	17MEL48B	**IA Marks**	40
No of Lecture Hrs + Practical Hrs/ Week	01+02	**Exam Marks**	60
Total No of Lecture+Practical Hrs	52	**Exam Hours**	03
CREDITS – 02			

FACULTY DETAILS:		
Name: Prof.Ravi C	**Designation:** Asst.Professor	**Experience:**28Years
No. of times course taught:05 Times	**Specialization:**TPE	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Mechanical Engineering	I	MES
02	Mechanical Engineering	III	Manufacturing Process I
03	Mechanical Engineering	IV	Manufacturing Process II

2.0 Course Objectives

1 To provide an insight to different machine tools, accessories and attachments
2 To train students into machining operations to enrich their practical skills
3 To inculcate team qualities and expose students to shop floor activities
4 To educate students about ethical , environmental and safety standard.

3.0 Course Outcomes

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

CO	Course Outcome	Cognitive Level	Pos
C28A.1	**Demonstrate basic Lathe, Milling and Shaping machine operations**	**L1,l2**	**PO1, PO6, PO9**
C28A.2	**Prepare the jobs using lathe which include Facing, Turning, Knurling**	**L2,L3**	**PO1, PO6, PO9**
C28A.3	**Prepare the jobs using Milling machine to cut gear teeth by Indexing**	**L2,L3**	**PO1, PO6**
C28A.4	**Prepare the jobs using Shaper to cut dovetail/ rectangular/V-grooves**	**L2,L3**	**PO1, PO6**
Total Hours of instruction		**50**	

4.0 Course Content

PART – A
Preparation of three models on lathe involving Plain turning, Taper turning, Step turning, Thread cutting, Facing, Knurling, Drilling, Boring, Internal Thread cutting and Eccentric turning.

PART – B
Cutting of V Groove/ dovetail / Rectangular groove using a shaper Cutting of Gear Teeth using Milling Machine

PART –C
For demonstration of formation of cutting parameters of single point cutting tool using bench grinder / tool & cutter grinder. Demonstration of surface milling /slot milling

5.0 Relevance to future subjects

SL. No	Semester	Subject	Topics / Relevance
01	IV	Machine tool and operations	Provides basics of machine tools 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	Producing different models by machining process.
02	Producing ancillary products for assembly of machines.

7.0 Books Used and Recommended to Students

Text Books
1. Workshop Technology by HazraChaudharyvol I &vol II. 2. Fundamentals of metal cutting and Machine tools By B L Juneja
Reference Books
3. Machine Tool Operations By Anup Goel 4. Metal Processing II BY Kestoor Praveen
Additional Study material & e-Books
A Textbook of Metal processing eBook By O P Khanna PDF.

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

Website and Internet Contents References
https://en.wikipedia.org/wiki/Machine_shop https://www.ameslab.gov/mpc/equipment/machine-shop http://www.nptel.ac.in

9.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	Website
1	International Journal of Machine tool and manufacture	www.journals.elsevier.com/international-journal-of-machine-tools-and-manufacture
2	International Journal of Mechanical and Materials Engg	http://www.springer.com/engineering/mechanics/journal/40712
3	International Journal of Precision engg and manufacturing	http://www.springer.com/engineering/production+engineering/journal/12541
4	International Journal of Machine tool design and Research	http://www.sciencedirect.com/science/journal/00207357

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)
(e) Internal Assessment test in the same pattern as that of the main examination 40marks.

SCHEME OF EXAMINATION:
One question is to be set from Part-A 50Marks One question is to be set from either Part-B 30Marks
Viva–Voce 20Marks

Total 100Marks

11.0 Course Delivery Plan

Expt No	Lecture/Practical No	Name of the Experiment	% Of Portion
1	16	Introduction to various machine tools.	47.61
2	17	Facing and plain turning	
3	18	Knurling and thread cutting	
4	19	Taper turning and eccentric turning	
5	20	V groove cutting and rectangular groove cutting	
6	21	To study the indexing and milling machine operation	
7	22	Perform gear tooth cutting on milling machine	
8	23	To understand the cutting tool parameters of single point cutting tool using bench grinder	42.39
9	24	Understand surface milling/slot milling	
10	25	Demonstrate the precautions and safety measures followed in machine shop	
11	26	Kea way cutting/slot cutting on shaper	

12.0 QUESTION BANK

1. 1.Define lathe 2. List the operations performed on the lathe 3. What are the principal parts of the lathe? 4. Various parts mounted on the lathe? 5. Mention the types of head stock 6. Mention the four types of tool post 7. What is an apron? 8. Mention the specifications of the lathe 9. List the types of lathe 10. Define semi automatic lathe 11. State the various feed mechanisms of the lathe 12. List 4 holding devices 13. Define 'Conicity'? 14. Advantages of capstan lathe and turret lathe. 15. Define tooling 16. What are 3 stage tool layout 17. Define shaper	25. Comparison between universal and plain milling machine 26. What are cutter holding devices 27. Operations of milling machines and explain each of them. 28. Milling cutter nomenclature 29. Advantages of milling machine 30. Define indexing 31. Explain Universal dividing head 32. What is cam milling? 33. Explain spur gear cutting 34. Various parts of single point cutting tool 35. Define tool signature 36. What is the effect of back rake angle and mention its type 37. What is side rake angle and mention its effects? 38. Conditions for positive rake angle

18. List and explain Important parts of shaper. 19. Driving Mechanism involved in shaper 20. List and explain Shaping operations 21. Principle of shaping 22. Classification of shaping machine 23. Specifications of milling machine 24. Specifications of milling machine	39. Conditions for negative rake angle 40. Define orthogonal and oblique cutting 41. Define cutting force 42. Chip thickness ratio 43. Factors affecting machinability 44. Define machinabilty of metal? 45. What is machinabilty index? 46. How tool life is defined

13.0 University Result

Examination	S+	S	A	B	C	D	E	F	% Passing
July 2018	**61**	**00**	**00**	**00**	**00**	**00**	**00**	**00**	**100**
July 2017	**59**	**05**	**00**	**00**	**00**	**01**	**00**	**00**	**100**

Prepared by	Checked by		
PROF.R.K.CHITGOPKAR	**PROF.G.A.NAIK**	**HOD**	**Principal**