Department of Mechanical Engineering

COURSE PLAN 2019-20

V Semester "A and B" division

Nidasoshi-591 236, Taq: Hukkeri, Dist: Belagavi, Karnataka, India.
Phone: +91-8333-278887, Fax: 278886, Web: www.hsit.ac.in, E-mail: principal@hsit.ac.in

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"

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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.

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Student Help Desk

S. N.	Additional Responsibility	Contact Person	
		Faculty	Staff
1.	Attestations, Dept. & Institute Work.	HOD	Sri. V G Badiger
2.	PG Coordinator/ Research Centre Head	Prof. S A Alur	Sri. R M Hunchyali
3.	I I I coordinator (INDUSTRY)	Prof. G A Naik	Sri. S C Jotawar
4.	I I I coordinator (INTERNSHIP)	Prof. R. V. Chitgopkar	Sri. R B Kumbar
5.	Class Teachers In-charges	Prof.K.M.Akkoli (III A)	Sri. M S Kurani
		Prof.Jagadeesh S A (III B)	Sri. R B Kumbar
		Prof.M. R. Ingalagi (V A)	Sri. R M Hunchyali
		Prof. R.K.Chitagopkar (V B)	Sri. S R Nakade
		Prof.S.A.Goudadi (VII A)	Sri. S C Jotawar
		Prof. M S Futane (VII B)	Sri. M B Badiger
6.	Record Room Coordinator	Prof. S. B. Awade	Sri. M S Kurani
7.	I A Test Coordinator	Prof. S. B. Awade/Prof. A M Biradar	Sri. M B Badiger
8.	Seminar/Project Coordinator	Prof. N.M.Ukkali/ Prof. B. M. Dodamani	Sri. M B Badiger/ Sri. S C Jotawar
9.	Faculty / AICTE/LIC/ Staff Activities	Prof. B. M. Dodamani	All Instructors
10.	Student Activities/Feedback Coordinator	Prof. Jagdeesh A	All Instructors
11.	AIMSS Coordinator	Prof. M. M. Shivashimpi/Prof. M R Ingalagi	Sri. M B Badiger
12.	NBA Coordinator	Prof. S. A. Goudadi	
13.	Extra Curricular/ Induction Coordinator	Prof. T S Vandali	
14.	Dept. Meeting Proceedings Coordinator	Prof. K G Ambli	
15.	PhD.EMS/ News Letter Coordinator	Prof. M. M. Shivashimpi	
16.	Choice of Electives	Dr. S. N. Toppannavar Prof. D. N. Inamdar Prof. T. S. Vandali	
17.	EMS Coordinator	Prof. S. B. Awade/ Prof. N.M.Ukkali/ Prof. M R Ingalagi	
18.	T P Cell Coordinator	Prof. R V Nyamagoud	Sri S. R. Nakade
19.	Alumni Coordinator.	Prof. M A Hipparagi	
20.	Robo Vidya Coordinator	Prof. A M Biradar	Sri. V G Badiger
21.	Department Library Coordinator	Sri. Mahantesh Tanodi	Sri. R M Hunchyali
22.	Time Table/ISTE Coordinator	Prof. G. V. Chiniwalar	
23.	GATE Coordinator	H.O.D	
24	News Letter/ Tech. Magazine/ Coordinator,	Prof. S R Kulkarni/ Prof. M S Futane	
25	Central Counseling Coordinator (Dept.)	HOD & Class Teachers	
26	Dispensary	Dr. Arun G. Bullannavar - Cell No. 9449141549	
Institute Level			
01	NBA/NIRF Coordinator	Prof. D. N. Inamdar (9591208980)	
02	Student Welfare Convener	Prof. S. B. Akkoli (9480422508)	
03	Hostel warden KSCST Coordinator	Prof. M S Futane (7829611609)	
04	AICTE/ Hostel Asst. Warden Coordinator	Prof. K. M. Akkoli (9739114856)	
05	TP Cell Coordinator	Prof. N. M. Patel (9739619661)	
06	Anti Ragging Convener	Prof. M. S. Futane (9480849334)	
07	Anti Squad Convener	Prof. K. M. Akkoli (9739114856)	
08	Anti Sexual Harassment Convener	Prof. S S Kamate (9008696825)	
09	Grievance Redressal Convener	Prof. G. A. Naik (9480539283)	
10	Institute News & publicity	Prof. Mahesh Hipparagi (7411507405)	
11	First Year Coordinator	Dr. S. N. Toppannavar (9945082054)	

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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	24	17
2	Technical staff	11	14
3	Helper / Peons	05	09

Major Laboratories

S.N.	Name of the laboratory	Area in Sq. Meters	Amount Invested (Rs.)
1	Basic Workshop Laboratory	170	427698
2	Fluid Mechanics Machinery Laboratory	172	775316.75
3	Energy Conversion Engg. Laboratory	173	1269190.2
4	Machine shop Laboratory	170	1361344.5
5	Foundry & Forging Laboratory	179	318787.11
6	Design Laboratory	73	364998
7	Heat & Mass Transfer Laboratory	148	524576
8	Metallography & Material Testing Laboratory	149	1095679.24
9	Mechanical Measurements & Metrology Laboratory	95	548011.75
10	CIM & Automation/CAMA Laboratory	66	3720223.1
11	Computer Aided Machine Drawing Laboratory	66	2013811.5
12	Computer Aided Engg Drawing Laboratory	66	1427271.3
13	Department/Other	--	1908664.2
	Total	**1527**	**1,57,55,571.65**

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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	26	9480849331
2	Dr. S. A. Alur	Professor	Ph. D	Thermal Power Engg.	LMISTE	--	24	9686856029
3	Dr. B M Shrigiri	HOD/Professor	Ph. D	Thermal Power Engg.	LMISTE	01	20	9741483339
4	Dr. S. N. Topannavar	Assoc. Professor	M Tech.(Ph. D)	Thermal Power Engg.	LMISTE	01	18	9482440235
5	Prof. D. N. Inamdar	Asso. Professor	M Tech.(Ph. D)	Tool Engg	LMISTE	08	14	9591208980
6	Prof. K. M. Akkoli	Asso. Professor	M Tech.(Ph. D)	Thermal Power Engg.	LMISTE	1.5	14	9739114856
7	Prof.R.K.Chitgopkar	Asst. Professor	M Tech.	Thermal Power Engg.	LMISTE	1.5	26	9886070475
8	Prof.G. A. Naik	Asst. Professor	M Tech.	Production Management	LMISTE	02	21	9480539283
9	Prof. G. V. Chiniwalar	Asst. Professor	M Tech.	Machine Design	LMISTE	04	14	8762336434
10	Prof.M.S.Futane	Asst. Professor	M Tech.	Computer Integrated Manufacturing	LMISTE	01	12	9164105035
11	Prof. T. S. Vandali	Asst. Professor	M Tech.	Machine Design	LMISTE	8.5	08	9686235904
12	Prof.S. A. Goudadi	Asst. Professor	M Tech.	Design Engineering	LMISTE	--	10	9448876682
13	Sri. S.R. Kulkarni	Asst. Professor	M Tech.	Design Engineering	LMISTE	--	10	8123661692
14	Prof.M.M.Shivashimpi	Asst. Professor	M Tech.(Ph.D)	Thermal Power Engg.	LMISTE	01	08	9742197173
15	Prof.M.A.Hipparagi	Asst. Professor	M Tech.(Ph.D)	Production Technology	LMISTE	02	07	7411507405
16	Prof. A. M. Biradar	Asst. Professor	M Tech.	Machine Design	LMISTE	02	07	9986127703
17	Prof. K. G. Ambli	Asst. Professor	M Tech.(Ph.D)	Product Design and Manufacturing	LMISTE	0.8	06	9164534514
18	Prof. S. B. Awade	Asst. Professor	M Tech.	Machine design	LMISTE		05	9632606108
19	Prof.Mahantesh Tanodi	Asst. Professor	M Tech.	Machine design	LMISTE	--	06	9611998812
20	Prof. N. M. Ukkali	Asst. Professor	M Tech.	Machine Design	LMISTE	--	05	9620152199
21	Prof. M. R. Inagalagi	Asst. Professor	M Tech.	Thermal Power Engg	LMISTE	--	04	9743868503
22	Prof. Jagadeesh A.	Asst. Professor	M Tech.	Thermal Power Engg	LMISTE	--	05	9902847774
23	Prof. R. V. Nyamagoud	Lecturer	M Tech.	Thermal Power Engg	LMISTE	--	04	9964822494
24	Prof. B. M. Dodamani	Asst. Professor	M Tech.	Energy System Engg	LMISTE	02	04	9535447575

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Inculcating Values, Promoting Prosperity
Approved by AICTE New Delhi, Recognized by Govt. of Karnataka and Affiliated to VTU Belagavi.
Accredited at 'A' Grade by NAAC and Recognized Under Section 2(f) of UGC Act, 1956.

Institute
File I-11
2019-20 (Odd)
Rev: 0

CALENDAR OF EVENTS FOR THE ACADEMIC YEAR 2019-20 (Odd)

Date	Events
29-07-2019	Commencement of III /V/VII Sem Classes
01-08-2019	Commencement of I Sem Classes
01-08-2019 to 11-08-2019	Induction Program for I Sem students
15-08-2019	Independence Day & Swachh Bharat Abhiyan
05-09-2019	Teachers Day, Mahadasoha
06-09-2019	Indoor Games & & Health Checkup Camp
12-09-2019 to 14-09-2019	First Internal Assessment of I/III/V/VII Sem
15-09-2019	Engineers Day
16-09-2019	Feed Back-1 on Teaching-Learning
18-09-2019	Display of First Internal Assessment Marks & Submission of Feedback-1 report to office
24-09-2019	EDP Activities/ Green Club activites
02-10-2019	Gandhi Jayanti & Swachh Bharat Abhiyan
11-10-2019	Blood donation camp
21-10-2019 to 23-10-2019	Second Internal Assessment of I/III/V/VII Sem
24-10-2019	Feed Back-2 on Teaching-Learning
28-10-2019	Display of Second Internal Assessment Marks & Submission of Feedback-2 Report to Office
01-11-2019	Kannada Rajyotsava
21-11-2019 to 23-11-2019	Third Internal Assessment of I/III/V/VII Sem
25-11-2019 to 27-11-2019	Lab Internal Assessment of I/III/V/VII Sem
28-11-2019	Display of Third & Final Internal Assessment Marks (I/III/V/VII Sem)
29-11-2019	Last Working Day of I Sem
30-11-2019	Last Working Day of III/V/VII Sem
03-12-2019 to 13-12-2019	Practical Exams of I/III/V/VII Sem
16-12-2019 to 07-02-2020	Theory Exams of I/III/V/VII Sem

August-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

12-Bakrid, 15- Independance day, 26- Last Shravana Monday

September-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					

02- Ganesh Chaturthi , 05- Mahadasoha, 10- Moharam, 28-Mahalaya Amavasye

October-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		

02- Gandhi Jayanti, 07-Ayudha Pooja, 08- Vijayadashami, 13- Valmiki Jayanti, 27- Naraka Chaturdashi, 29- Balipadyami

November-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

01- Kannada Rajyotsava, 10- Id-e-Milad, 15- Kanakadasa Jayanthi

Dr. Shilpa Shrigiri
IQAC Co-ordinator

Hirasugar Institute of Technology Nidasoshi Pin-591236 Dist. Belagavi

Dr. S C Kamate
PRINCIPAL
Hirasugar Institute of Technology
NIDASOSHI 591 236

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DEPARTMENT CALENDAR OF EVENTS FOR THE ACADEMIC YEAR 2019-20 (Odd)

Date	Events
29-07-2019	**Commencement of III /V/VII Sem Classes**
17-08-2019	**Welcome Function for Fresher's and Inauguration of AIMSS Activities**
31-08-2019	Industrial Visit for III semester students
06-09-2019	Technical Talk by environmentalist
12-09-2019 to 14-09-2019	**First Internal Assessment**
16-09-2019	Feedback - 01 on Teaching and Learning
18-09-2019	Display of First I.A. Marks, Submission of Students Feedback-1 report and Central Counseling.
21-09-2019	Industrial Visit for V semester students
24-09-2019	ED Cell Activity
11-10-2019	Technical Talk by Academic Expert
21-10-2019 to 23-10-2019	**Second Internal Assessment**
24-10-2019	Feedback - 02 on Teaching and Learning
28-10-2019	Display of Second I.A. Marks, Submission of Feedback-2 Report to Office and Central Counseling.
08-11-2019	Technical Talk by Industry Expert
21-11-2019 to 23-11-2019	**Third Internal Assessment**
25-11-2019 to 27-11-2019	**Lab Internal Assessment**
28-11-2019	Display of Third & Final I.A. Marks
30-11-2019	**Last Working Day**
03-12-2019 to 13-12-2019	**Commencement of Practical Exams**
16-12-2019 to 07-02-2020	**Commencement of Theory Exams**

August-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

12-Bakrid, 15- Independance day, 26- Last Shravana Monday

September-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					

02- Ganesh Chaturthi , 05- Mahadasoha, 10- Moharam, 28-Mahalaya Amavasye

October-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		

02- Gandhi Jayanti, 07-Ayudha Pooja, 08- Vijayadashami, 13- Valmiki Jayanti, 27- Naraka Chaturdashi, 29- Balipadyami

November-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

01- Kannada Rajyotsava, 10- Id-e-Milad, 15- Kanakadasa Jayanthi

Prof. M. M. Shivashimpi
AIMSS Co-ordinator

Dr. B. M. Shrigiri
HOD

HOD
Mechanical Engg.
HIT, Nidasoshi

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Scheme of Teaching and Examination

5th Semester "A and B" division

Sl. No.	Subject Code	Title	Teaching Hours per week			Examination				Credits
			Lecture	Tutorial	Practical	Duration (hours)	SSE marks	CIE marks	Total marks	
1	17ME51	Management and Engineering Economics	3	2	0	03	60	40	100	4
2	17ME52	Dynamics of Machinery	3	2	0	03	60	40	100	4
3	17ME53	Turbo Machines	3	2	0	03	60	40	100	4
4	17ME54	Design of Machine Elements-I	3	2	0	03	60	40	100	4
5	17ME55X	Professional Elective- I	3	0	0	03	60	40	100	3
6	17ME56X	Open Elective	3	0	0	03	60	40	100	3
7	17MEL57	Fluid Mechanics & Machinery Lab	1	0	2	03	60	40	100	2
8	17MEL58	Energy Lab	1	0	2	03	60	40	100	2
		Total	20	08	04		480	320	60	40

Professional Elective-I		Open Elective-I	
17ME551	Refrigeration and Air-conditioning	17ME561	Optimization Techniques
17ME552	Theory of Elasticity	17ME562	Energy and Environment
17ME553	Human Resource Management	17ME563	Automation and Robotics
17ME554	Non Traditional Machining	17ME564	Project Management

1. **Core subject:** This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.
2. **Professional Elective:** Elective relevant to chosen specialization/ branch
3. **Open Elective:** Electives from other technical and/or emerging subject areas.

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Subject Title	ENGINEERING MANAGEMENT & ECONOMICS		
Subject Code	17ME51	**IA Marks**	40
No of Lecture Hrs + Tutorial Hrs / Week	04	**Exam Marks**	60
Total No of Lecture + Tutorial Hrs	50	**Exam Hours**	03
			CREDITS – 04

FACULTY DETAILS:		
Name: Prof. G. A. Naik	**Designation:** Asst. Professor	**Experience:** 23Years
No. of times course taught: 04 Time	**Specialization:** Production Technology	
Name: Prof. S.R.Kulkarni	**Designation:** Asst. Professor	**Experience:** 12Years
No. of times course taught: 01Time	**Specialization:** Production Management	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
1	Mechanical Engineering	1,2,3,4	Engineering Mathematics

2.0 Course Objectives

· Examine the meaning, importance, nature of management, its difference between management and administration and role of managers in management.
· Examine the meaning characteristics principles and process of organizing.
· Describe effective communication process, its importance, types and purpose for running an organization.
· Explain the importance of engineering economics, Law of demand and supply in engineering decision making.
· Describe various interest rate factors and implement the same for economic decision making.
· Examine different economic analysis methods-NPW, EAW, IRR, FW for decision making.
· Discuss different component of costs and methods of cost estimation.
· Explain depreciation, different methods of computing depreciation.

3.0 Course Outcomes

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

CO	Course Outcome	Cognitive Level	POs
CO1	Understand needs, functions, roles, scope and evolution of Management	U	5,7,8,9,10,11,12
CO2	Understand importance, purpose of Planning and hierarchy of planning and also analyze its types	U	5,7,8,9,10,11,12
CO3	Discuss Decision making, Organizing, Staffing, Directing and Controlling	U	5,7,8,9,10,11,12
C04	Select the best economic model from various available alternatives.	A	1,2,3,5,6,10,11,12
C05	Understand various interest rate methods and implement the suitable one.	A	1,2,3,5,6,10,11,12
C06	Estimate various depreciation values of commodities.	A	1,2,3,5,6,10,11,12
C07	Prepare the project reports effectively.	A	1,2,3,5,6,10,11,12
Total Hours of instruction		**50**	

4.0 Course Content

MODULE – 1

Management: Introduction - Meaning - nature and characteristics of Management, Scope and Functional areas

of management - Management as a science, art of profession - Management & Administration - Roles of Management, Levels of Management, Development of Management Thought - early management approaches – Modern management approaches. **Planning:** Nature, importance and purpose of planning process Objectives - Types of plans (Meaning Only) - Decision making Importance of planning - steps in planning & planning premises - Hierarchy of plans. **10 Hours**

MODULE - 2

Organizing And Staffing: Nature and purpose of organization Principles of organization -Types of organization - Departmentation Committees- Centralization Vs Decentralization of authority and responsibility - Span of control - MBO and MBE (Meaning Only) Nature and Importance of staffing- -: Process of Selection & Recruitment (in brief). **Directing & Controlling:** Meaning and nature of directing Leadership styles, Motivation Theories, Communication - Meaning and importance - coordination, meaning and importance and Techniques of Co Ordination. Meaning and steps in controlling - Essentials of a sound control system - Methods of establishing control (in brief) **10Hours**

MODULE -3

Introduction: Engineering and economics, Problem solving and decision making, Laws of demand and supply, Difference between Microeconomics & Macroeconomics, equilibrium between demand & supply, elasticity of demand, price elasticity, income elasticity. Law of Returns, Interest and interest factors, simple and compound interest, Cash flow diagrams, personal loans and EMI payment calculation with flexible interest rates, Discussion and problems **10Hours**

MODULE -4

Present, future and annual worth and rate of returns: Basic present worth comparisons, Present worth-equivalence, Assets with unequal lives and infinites lives, future worth comparisons, payback comparisons, Equivalent annual worth comparisons, situations for annual worth comparisons. Asset life, Rate of return, minimum acceptable rate of return, IRR anomalies and misconceptions, Cost of capital, comparisons of all present future and annual worth with IRR, product costing, Discussions and problems. **10 Hours**.

MODULE -5

Costing and depreciation: Components of costs, estimation of selling price, marginal cost, first cost, all kinds of overheads, indirect cost estimation with depreciation, mensuration and estimation of material cost, cost estimation of mechanical process, idling time. Product costing (approaches to product costing), causes of depreciation, methods of computing depreciation charges, straight line method, declining balance method, sum of years method, sinking fund method, service output methods, taxation concepts, personal income taxes and corporate taxes, Discussions and problems. **10 Hours**

5.0 Relevance to future subjects

SL. No	Semester	Subject	Topics / Relevance
01	VII	Total Quality Management	Principles and Practice

6.0 Relevance to Real World

SL. No	Real World Mapping
01	Management of production, service and NGOs
02	Management concept is using in running and maintaining educational and government organizations.

7.0 Gap Analysis and Mitigation

Sl.	Delivery Type	Details

No		
01	Tutorial	Solving the unsolved problems from the reference and text books
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. Principles of Management by Tripathy and Reddy 2. Mechanical estimation and costing, T.R. Banga & S.C. Sharma, 17th edition 2015 3. Engineering Economy, Riggs J.L. McGraw Hill, 2002 4. Engineering Economy, Thuesen H.G. PHI , 2002
Reference Books
1. Management Fundamentals - Concepts, Application, Skill Development - Robers Lusier -Thomson 2. Basics of Engineering Economy, Leland Blank & Anthony Tarquin, McGraw Hill Publication (India) Private Limited 3. Engineering Economics, R.Paneerselvam, PHI publication 4. Fundamentals of Management: Essential Concepts and Applications, Pearson Education, Robbins S.P. and Decenzo 5. Economics: Principles of Economics, N Gregory Mankiw, Cengage Learning 6. Modern Economic Theory, By Dr. K. K. Dewett & M. H. Navalur, S. Chand Publications
Additional Study material & e-Books
• Nptel.ac.in • VTU, E- learning

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

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

10.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	International Journal of Engineering Management and Economics	http://www.inderscience.com/jhome.php?jcode=ijeme
2	The Engineering Economist	http://www.tandfonline.com/loi/utee20
3	Engineering Costs and Production Economics	http://www.sciencedirect.com/science/journal/0167188X?sdc=1

11.0 Examination Note

Internal Assessment: 40 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 40marks.
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: 100 Marks (Reduced to 60)

12.0 Course Delivery Plan

Module No.	Lecture No.	Content of Lecture	% of Portion
1		**Management**	20
	1	Introduction - Meaning - nature and characteristics of Management.	
	2	Scope and Functional areas of management - Management as a science, art of profession.	
	4	Management & Administration - Roles of Management, Levels of Management.	
	5	Development of Management Thought - early management approaches.	
	6	Modern management approaches.	
	7	**Planning:** Nature, importance and purpose of planning process	
	8	Objectives - Types of plans(Meaning Only)	
	9	Decision making Importance of planning	
	10	Steps in planning & planning premises - Hierarchy of plans.	
2		**Organizing And Staffing:**	20
	1	Nature and purpose of organization Principles of organization	
	2	Types of organization - Departmentation Committees- Centralization Vs Decentralization of authority and responsibility	
	3	Span of control - MBO and MBE (Meaning Only)	
	4	Nature and importance of staffing.	
	5	Process of Selection & Recruitment (in brief).	
	6	**Directing & Controlling:** Meaning and nature of directing Leadership styles	
	7	Motivation Theories, Communication - Meaning and importance.	
	8	Coordination, meaning and importance and Techniques of Co Ordination.	
	9	Meaning and steps in controlling - Essentials of a sound control system.	
	10	Methods of establishing control (in brief)	
3		**Introduction**:	20
	1	Engineering and economics	
	2	Problem solving and decision making, Laws of demand and supply,	
	3	Difference between Microeconomics & Macroeconomics,	
	4	Equilibrium between demand & supply, elasticity of demand	
	5	Price elasticity, income elasticity.	
	6	Law of Returns, Interest and interest factors	
	7	simple and compound interest, Cash flow	
	8	diagrams, personal loans and EMI payment	
	9	calculation with flexible interest rates,	
	10	Discussion and problems	
4		**Present, future and annual worth and rate of returns**:	20
	1	Basic present worth comparisons, Present worth-equivalence.	
	2	Assets with unequal lives and infinites lives.	
	3	Future worth comparisons, payback comparisons.	
	4	Equivalent annual worth comparisons.	
	5	Situations for annual worth comparisons.	
	6	Asset life, Rate of return, minimum acceptable rate of return.	
	7	IRR anomalies and misconceptions	
	8	Cost of capital, comparisons of all present future and annual worth with IRR.	
	9	Product costing, Discussions and problems.	
	10	Product costing, Discussions and problems.	
5		**Costing and depreciation**:	20
	1	Components of costs, estimation of selling price, marginal cost, first cost.	

	2	All kinds of overheads, indirect cost estimation with depreciation, mensuration	
	3	Estimation of material cost	
	4	Cost estimation of mechanical process, idling time.	
	5	Product costing (approaches to product costing),	
	6	Causes of depreciation, methods of computing	
	7	Depreciation charges, straight line method, declining balance method,	
	8	Sum of years method, sinking fund method,	
	9	Service output methods, taxation concepts,	
	10	Personal income taxes and corporate taxes, Discussions and problems	

13.0 Assignments, Pop Quiz, Mini Project, Seminars

Sl.No.	Title	Outcome expected	Allied study	Week No.	Individual / Group activity	Reference: book/website /Paper
1	Assignment 1: University Questions	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 1 syllabus	3	Individual Activity and submission of hard copy.	Book 1 and all the reference book
2	Assignment 2: University Questions	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 2 syllabus	6	Individual Activity and submission of hard copy.	Book 1 and all the reference book
3	Assignment 3: University Questions	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 3 syllabus	9	Individual Activity and submission of hard copy.	Book 1 and all the reference book
4	Assignment 3: University Questions	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 4 syllabus	12	Individual Activity and submission of hard copy.	Book 1 and all the reference book
5	Assignment 3: University Questions	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 5 syllabus	15	Individual Activity and submission of hard copy.	Book 1 and all the reference book

14.0 Assignment Questions

Assignment No	Questions	Marks
1.	1. Define the term management and write down the characteristic 2. What is meant by the scope of management and how it can be understood, explain in detail 3. What are the different functional areas of management and at least explain 5 of them. 4. What is the basic aim of management and write down its functions. 5. "Management as a Science" explain this term and explain its properties. 6. What are the objectives of planning process? 7. How organizational plans can be broadly classified. 8. What is decision making and write down the characteristics of it. 9. Write notes on a) strategic planning b) tactical planning c) operational planning. 10. Draw a block diagram showing hierarchy of plans.	20
2.	1. Explain the term organization and write down its characteristics. 2. Write down the different principles of organization and explain each. 3. What is meant by formal and informal organization? 4. With neat block diagram explain line, military or scalar organization. 5. Draw a neat block diagram showing the functional organizational chart and explain it. 6. What are the different types of committees 7. Write a note on the two-factor theory. 8. Compare the Maslow's theory and Herzberg theory. 9. Distinguish between theory X and theory Y. 10. Explain McClelland's three need model, vroom's valance expectancy Theory.	20
3.	1. Discuss the relationship between engineering and economics. 2. With the help of a block diagram explain problem solving and decision Making. 3. Explain the significance of intuition and analysis. 4. Explain in brief engineering economic decision maze with help of a neat sketch. 5. Differentiate between law of demand, supply and returns.	20
4.	1. How interest rate signifies the time value of money, explain 2. Differentiate between simple interest and compound interest. 3. Explain the significance of cash flow diagrams in computing interest. 4. At what annual interest rate will Rs.1000 invested today be worth Rs.2000 in 9 years? 5. A loan of Rs.1000 is made today under an agreement that Rs.1400 will be received in payment sometime in the future. When the Rs.1400 should be received if the loan is to earn interest at a rate of 8% compounded quarterly. 6. Now is March 31, 2005.Three payments of Rs.500each are to be received every 2 years, starting 2 years from now , and deposited in a bank where they will earn interest at 7% per year. How large will the bank account be on March 31, 2013? 7. What is the present worth of a series of 15 year end payments of Rs.1000 each, when the first payment is due today and the interest rate is 5%. 8. With interest at 6%, what is the worth on December 31, 1994, of a series of year end payments of Rs.317.70 made from the years 2000 through 2004? 9. Two devices are available to perform a necessary function for 3 years. The initial costs for each device at time 0 and subsequent annual savings are shown in the following table. The required interest rate is 8%. | | 0 | 1 | 2 | 3 | | Device A | 9000 | 4500 | 4500 | 4500 | | Device B | 14500 | 6000 | 6000 | 8000 | 10. Assets A and B have the capability of satisfactorily performing a required function. Asset B has an initial cost of Rs.3200 and an expected salvage value of Rs.400 at the end of its 4 year service life. Asset A costs Rs.900 less initially, with an economic life	20

	1 year shorter than that of B, but A has no salvage value, and its annual operating costs exceed those of B by Rs.250.When the required rate of return is 15%, state which alternative is preferred when comparison is by: a) The repeated projects method b) A 2 year study period (assuming the assets are needed for only 2 years).	
5.	1. What is depreciation? What are the various causes of depreciation? 2. Explain in brief the basic methods of computing depreciation charges. 3. Classify the various components of cost. 4. With specific examples, explain the following: a)Direct material cost b)Direct labor cost c)Fixed overhead cost d)Factory cost e)Administrative overhead cost f)First cost g)Marginal cost 5. Explain the significance of selling price.	20

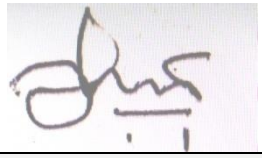
15.0 QUESTION BANK

S.No	Questions	Marks
1	1. Define the term management and write down the characteristic 2. What is meant by the scope of management and how it can be understood, explain in detail 3. What are the different functional areas of management and at least explain 5 of them. 4. What is the basic aim of management and write down its functions. 5. "Management as a Science" explain this term and explain its properties. 6. Explain the properties of management. 7. Management as an art explains the term and write down its properties. 8. Define the term planning and explain its different characteristics. 9. What are the different steps in planning processes explain each step in detail. 10. What are the objectives of planning process?	20
2.	1. Write down the different principles of organization and explain each. 2. What is meant by formal and informal organization? 3. With neat block diagram explain line, military or scalar organization. 4. Draw a neat block diagram showing the functional organizational chart and explain it. 5. Write down the different application of functional organization. 6. List the applications line and staff organization. 7. Explain the meaning of directing. What are the different features of directing? 8. What is leader ship and what are the different leader ship styles. 9. What is motivation? Write down its characteristics. 10. Explain McClelland's three need model, VROOM'S VALANCE EXPECTANCY Theory.	20
3.	1. Discuss the relationship between engineering and economics. 2. With the help of a block diagram explain problem solving and decision Making. 3. Explain the significance of intuition and analysis. 4. Explain in brief engineering economic decision maze with help of a neat sketch. 5. Differentiate between law of demand, supply and returns.	20
4.	1. How interest rate signifies the time value of money, explain 2. Differentiate between simple interest and compound interest. 3. Explain the significance of cash flow diagrams in computing interest. 4. At what annual interest rate will Rs.1000 invested today be worth Rs.2000 in 9 years. 5. Now is March 31, 2005.Three payments of Rs.500each are to be received every 2 years, starting 2 years from now , and deposited in a bank where they will earn interest at 7% per year. How large will the bank account be on March 31,2013. 6. What is the present worth of a series of 15 year end payments of Rs.1000 each, when the first payment is due today and the interest rate is 5%. 7. What are the various conditions for present worth comparisons? 8. Differentiate between present worth equivalence and net present worth with an example. 9. Two devices are available to perform a necessary function for 3 years. The initial costs for each device at time 0 and subsequent annual savings are shown in the following table. The required interest rate is 8%.	20

	10. Assets A and B have the capability of satisfactorily performing a required function. Asset B has an initial cost of Rs.3200 and an expected salvage value of Rs.400 at the end of its 4 year service life. Asset A costs Rs.900 less initially, with an economic life 1 year shorter than that of B, but A has no salvage value, and its annual operating costs exceed those of B by Rs.250.When the required rate of return is 15%, state which alternative is preferred when comparison is by: a) The repeated projects method b) A 2 year study period (assuming the assets are needed for only 2 years). 0 / 1 / 2 / 3 Device A: 9000 / 4500 / 4500 / 4500 Device B: 14500 / 6000 / 6000 / 8000	
5.	1. What is depreciation? What are the various causes of depreciation? 2. Explain in brief the basic methods of computing depreciation charges. 3. Explain the various tax concepts with an example. 4. Give the significance of corporate income tax. 5. With specific examples, explain the following: a)Direct material cost b)Direct labor cost c)Fixed overhead cost d)Factory cost e)Administrative overhead cost f)First cost g)Marginal cost.	20

16.0 University Result

Examination	S+	S	A	B	C	D	E	F	% Passing
July 2018-19	-	9	25	20	21	7	5		100

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

Subject Title	DYNAMICS OF MACHINERY		
Subject Code	17ME52	**IA Marks**	40
No of Lecture Hrs / Week	04	**Exam Marks**	60
Total No of Lecture Hrs	50	**Exam Hours**	03
			Credits – 04

FACULTY DETAILS:		
Name: Mr. G A Naik	**Designation:** Asst. Professor	**Experience: 24** Years
No. of times course taught: 01 Time	**Specialization:** Production Technology	
Name: Mr. S.A Goudadi	**Designation:** Asst. Professor	**Experience: 12** Years
No. of times course taught:01 Times	**Specialization:** Machine Design	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
1	Mechanical Engineering	I/II	EME
2	Mechanical Engineering	I/II/III/IV	Engg Mathematics
3	Mechanical Engineering	III	MOM

2.0 Course Objectives

1. To gain the knowledge static and dynamic equilibrium conditions of mechanisms subjected forces and couple, with and without friction.
2. Analyze the mechanisms for static and dynamic equilibrium.
3. To understand the balancing principles of rotating and reciprocating masses, governors and gyroscopes.
4. Analyze the balancing of rotating and reciprocating masses, governors and gyroscopes.
5. To understand vibrations characteristics of single degree of freedom systems.
6. Characterize the single degree freedom systems subjected to free and forced vibrations with and without damping.

3.0 Course Outcomes

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

CO	Course Outcome	Cognitive Level	POs
CO1	Determine the forces and couples for static and dynamic conditions of four bar and slider crank mechanisms to keep the system in equilibrium.	A	1,2,3,4,6,8,11,12
CO2	Determine magnitude and angular position of balancing masses under static and dynamic condition of rotating and reciprocating masses in same and different planes.	A	1,2,3,4,6,8,11,12
CO3	Determine sensitiveness, isochronism, effort and power of porter and hartnell governors.	A	1,2,3,4,6,8,11,12
CO4	Determine gyroscopic couple and effects related to 2, 4 wheeler, plane disc, ship and aero planes.	A	1,2,3,4,6,8,11,12

C05	Understand types of vibration, SHM and methods of finding natural frequencies of simple mechanical systems.	U	1,2,3,4,6,8,11,12
C06	Determine equation of motion, natural frequency, damping factor, logarithmic decrement and magnification factor, transmissibility of vibratory systems.	U	1,2,3,4,6,8,11,12
Total Hours of instruction		**50**	

4.0 Course Content

MODULE -1

Static force Analysis: Static equilibrium. Equilibrium of two and three force members. Members with two forces and torque, Free body diagrams, Static force analysis of four bar mechanism and Slider-crank mechanism with and without friction.

Dynamic force Analysis: D'Alembert's principle, Inertia force, Inertia torque. Dynamic force analysis of four-bar mechanism and Slider crank mechanism without friction, numerical problems. **10 Hours**

MODULE -2

Balancing of Rotating Masses: Static and dynamic balancing, balancing of single rotating mass by balancing masses in same plane and in different planes. Balancing of several rotating masses by balancing masses in same plane and in different planes.

Balancing of Reciprocating Masses: Inertia effect of crank and connecting rod, Single cylinder engine, balancing in multi cylinder-inline engine (primary and secondary forces), numerical problems. **10 Hours**

MODULE 3

Governors: Types of governors, force analysis of Porter and Hartnell governors. Controlling force, Stability, Sensitiveness, Isochronism, Effort and Power.

Gyroscope: Vectorial representation of angular motion, Gyroscopic couple. Effect of gyroscopic couple on plane disc, aeroplane, ship, stability of two wheelers and four wheelers, numerical problems. **10 Hours**

MODULE - 4

Introduction & Undamped free Vibrations (Single Degree of Freedom)

Types of vibrations, Definitions, Simple Harmonic Motion (SHM), Work done by harmonic force, Principle of super position applied to SHM. Methods of analysis – (Newton's, Energy & Rayleigh's methods). Derivations for spring mass systems, Natural frequencies of simple systems, Springs in series and parallel, Torsional and transverse vibrations, Effect of mass of spring and problems. **10 Hours**

MODULE – 5

Damped free Vibrations (Single Degree of Freedom)

Types of damping, Analysis with viscous damping - Derivations for over, critical and under damped systems, Logarithmic decrement and numerical problems.

Forced Vibrations (Single Degree of Freedom):

Analysis of forced vibration with constant harmonic excitation, Magnification factor (M.F.), Vibration isolation - Transmissibility ratio, Excitation of support (absolute and relative), Numerical problems. **10Hours**

5.0 Relevance to future subjects

SL. No	Semester	Subject	Topics / Relevance
01	VI	Design Of machine element II	Gears/Cams
02	VIII	Project Work	Design of parts

6.0 Relevance to Real World

SL. No	Real World Mapping
01	Industrial drawings and design of various components
02	Design of Automobile ,Boilers, Heat exchangers and other industrial components

7.0 Books Used and Recommended to Students

Text Books
1. Theory of Machines, Sadhu Singh, Pearson Education, 2nd Edition. 2007. 2. Mechanism and Machine Theory, A. G. Ambekar PHI, 2007 3. Mechanical Vibrations, V. P. Singh, Dhanpat Rai and Company, 4. Mechanical Vibrations, G. K.Grover, Nem Chand and Bros.
Reference Books
1. Theory of Machines, Rattan S.S. Tata McGraw Hill Publishing Company Ltd., New Delhi, 3rd Edition, 2009. 2. Mechanical Vibrations, S. S. Rao, Pearson Education Inc, 4edition, 2003.
Additional Study material & e-Books
• Nptel.ac.in • VTU, E- learning

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

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

9.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	Mechanism and machine theory	https://www.journals.elsevier.com/mechanism-and-machine-theory
2	Theory of machines	https://www.indiabix.com/mechanical-engineering/theory-of-machines

10.0 Examination Note

Internal Assessment: 40 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 the three Tests):40marks.

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

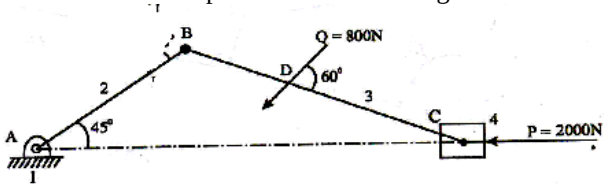
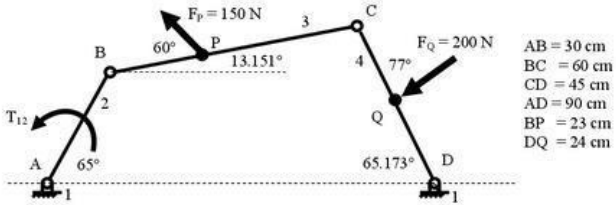
Module No.	Lecture No.	Content of Lecture	% of Portion
1		**Static force Analysis, Dynamic force Analysis:**	20
	1	Introduction: Static Equilibrium. Equilibrium of Two and Three Force Members	
	2	Members with Two Forces and Torque, Free Body Diagrams, Principle of Virtual Work.	
	4	Static Force Analysis of Four Bar Mechanism without friction	
	5	Slider-Crank Mechanism without friction	
	6	Static Force Analysis of Four Bar Mechanism with friction	
	7	Slider-Crank Mechanism with friction	
	8	D'Alembert's Principle, Inertia Force, Inertia Torque	
	9	Dynamic Force Analysis of Four-Bar Mechanism	
	10	Dynamic Force Analysis of Slider Crank Mechanism	
2		**Balancing of Rotating Masses, Balancing of Reciprocating Masses:**	20
	1	Static and Dynamic Balancing	
	2	Balancing of Single Rotating Mass by Balancing Masses in Same plane	
	3	Balancing of Single Rotating Mass by Balancing Masses in Different planes.	
	4	Balancing several rotating masses by balancing mass in same plane.	
	5	Balancing several rotating masses by balancing masses in different planes.	
	6	Inertia Effect of Crank and Connecting rod,	
	7	Balancing of Single Cylinder Engine,	
	8	Balancing in Multi Cylinder inline engine (Primary & Secondary forces),	
	9	Balancing in Multi Cylinder inline engine (Primary & Secondary forces),	
	10	Numerical Problems	
3		**Governors, Gyroscope**	20
	1	Types of Governors;	
	2	Force Analysis of Porter Governors.	
	3	Force Analysis of Hartnell Governors.	
	4	Controlling Force, Stability, Sensitiveness, Isochronism, Effort and Power in Porter Governor	
	5	Controlling Force, Stability, Sensitiveness, Isochronism, Effort and Power in Hartnell Governor	
	6	Vectorial Representation of Angular Motion,. Stability of Two Wheelers and Four Wheelers.	
	7	Gyroscopic Couple of Plane disc	
	8	Effect of Gyroscopic Couple on Ship	
	9	Effect of Gyroscopic Couple on Aeroplane,	
	10	Stability of Two Wheelers , Stability of Four Wheelers.	
4		**Introduction & Undamped free Vibrations (Single Degree of Freedom)**	20
	1	Types of vibrations, Definitions, Simple Harmonic Motion (SHM),	
	2	Work done by harmonic force	
	3	Principle of super position applied to SHM	
	4	Methods of analysis – (Newton's, Energy & Rayleigh's methods)	
	5	Derivations for spring mass systems	
	6	Natural frequencies of simple systems	
	7	Springs in series and parallel	

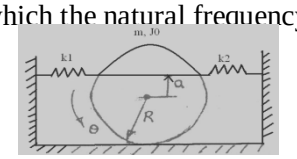
	8	Torsional and transverse vibrations	
	9	Effect of mass of spring	
	10	Problems	
5		**Damped free Vibrations, Forced Vibrations (Single Degree of Freedom)**	**20**
	1	Types of damping, Analysis with viscous damping	
	2	Derivations for over, critical systems	
	3	Derivations for damped systems	
	4	Logarithmic decrement	
	5	Numerical problems.	
	6	Analysis of forced vibration with constant harmonic excitation	
	7	Magnification factor	
	8	Vibration isolation - Transmissibility ratio	
	9	Excitation of support (absolute and relative)	
	10	Numerical 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 Static force Analysis, Dynamic force Analysis:	Determine the forces and couples for static and dynamic conditions of four bar and slider crank mechanisms to keep the system in equilibrium.	Module 1	2	Individual Activity.	Text Book 1,2,3 & 4
2	Assignment 2: Questions on Balancing of Rotating Masses, Balancing of Reciprocating Masses:	Determine magnitude and angular position of balancing masses under static and dynamic Condition of rotating masses in same and different planes.	Module 2	4	Individual Activity.	Text Book 1,2,3 & 4
3	Assignment 3: Questions on Governors, Gyroscope	Determine sensitiveness, isochronism, effort and power of porter and hartnell governors. Determine gyroscopic couple and effects related to 2, 4 wheeler, plane disc, ship and aeroplanes.	Module 3	6	Individual Activity.	Text Book 1,2,3 & 4
4	Assignment 4: Questions on Introduction & Undamped free Vibrations (Single Degree of Freedom)	Understand types of vibration, SHM and methods of finding natural frequencies of simple Mechanical systems.	Module 4	8	Individual Activity.	Text Book 1,2,3 & 4
5	Assignment 5: Damped free Vibrations, Forced Vibrations (Single Degree of Freedom)	Determine equation of motion, natural frequency, damping factor, logarithmic decrement , rotating and reciprocating unbalance systems, Magnification factor and transmissibility of forced vibration (SDOF) systems.	Module 5	8	Individual Activity.	Text Book 1,2,3 & 4

12.0 QUESTION BANK

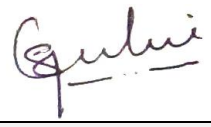
Assignment No	Questions	Marks
2.	1. Determine the various forces and couple T_2 shown in the figure 1  2. Calculate T2 and various forces on links for the equilibrium of the system shown in fig.  3. Explain Dynamic force analysis, Alembert's principle, Inertia force and Inertia torque. 4. When the crank is 450 from the inner dead center on the down stroke, the effective steam pressure on the piston of a vertical steam engine is 2.5bar. the diameter of the cylinder = 0.75 m, stroke of the piston = 0.50 m and length of connecting rod=1 m. determine the torque on the crank shaft if the engine runs at 350 rpm and the mass of reciprocating parts is 200kg. 5. What is function of a flywheel? How does it differ from that of a governor? 6. Find the relation for the coefficient fluctuation of speed in terms of maximum fluctuation of energy and the kinetic energy of the flywheel at mean speed.	20
2.	1. Four masses 150kg, 250kg, 200kg and 300kg are rotating in the same plane at radii of 0.25m, 0.2m, 0.3m and 0.35m respectively. Their angular location is 40, 120 and 250 degrees from the mass 150kg respectively measured in anticlockwise direction. Find the position and magnitude of the balance mass required, if its radius of rotation is 0.25m. 2. A 3.6 m long shaft carries 3 pulleys, two at its two ends and the third at the midpoint. The two end pulleys have masses 79 Kg and 40 Kg with their radii 3 mm and 5 mm from the axis of the shaft respectively. The middle pulley has a mass of 50 Kg with radius 8 mm. The pulleys are so keyed to the shaft that the assembly is in static balance. The shaft rotates at 300 rpm in two bearings 2.4 m apart with equal overhangs on either side. Determine (i) Relative angular positions of the pulleys, (ii) Dynamic reaction on the bearings. 3. Prove that the resultant unbalanced force is minimum when half of the reciprocating masses are balanced by rotating masses i.e., when c = 1/2 4. A four cylinder vertical engine has cranks 150 mm long. The planes of rotation of the first, second and fourth cranks are 400mm, 200 mm and 200 mm respectively from the third crank and their reciprocating masses are 50 kg, 60 kg and 50 kg respectively. Find the mass of the reciprocating parts for the third cylinder and the relative angular positions of the cranks in order that the engine may be in complete primary balance. 5. The firing order in a 6 cylinder vertical 4 stroke in line engine 1-4-2-6-3-5, the piston stroke is 100 mm. length of each C.R = 200 mm. the pitch distance between cylinder centerlines are 100 mm, 100 mm, 150 mm, 100 mm and 100mm. determine the out of balance primary and secondary forces and couples on this engine taking a plane midway between cylinders 3 and 4 as reference plane. The reciprocating mass per cylinder is 2kg and the engine runs at 1500 rpm.	20

3.	1. Explain the terms a) Sensitiveness b) Stability c) Isochronisms d) Hunting e) Governor effort f) Governor power 2. All the arms of porter governor arc 178 mm long and arc hinged at a distance of 38 mm from the axis of rotation. The mass of each ball is 1.15 kg and mass of the sleeve is 20 kg. The governor sleeve begins to rise at 280 rpm. When the links arc at on angle of 30 degree to the vertical. Assuming the friction force to be constant determine the minimum and maximum speed of rotation when the inclination of the arms to the vertical is 45 degree. 3. In a porter governor the arms and links are each 10 cm long and intersect on the main axis. Mass of each ball is 9 Kg and the central mass is 40 Kg. When sleeve is in its lowest position the arms are inclined at 300 to the axis. The lift of the sleeve is 2 cm. What is the force of friction at the sleeve, If the speed at the beginning of ascend from the lowest position is equal to the speed at the beginning of descend from the highest position. What is the range of speed of governor, if all other things remain same 4. Discuss effect of gyroscopic couple on a two wheeled vehicle taking turn. 5. A ship is propelled by a turbine rotor, which has a mass of 5 tones and a speed of 2100 rpm. The rotor has a radius of gyration of 0.5 m and rotates in clockwise direction, when viewed from the stress. Find the gyroscopic effects in the following conditions: a) the ship sails at a speed of 30 km/hr and steers to the left in a curve having 60 m radius b) the ship pitches 6 degree above and 6 degree below the horizontal position. The bow is descending with its maximum velocity. The motion due to pitching is simple harmonic and the periodic time is 20 seconds b) the ship rolls and at a certain instant it has an angular velocity of 0.03 rad/sec. clockwise when viewed from stern. Determine also the maximum angular acceleration during pitching. Explain how the direction of motion due to gyroscopic effect is determined in each case. 6. A four wheeler trolley car weighing 25kN runs on rails which are 1.5 m apart and travels around a curve of 30 m radius at 24 km/hr. the rails are at the same level, each wheel of the trolley is 7.5 cm in diameter and each of two axels is driven by a motor running in direction opposite to that of wheels at a speed of 5 times the speed of rotation of wheel. The M.I of each axel with gear and wheel is 18 kgm2. Each motor shaft with pinion has M.I of 12 kgm2. C.G of car is 90 cm above rail. Determine the vertical force exerted by each wheel on the rail taking into consideration of centrifugal and gyroscopic effect. State the centrifugal and gyroscopic effect of the trolley.	20
4	1. What are the different types of vibrations? 2. Determine the natural frequency of spring - mass system taking the mass of the spring in to account. 3. Split the Harmonic function X= 5 Sin ($\omega t + \pi/4$) into two Harmonic functions one having phase of zero and the other of 600. 4. A cylinder of mass m and mass moment of inertia Jo rolling without slipping but restrained by two linear springs of stiffness k_1 and k_2 as shown in Figure. Determine: i) The natural frequency of vibration of the system. ii) The value of "a" for which the natural frequency is maximum.  5. Determine the natural frequency of a spring mass system where the mass of is also to be taken in to account 6. Derive differential equation for undamped free vibrations. (Newton's method).	20
5	1. In a single degree damped vibrating system, a suspended mass of 18 kg makes 10 oscillations in 8 seconds. The amplitude decreases to 25% of the initial value after 5 cycles. 2. The disc of a torsional pendulum has a moment of inertia of 0.06kgm2 and is immersed in viscous fluid. The brass shaft attached to it is of 100 mm diameter and 400 mm long	

	when the pendulum is vibrating, the amplitude on the same side for the successive cycles are 90, 60, and 40. Determine (i) logarithmic decrement (ii) damping torque at unit velocity (iii0 periodic time of vibration. Assume for brass shaft G= 4.4x1010 N/m2. What would be the frequency if the disc is removed from the viscous fluid. Determine : i) Damped natural frequency; ii) Logarithmic decrement; iii) Undamped natural frequency ; iv) Spring constant ; v) Damping coefficient. 4. A machine of mass 75 kg is mounted on springs of stiffness 12 kN/cm with an assumed damping factor 0.2. A piston within the machine of mass 2 kg has a reciprocating motion with a stroke of 7.5 cm and a speed 50 Hz. Assuming the motion of the piston to be harmonic, determine: i) Amplitude of the machine; ii) Transmissibility; iii) Force transmitted to the foundation iv) The phase angle of the transmitted force with respect to the exciting force. 5. A mass of 6kg suspended by a spring of stiffness 1180 N/m is forced to vibrate by the harmonic force 10N. Assuming viscous damping coefficient of 85 Ns/m, determine the resonant frequency, amplitude at resonance, phase angle at resonance, frequency corresponding to the peak amplitude and the phase angle corresponding to peak amplitude.	20

13.0 University Result

Examination	FCD	FC	SC	% Passing
2017-18	12	32	63	90.67
2018-19	20	28	64	88.88

Prepared by	Checked by		
			
Prof. S A Goudadi	**Prof. G A Naik**	**HOD**	**Principal**

Subject Title	**TURBOMAHINES**		
Subject Code	17ME53	**IA Marks**	40
Number of Lecture Hrs / Week	03 L+ 02 T	**Exam Marks**	100
Total Number of Lecture Hrs	50	**Exam Hours**	03
CREDITS – 04			

FACULTY DETAILS:		
Name: Dr. S.A. Alur	**Designation:** Professor	**Experience:**29
No. of times course taught: 10	**Specialization:** Thermal Power Engineering	
Name: Prof. M. M. Shivashimpi	**Designation:** Asst. Professor	**Experience:**11
No. of times course taught: 06	**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
03	Mechanical Engineering	IV	Applied Thermodynamics
04	Mechanical Engineering	IV	Fluid Mechanics

2.0 Course Objectives

1. The course aims at giving an overview of different types of turbo machinery used for energy transformation, such as pumps, fans, compressors, as well as hydraulic and steam turbines.
2. Explain the working principles of turbo machines and apply it to various types of machines
3. It will focus on application of turbo machinery in power generation, power absorption and transportation sectors.

3.0 Course Outcomes

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

CO's	Course Outcome	Cognitive Level	POs
C303.1	List the different types of Turbo machine and Compare the various efficiencies of turbo machines for expansion and compression processes.	A	1,2, 12
C303.2	Apply Euler's turbine equation to determine the power/ head developed.	U	1,2, 3,12
C303.3	Construct velocity triangle to determine power developed by steam turbine.	U	1,2,3, 12
C303.4	Compare the performance and working principle of different hydraulic turbines.	U	1,2,3, 12
C303.5	Analyze the effect of blade angle on the performance of centrifugal pump and Develop the expression for pressure developed in compressors.	U	1,2,3, 12
	Total Hours of instruction	**50**	

4.0 Course Content

Module - I

Introduction: Definition of turbo machine, parts of turbo machines, Comparison with positive displacement machines, Classification, Dimensionless parameters and their significance, Effect of Reynolds number, Unit and specific quantities, model studies. (Note: Since dimensional analysis is covered in Fluid Mechanics subject, questions on dimensional analysis may not be given. However, dimensional parameters and model studies may be given more weightage.)
Thermodynamics of fluid flow: Application of first and second law of thermodynamics to turbo machines, Efficiencies of turbo machines, Static and Stagnation states, Incompressible fluids and perfect gases, overall isentropic efficiency, stage efficiency (their comparison) and polytropic efficiency for both compression and expansion processes. Reheat factor for expansion process. **10 Hours**
expansion process

Module –II

Energy exchange in Turbo machines: Euler's turbine equation, Alternate form of Euler's turbine equation, Velocity triangles for different values of degree of reaction, Components of energy transfer, Degree of Reaction, utilization factor, Relation between degree of reaction and Utilization factor, Problems.
General Analysis of Turbo machines: Radial flow compressors and pumps – general analysis, Expression for degree of reaction, velocity triangles, Effect of blade discharge angle on energy transfer and degree of reaction, Effect of blade discharge angle on performance, Theoretical head – capacity relationship, General analysis of axial flow pumps and compressors, degree of reaction, velocity triangles, Problems. **10 Hours**

Module –III

Steam Turbines: Classification, Single stage impulse turbine, condition for maximum blade efficiency, stage efficiency, Need and methods of compounding, Multi-stage impulse turbine, expression for maximum utilization factor.
Reaction turbine – Parsons's turbine, condition for maximum utilization factor, reaction staging. Problems. **10 Hours**

Module –IV

Hydraulic Turbines: Classification, various efficiencies. Pelton turbine – velocity triangles, design parameters, Maximum efficiency. **Francis turbine** - velocity triangles, design parameters, runner shapes for different blade speeds. Draft tubes-Types and functions. **Kaplan and Propeller turbines** – velocity triangles, design parameters. Problems. **10 Hours**

Module –V

Centrifugal Pumps: Classification and parts of centrifugal pump, different heads and efficiencies of centrifugal pump, Minimum speed for starting the flow, Maximum suction lift, Net positive suction head, Cavitation, Need for priming, Pumps in series and parallel. Problems.
Centrifugal Compressors: Stage velocity triangles, slip factor, power input factor, Stage work, Pressure developed, stage efficiency and surging and problems. Axial flow Compressors: Expression for pressure ratio developed in a stage, work done factor, efficiencies and stalling. Problems. **10 Hours**

5.0 Relevance to future subjects

Sl No	Semester	Subject	Topics
01	VIII	Project work	Application of IC engine, Turbine, Compressor.

6.0 Relevance to Real World

SL. No	Real World Mapping
01	Application of IC Engine, Power generation from Gas turbine hydraulic turbine and steam turbine.
02	Analysis of power by various power generating and power absorbing machines.

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. An Introduction to Energy Conversion, Volume III, Turbo machinery, V. Kadambi and Manohar Prasad, New Age International Publishers, reprint 2008. 2. Turbines, Compressors & Fans, S. M. Yahya, Tata McGraw Hill Co. Ltd., 2nd edition, 2002 3. Turbomachines, B. U Pai , Wiley First Edition 2013.
Reference Books
1. Principals of Turbo machines, D. G. Shepherd, The Macmillan Company (1964). 2. Fluid Mechanics & Thermodynamics of Turbo machines, S. L. Dixon, Elsevier (2005). 3. Turbo machine, B.K.Venkanna PHI, New Delhi 2009. 4. Text Book of Turbo machines, M. S. Govindgouda and A. M. Nagaraj, M. M. Publications, 4Th Ed, 2008.
Additional Study material & e-Books
1. Fluid Mechanics by R.K. Banasal

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

10.0 Magazines/Journals Used and Recommended to Students

Sl. No	Magazines/Journals	website
1	International Turbo machinery	https://www.turbomachinerymag.com/
2	Journal of Engineering for Gas Turbines and Power	https://gasturbinespower.asmedigitalcollection.asme.org/journal.aspx
3	Thermal News	http://www.thermalnews.com/main/
4	Turbine Magazine	http://www.windarphotonics.com/turbine-magazine
5	Future Power Technology Magazine	http://www.power-technology.com/features/featurefuture-power-technology-magazine-turbine-edition/

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	1	**Introduction:** Definition of turbo machine, parts of turbo machines, Comparison with positive displacement machines,	20

	2	Classification, Dimensionless parameters and their significance, Effect of Reynolds number	
	3	Unit and specific quantities, model studies	
	4	Solving related Numericals	
	5	Solving related Numericals	
	6	**Thermodynamics of fluid flow:** Application of first and second law of thermodynamics to turbo machines	
	7	Efficiencies of turbo machines, Static and Stagnation states, Incompressible fluids and perfect gases, overall isentropic efficiency	
	8	Stage efficiency (their comparison) and polytropic efficiency for both compression and expansion processes. Reheat factor for expansion process.	
	9	Solving related Numericals	
	10	Solving related Numericals	
II	11	**Energy exchange in Turbo machines:** Euler's turbine equation, Alternate form of Euler's turbine equation,	40
	12	Velocity triangles for different values of degree of reaction, Components of energy transfer,	
	13	Degree of Reaction, utilization factor, Relation between degree of reaction and Utilization factor	
	14	Solving related Numericals	
	15	Solving related Numericals	
	16	**General Analysis of Turbo machines:** Radial flow compressors and pumps – general analysis, Expression for degree of reaction, velocity triangles	
	17	Effect of blade discharge angle on energy transfer and degree of reaction, Effect of blade discharge angle on performance, Theoretical head – capacity relationship,	
	18	General analysis of axial flow pumps and compressors, degree of reaction, velocity triangles	
	19	Solving related Numericals	
	20	Solving related Numericals	
III	21	**Steam Turbines:** Classification, Single stage impulse turbine, condition for maximum blade efficiency,	60
	22	Stage efficiency, Need and methods of compounding	
	23	Multi-stage impulse turbine, expression for maximum utilization factor.	
	24	Solving related Numericals	
	25	Solving related Numericals	
	26	Solving related Numericals	
	27	**Reaction turbine** – Parsons's turbine, condition for maximum utilization factor, reaction staging	
	28	Solving related Numericals	
	29	Solving related Numericals	
	30	Solving related Numericals	
IV	31	**Hydraulic Turbines:** Classification, various efficiencies	80
	32	Pelton turbine – velocity triangles, design parameters, Maximum efficiency.	
	33	**Francis turbine** - velocity triangles, design parameters, runner shapes for different blade speeds	
	34	Draft tubes- Types and functions	
	35	**Kaplan and Propeller turbines** – velocity triangles, design parameters.	
	36	Solving related Numericals	
	37	Solving related Numericals	
	38	Solving related Numericals	
	39	Solving related Numericals	
	40	Solving related Numericals	
V	41	**Centrifugal Pumps**: Classification and parts of centrifugal pump,	100

	42	Different heads and efficiencies of centrifugal pump, Minimum speed for starting the flow,.	
	43	Maximum suction lift, Net positive suction head, Cavitation, Need for priming, Pumps in series and parallel	
	44	Solving related Numericals	
	45	Solving related Numericals	
	46	**Centrifugal Compressors:** Stage velocity triangles, slip factor, power input factor, Stage work, Pressure developed, stage efficiency and surging	
	47	Solving related Numericals	
	48	**Axial flow Compressors:** Expression for pressure ratio developed in a stage, work done factor, efficiencies and stalling.	
	49	Solving related Numericals	
	50	Solving related Numericals	

13.0 Assignments, Pop Quiz, Mini Project, Seminars

Sl. No.	Title	Outcome expected	Allied study	Week No.	Individual / Group activity	Reference: book/website /Paper
1	Assignment 1: University Questions	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 1 syllabus	3	Individual Activity and submission of hard copy.	Text book 1 and all the reference books
2	Assignment 2: University Questions	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 2 syllabus	6	Individual Activity and submission of hard copy.	Text book 1 and all the reference books
3	Assignment 3: University Questions	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 3 syllabus	9	Individual Activity and submission of hard copy.	Text book 1 and all the reference books
4	Assignment 3: University Questions	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 4 syllabus	12	Individual Activity and submission of hard copy.	Text book 1 and all the reference books
5	Assignment 3: University Questions	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 5 syllabus	15	Individual Activity and submission of hard copy.	Text book 1 and all the reference books

14.0 Assignments Questions

Q. No	Description of Question	Marks	CO
	ASSIGNMENT-1		
1	Define and derive expression for following i) flow coefficient ii) head coefficient iii) power coefficient iv) specific speed.	05	CO303.1
2	Explain the effect of Reynolds number on the performance analysis of turbo machines.	05	CO303.1
3	Prove that polytropic efficiency of compressor.	05	CO303.1
4	The quantity of water available for a hydroelectric power station is 310 m^3/s under a head of 1.8 m. Assuming the speed of the turbine to be 60 rpm and their efficiency to be 85%, find the number of turbine required and power produced by each turbine. Each turbine has specific speed of 890.	05	CO303.1
5	Air enters a compressor at static pressure of 1.5 bar, static temperature of 15 ° C and flow velocity of 15 m/s. At the exit the static pressure is 3 bar, the static temperature is 100 °C and the flow velocity is 100 m/s. The outlet is 1 m above the inlet. Evaluate i) the isentropic change in enthalpy ii) actual change in enthalpy and iii) efficiency of the compressor.	05	CO303.1
	ASSIGNMENT-2		
1	Derive alternate form of Euler turbine equation and explain each component in that.	05	CO303.2
2	Define utilization factor and degree of reaction. Obtain a relation between degree of reaction and the utilization factor.	05	CO303.2
3	Derive the theoretical head capacity in case of radial flow centrifugal pump.	05	CO303.2
4	An inward flow radial reaction turbine has axial discharge at outlet with outlet blade angle of 45 °. The radial flow velocity is constant. The blade speed at inlet is twice that the exit. Express the energy transfer per unit mass and degree of reaction in terms of inlet nozzle angle α1. Assume $V_m = (2g_c)^{1/2}$. At what angle of α1, will the degree of reaction be zero and unity? What are the corresponding values of energy transfer per unit mass?	05	CO303.2
5	A single stage axial flow blower with no inlet guide vanes operates at 3600 rpm. The tip and hub diameters of the rotor are 20 cm and 12.5 cm respectively. The air flow through the stage is 0.45 kg/s. The air turned through an angle of 20 ° towards the axial direction during the passage through the rotor at mean diameter. Assuming standard atmospheric conditions, constant axial velocity and no losses in the rotor. Compute i) the power in KW ii) degree of reaction.	05	CO303.2
	ASSIGNMENT-3		
1	What is compounding? Explain any two methods of compounding.	05	CO303.3
2	Derive the condition for maximum efficiency of an impulse single stage steam turbine and show that maximum efficiency is $\cos\alpha^2$.	05	CO303.3
3	For a 50% reaction steam turbine, show that **α1** = **β2**and **α2** = **β1** where **α1** and **β1** are the inlet angles of fixed and moving blades, **α2** and **β2** are the outlet angles of fixed and moving blades.	05	CO303.3
4	Dry saturated steam at 10 bar pressure is supplied to single rotor impulse wheel, the condenser pressure being 0.5 bar with nozzle efficiency of 0.94 and the nozzle angle at the rotor inlet is 18° to the wheel plane. The rotor blade which moves with the speed of 450 m/s are equiangular. If the coefficient of velocity for rotor blades is 0.92 find i) the specific power output ii) the rotor efficiency iii) the stage efficiency	05	CO303.3

	iv) Axial thrust v) the direction of exit steam.		
5	The following data refers to a velocity compounded impulse turbine having two rows of moving blades and a fixed row between them. Velocity of steam leaving the nozzle is 1200 m/s, nozzle angle is 20°, blade speed is 250 m/s, the blade angles of first moving row are equiangular, blade outlet angle of the fixed blade is 25°, blade outlet angle of the second moving row is 30°. Friction factor for all the rows is 0.9. Draw the velocity triangles for a suitable scale and calculate the power developed, axial thrust, diagram efficiency for steam flow rate is 5000 kg/hr.	05	CO303.3
	ASSIGNMENT-4		
1	Show that for a maximum efficiency of pelton wheel, the bucket velocity is equal to half of jet velocity.	05	CO303.4
2	Show that pressure at the exit of the reaction turbine with draft is less than atmospheric pressure.	05	CO303.4
3	With a neat sketch, explain the working of Kaplan turbine, Draw the velocity triangles at inlet and outlet of the turbine. Also explain the functions of the draft tube.	05	CO303.4
4	A double jet pelton wheel is required to generate 7500 kW when the available head at the base of nozzle is 400 m. The jet is deflected through 165 ° and relative velocity of the jet reduced by 15 % in passing over the buckets. Determine i) diameter of each jet ii) Total flow iii) force exerted by the jets in the tangential direction. Assuming generator efficiency is 95 %, ηo = 80 %, speed ratio = 0.47.	05	CO303.4
5	The Kaplan turbine produces 30,000 kW under a head of 9.6 m, running at 652 rpm. The discharge through the turbine is 350 m^3/s. The tip diameter of the runner is 7.4 m. The hub diameter is 0.432 times the tip diameter. Calculate i) the turbine efficiency ii) the specific speed of turbine iii) the speed ratio (base on tip diameter) and iv) the flow ratio.	05	CO303.4
	ASSIGNMENT-5		
1	With a neat sketch, explain the centrifugal pumps in series and parallel.	05	CO303.5
2	Derive the expression for the minimum speed for starting a centrifugal pump.	05	CO303.5
3	Show that the pressure rise in the impeller of a centrifugal pump when the frictional and other losses in the impeller are neglected , is given by, $\frac{1}{2g}\{Vf1^2 + U2^2 - Vf2^2 \ Cosec\beta 2^2\}$ Where Vf1 and Vf2 are the flow velocities at inlet and outlet of the impeller, U2 = Tangential speed of the impeller at exit, β2 = Exit blade angle.	05	CO303.5
4	Explain the working principle of the axial flow compressor along with neat sketch of compressor with inlet guide vane.	05	CO303.5
5	The four stage centrifugal pump has four identical impellers keyed to the same shaft. The speed of the shaft is 500 rpm. The total manometric head developed from four impellers is 50 m. The width at exit is 5 cm and the diameter at exit is 50 cm. The whirl velocity at exit is 10 m/s. and the radial flow velocity at exit is 2 m/s. Calculate i) discharge ii) the exit vane angle and iii) the manometric efficiency.	05	CO303.5

15.0 QUESTION BANK

Module I:

1. Define Turbo machine. Briefly classify turbo machines
2. With a neat sketch explain the parts of a turbo machine.
3. Compare the turbo machines with positive displacement machines

4. Define specific speed of a turbine. Derive an expression for specific speed of a turbine from fundamentals
5. Give the significance of the dimensionless terms i. Flow coefficient ii. Head coefficient iii. Power coefficient, With respect to turbo machines.
6. Define fluid machinery, and then further define its two type's i.e. (i) Turbo machine and (ii) reciprocating machine with example and their working principle.
7. Describe in brief dynamic action of flowing fluid and rotating element.
8. How a turbo machines are classified?
9. Sketch and explain main parts of turbo machines.
10. Write in brief importance of Turbo machines.
11. Compare reciprocating machines with Turbo machines or Rotary machines or Dynamic machines.
12. Write in brief dimensional analysis of turbo machines. What are the important quantities which influence the performance of turbo machines? List the variables (quantities) and write their symbol and dimensions.
13. State Buckingham's π - theorem. What is repeating variables? How they are of selected?
14. What do you mean by dimensionless number? Define Reynolds's number, Fraud's number, Euler's number, Weber's number, Mach number etc and derive their expression.
15. Write the importance of dimensionless number of turbo machines for model analysis.
16. Apply the concept of dimensional analysis to incompressible (liquid) flow Turbo machines, and obtain expression for i) discharge co-efficient ii) head or pressure or energy co-efficient (iii) Power co-efficient (iv) Reynolds number.
17. Apply the concept of dimensional analysis to compressible flow turbo machines and obtain and expressions for 5 non dimensional numbers.
18. Define specific speed and write its expressions for pump and hydraulic turbines.
19. Describe in brief effect of Reynolds number on turbo machine.
20. Define i) Unit flow, ii) Unit speed, iii) Unit power use and derive their expression. of incompressible flow turbo machines. 1. What is velocity of sound? Derive an expression for the velocity of sound for a perfect gas
21. Explain the terms mach number
22. What is Sub sonic, supersonic and hypersonic flow?
23. Explain the following with respect to a turbine i) overall efficiency ii. Stage efficiency iii. Polytrophic efficiency v. Mechanical efficiency
24. What is infinitesimal stage efficiency in the expansion and compression process and derive the corresponding equation.
25. What is the reheat factor? Show that reheat factor is greater than unity in multistage turbine

Numiricals

1. A storage unit has a head of 30 m and has a discharge 30 m3 /s through the pipe which is connected to storage unit. The speed of the rotor is 200 rpm. Suggest which turbine is suitable for this data.
2. Calculate the number of pumps required to take water from a deep well under a total head of 90 m. All the pumps are identical and are running at 800 rpm. The specific speed of each pump is given as 30 while the rated capacity of each pump is $0.2m^3$/sec.
3. The four water turbines of specific speed 890 each are installed in a hydel station. Each of the turbines runs at 50rpm and share equally a discharge of 260 m^3/sec. Available under a head of 1.73, assuming each turbine has an efficiency of 82.5%. Find the power of each turbine R.
4. Air enters compressors at a static pressure of 1.5 bar a static temperature of 15 o C and flow velocity of 15 m/s. At exit static pressure is 3 bar. Static temperature is 100 ° C and flow velocity is 100 m/s. The outlet is 1m above inlet. Evaluate i) Isentropic change in enthalpy ii) Actual change in enthalpy and iii) Efficiency of compressor.
5. Total to total efficiency of power absorbing turbo machines handling liquid water of standard density is 70 %. Suppose that pressure of water increased by 4 bar. Find a) Isentropic change in enthalpy ii) Actual change in total enthalpy iii) Change in total enthalpy of water iv) Power input to water if flow rate 30 kg/s.
6. Air enters a straight Asymmetric duct at 300 K , 3.5 bar and 3.5 bar and 150 m/s and leaves it at 275 K, 2.2 bar and 270 m/s . The area of cross section at entry is 550 cm 2. Assume adiabatic flow, ɼ = 1.4 R = 287 J/Kg K,. Calculate Stagnation temperature, mass flow rate and area of cross section at exit.
7. The air enters a compressor at a static pressure of 1.7 atm. A static temperature of 15 ° C and flow velocity of 50 m/s. At the exit the static pressure is 3.5 atm . The static temperature 110 o C and the flow velocity 110 m/s. The outlet is 2.2 m above the inlet. Calculate a) The isentropic change in total enthalpy and b) The actual change in total enthalpy.

Module II:

1. Define utilization factor and vane efficiency
2. Derive the relationship between utilization factor and degree of reaction
3. Write combined velocity triangles for different values of degree of reaction
4. What is the condition for maximum utilization factor?
5. Differentiate between i) Impulse turbine ii) Reaction turbine
6. Explain in brief general analysis of an impulse and reaction turbo machine. Write the effect of blade discharge angle on energy transfer. Writer the values of degree of reaction for impulse and reaction type turbo machine.
7. Analyze a radial flow turbo machine. Draw the velocity triangle diagram at inlet and for different discharge angles at outlet. Derive an expression for energy transfer in terms of blade discharge angles. Also derive an equation for Degree of Reaction in terms of blade discharge angles.
8. Draw on a common graph. (1) Energy transfer versus blade discharge angles and Degree of reaction versus blade discharge angles. Then write the effect of blade discharge angle on (i) Energy transfer and (ii) Degree of reaction.
9. Draw the combined velocity triangle diagram for the value of (i) R = 0.5 (ii) 1>R>0.5 and R>1.
10. Derive the relation between Utilization factor and degree of reaction for axial flow turbo machine.
11. Draw the velocity triangles for the following types of vanes of centrifugal pumps and compressors i) Back ward Vane ii) Radial Vane iii) Forward Curved Vane and also draw & explain the Head- Capacity relation for the above three types of vanes
12. Derive the expression for utilization factor and degree of reaction for axial flow compressors, pumps and blowers.
13. Derive the expression for Energy and Degree of reaction of radial flow compressors, blowers and pumps.

Numericals :

1. The following data refers to a hydraulic reaction turbine of radial type. a) Head of the water = 160 m , b) Rotor blade angle at energy = 119 o , c) Diameter at entry = 3.65 m, d) Diameter at exit = 2.45 m , e) Discharge angle at exit = 30 o , radial with a velocity of 15.5 m/s , f) Radial component at inlet = 10.3 m/s . Find the power developed in KW, Degree of reaction and utilization factor for a flow rate of 10 m^3 /s.
2. At a stage in a 50 % reaction axial flow turbine running at 300 rpm. The power output is 265 KW, Utilization factor being 0.615. Find the absolute velocities of V1 and V2. Assume symmetric velocity of triangles at inlet and outlet.
3. In De Laval steam nozzle angle at inlet 18 º. Relative velocities is reduced to the extent of 6 % when steam flows over the moving blades. The output of the turbine is 120 KW/kg flow of steam. If blades are equiangular, find the speed ratio, absolute velocity of steam and blade speed for maximum utilization factor
4. Air enters in an axial flow turbine with a tangential component of the absolute velocity equal to 600 m/s in the direction of rotation. At the rotor exit, the tangential component of the absolute velocity is 100 m/s in a direction opposite to that of rotational speed. The tangential blade sped is 250 m/s. Evaluate i) The change in total enthalpy of air between the inlet and outlet of the rotor ii) The power in KW if the mass flow rate is 10 kg/s iii) The change in total temperature across the rotor.
5. A mixed flow turbine handling water operates under a static head of 65 m. In a steady flow, the static pressure at the rotor inlet is 3.5 atmospheric (gauge). The absolute velocity at the rotor inlet has no axial component and is directed at an angle of 25 º to the tangent of wheel so that Vu1 is positive. The absolute velocity at exit purely axial. If the degree of reaction for the machine is 0.47 and utilization factor is 0.896, compute the tangential blade speed at inlet as well as the inlet blade angle β1. Find also the work output per unit mass flow of water.
6. In mixed flow turbo machine, the fluid enters such that the absolute velocity is axial at inlet and at outlet relative velocity is radial. What is the degree of reaction and energy input to the fluid, if relative velocity at outlet is same as tangential blade speed at inlet? The following data may be used. i) Inlet diameter = 0.16 m ii) Exit diameter = 0.5 m, iii) Speed = 3000 rpm, iv) Blade angle at inlet = 45 º.
7. Draw the velocity triangle at inlet and outlet of an axial flow compressor with the following data, R = 0. 5, γ1 = 45 o (inlet blade angle with respect to axial direction), axial flow velocity is constant and is equal to 120 m/s, radius of rotation = 0.2 m and speed of the compressor is 6500 rpm. Determine the power required in KW to handle 15 kg of air per second.
8. Air flows through one stage of an axial flow compressor at 33 º C and 1 atmospheric pressure. The axial speed of airflow throughout stage is 110 m/s. Compressor is one of 50 % reaction with symmetric inlet and outlet blade angle is 50 º. Compute absolute velocity and rotor inlet, mean blade tip speed, temperature rise in air is passing through stage.
9. The impeller of a centrifugal pump has an outer diameter of 1. 5 m. It lifts water at a rate of 2000 kg/s. The blade is making an angle of 145 º in direction of motion at outlet and speed being 3000 rpm. Radial velocity of flow is 3

m/s. Find power required to drive impeller.

Module III:

1. Define steam Turbine classify it.
2. With the help of neat arrangement along with the variation of pressure and velocity explain the working of simple impulse steam turbine.
3. What is compounding? Explain with sketches (i) Velocity compounding (ii) Pressure compounding and (iii) Pressure compounding.
4. Explain with sketch working of Reaction steam Turbine.
5. Compare impulse and Reaction steam turbine.
6. Write the advantage of steam turbine over other prime movers.
7. .Draw the velocity triangles at the inlet and outlet tips of blades of single stage impulse turbine; combined the velocity diagrams and derive an expression for i) Work done, ii) Power developed, iii) Blade or diagram efficiency etc.
8. Describe the effect of friction on blade efficiency.
9. What is speed ratio? Derive the condition of speed ratio for maximum blade efficiency.
10. Write an expression for i) Gross stage efficiency and ii) Axial thrust. 11. Describe with combined velocity diagrams two stage impulse turbine. Writs an expression for blade efficiency and maximum blade efficiency iii) maximum work done per kg of steam.

Numericals :

1. In a single stage steam turbine saturated at 10 bar is supplied through a convergent- divergent steam nozzle. The nozzle angle is 20 º. Find i) the best blade angle if blades are equiangular ii) The maximum power developed by turbine if number of nozzle used are 5 and area at throat of each nozzle is 0. 6 cm^2. Assume, Cb = 0.87 and ηn = 0.88, Take U = 400 m/s, steam pressure at exit of nozzle is 1 bar.
2. In two stage velocity compounded axial flow steam turbine, steam enters first row of moving blades with an absolute velocity of 550 m/s. Steam leaves last row of moving blades are axially. The nozzle angle at inlet of moving blades = 16 º. The blade angles at inlet and outlet of both rotors are same and equal to 32 º. Find blade speed to satisfy above conditions by drawing velocity triangles of inlet and outlet of each stage separately.
3. Steam flows through the nozzle with a velocity of 450 m/s at a direction which is inclined at an angle of 16 º to the plane tangent. Steam comes out of the moving blades with a velocity of 100 m/s in the direction of 110 º with the direction of blade motion. The blades are equiangular and the steam flow rate is 10 kg/s. Find i) Power developed ii) the power loss due to friction iii) Axial thrust iv) Blade efficiency and v) Blade coefficient
4. In an Impulse turbine (with single row wheel), the mean diameter of the blade is 1.05m and the speed is 3000rpm. The nozzle angle is 20 degree and ratio of blade speed to steam speed is 0.45 and the relative velocity and outlet from the blades to that at inlet is 0.85. Outlet angle is made 3 degree is less than the inlet angle. The steam flow is 10Kg/sec. Draw the velocity diagram for the blade and determine the following. i) tangential thrust on the blade ii) Axial thrust on the blade iii) Resultant thrust on the blade iv) Power developed in the blade v) Blading efficiency.
5. The first stage of an impulse turbine is compounded for velocity and has two rows of moving blades and one ring of fixed blades. The nozzle angle is 18 degree and leaving angles of blades are respectively, first moving 30 degree, fixed 20 degree, and second 30 degree. The velocity of steam leaving the nozzle is 550m/sec. The friction loss in each blade row is 10% of the relative velocity. Steam leaves second row moving blades axially, find i) blade velocity ii) Blade efficiency and specific speed consumption.

Module IV:

1. What is hydraulic Turbine? Classify it. Sketch the layout of hydro electric power plant.
2. Define i) hydraulic efficiency, ii) mechanical efficiency iii) overall efficiency and volumetric efficiency.
3. What are the main components of Pelton Turbine? Explain their function.
4. Design the pelton turbine.
5. Draw the velocity triangles diagrams at bucket inlet and outlet and write an expression for Force, work, power and efficiency; maximum hydraulic efficiency with its condition.
6. With the help of neat sketch explain the working of double regulation oil pressure governor.
7. Sketch Francis Turbine, Level its main components and explain its working.
8. Draw the velocity triangle diagrams at radial inward flow Francis turbine and derive an expression for (i) Work done, (ii) Hydraulic efficiency.
9. Sketch Kaplan Turbine, Label its main components and explain its working.
10. What is a draft tube? What is its function? What are its types? Derive an expression for -ve head created at the runner outlet by using a draft tube.

Numericals:

1. Following date refers to Kaplan turbine net head=20m.Power developed=15MW, Overall efficiency=80%. The runner diameter 4.2m, Hub diameter is 2m, Specific speed is 300. Hydraulic efficiency is 90%. Calculate the inlet and exit angles 0f the runner blades at the tip and at the hub if the flow leaving the runner is purely axial.
2. The following data refers to Pelton Wheel. Power = 6500KW, Head=250m, Overall efficiency=85%, Speed=220rpm. Calculate the unit discharge, unit power, unit speed. Take speed ratio=0.45 If the head on the same turbine falls to 125m.Calculate the discharge, Power and speed of for new head.
3. Find the specific speed and type of turbine. Power developed =7000KW, Head=25m, Speed=120rpm. Calculate its normal speed and out put under a 30 m head.
4. A Francis turbine working under a head of 150m runs at 800rpm. Velocity of water at entry is 32m/s. The outer and inner diameter of the runner is 1.5 and 0.75m respectively. The outlet angle of the guide blades is 12 degree. Calculate the runner blade angles at inlet and outlet, if the discharge is axial and velocity of flow is constant through the runner and hydraulic efficiency.
5. The following date refers to Francis turbine speed=1200rpm, Net head=130m, Discharge=0.7m^3/sec, Inner diameter=1.3m. Height of the runner at inlet=0.05m. The angle of the inlet guide vanes is set at 72 degree and absolute velocity at outlet is radial. Calculate Torque, Power and Hydraulic efficiency.

Module V:

1. What is centrifugal pump? Draw it lay out and explains.
2. How a centrifugal pump is classified.
3. Explain the following heads of a centrifugal pump: (i) Suction heat, (ii) Delivery head, (iii) Static heat, (iv) Manometer of head & (v) Total or gross or effective head.
4. Derive an expression for work done by impeller of a centrifugal pump on water.
5. Define explain, and write an expression for the following efficiencies of centrifugal pump: i) Mechanical efficiency, (ii) Manometric efficiency, (iii) overall efficiency and (iv) Hydraulic efficiency.
6. Derive an expression for pressure rise in pump impeller.
7. Derive an expression for minimum starting speed of a centrifugal pump.
8. What is cavitation? Explain causes of cavitation.
9. What is priming? Explain necessity and phenomenon of priming.
10. Explain with flow diagram the purpose of multistage pump when connected in series and parallel.
11. Explain important parts of centrifugal compressor
12. Derive expression for overall pressure ratio developed in centrifugal compressor
13. Define i) slip factor ii) power input factor
14. Explain with the help of a diagram the surging of centrifugal compressor
15. Classify the axial flow compressor
16. With the help of neat sketch explain the construction and working principle of axial flow compressors.
17. Sketch and explain axial compressor stage velocity triangles and derive an expression for (i) ratio of blade speed 6 velocity of flow (ii) degree of reaction. Also writer conditions for 50% R. 8. Derive an expression for work input to compressor. Also describe work done factor.
18. Describe in brief (i) Compressor stage efficiency (ii) Degree of Reaction (iii) Radial pressure gradient.

Numericals:

1. A centrifugal pump is running at 100 rpm. The outlet vane angle of the impeller is 30 ^{o} and velocity of flow rate at outlet is 3 m/s. The pump is working against a total head of 30 m and the discharge through the pump is 0.3 m^3 /s. If the man metric efficiency is 75 % determine a) Diameter of the impeller b) width of the impeller at outlet.
2. A centrifugal pump running at 1450 rpm discharges 110 lit/s against a head of 23 m. If the diameter of impeller is 25 cm and its width 5 cm find the vane angle at outer periphery. The man metric efficiency of the pumps is 75 %.
3. A centrifugal pump discharges 0.15 m^3 /s of water against at a head of 12.5 m. The speed of the impeller is 600 rpm. The outer and inner diameter and inner diameter of impeller are 50 cm and 25 cm respectively and vanes are bent back at 35 o to the tangent at the exit. If the area of flow remains 0.07 m2 from inlet to outlet determine a) Man metric efficiency b) Vane angle at inlet.
4. A centrifugal pump with an impeller outlet diameter of 375mm runs at 750 rpm and delivers 35 liters/sec of water. The radial velocity at the impeller exit is 2m/sec. The difference between the water levels at the over head tank and the sump is 14.2 m including frictional losses. The total power input needed to run the pump is 6.1KW, its mechanical and volumetric efficacies being 0.95 and 0.96 respectively. The rotor blades are backward curve with an exit angle of 45 degree. Compute i) The ideal head developed with no slip and no hydraulic losses ii) the actual pump efficiency.
5. A centrifugal pump is required to discharge water at the rate of 0.15m^3/sec while running at 1480 rpm against a

head of 30m.The impeller diameter is 25cm and the width at outlet is 6cm. The man metric

6. A centrifugal compressor delivers 18.2 kg/s of air with a total pressure ratio of 4:1. Speed is 15000 rpm. Inlet total temperature is 15 ° C. Slip coefficient is 0.9, Power input factor is 1.04. Efficiency is 0.8. Calculate overall diameter of impeller.
7. A single stage axial flow blower with no inlet guide vane but row of stationary vanes after rotor runs at 3600 rpm. The rotor hub and tip diameter are 20 cm and 12.5 cm respectively. Mass flow rate is 0.5 kg/s. The turning angle of rotor is 20 ° towards axial direction during air flow over blade. If atmospheric temperature and pressure are 25 o C and 1 atm. Respectively assuming constant axial velocity through machine find i) Total pressure rise of air if hydraulic efficiency is 0.9 ii) Power required iii) Degree of reaction.
8. An air compressor has 8 stages of equal pressure ratio 1.35. The flow rate through compressor 50 kg/s and its ηo = 82%. If the conditions of air at entry are 1 bar and 40° C find the i) stage of air at compressor exit ii) polytrophic efficiency iii) efficiency of each stage iv) power required to drive compressor assuming ηm = 90%.

16.0 University Result

Examination	S+	S	A	B	C	D	E	% Passing
December/ January 2019	00	02	07	26	26	11	24	79.83
December/ January 2018	00	00	01	08	19	19	37	77.67

Prepared by	Checked by		
Prof. M. M. Shivashimpi	Dr. S. A. ALUR	HOD	Principal

Subject Title	DESIGN OF MACHINE ELEMENTS I		
Subject Code	17ME54	**IA Marks**	40
No of Lecture Hrs + Tutorial Hrs / Week	03+02	**Exam Marks**	60
Total No of Lecture + Tutorial Hrs	50	**Exam Hours**	03
			CREDITS – 04

FACULTY DETAILS:		
Name: Prof. T S Vandali	**Designation:** Asst. Professor	**Experience:** 17Years
No. of times course taught: 04Times	**Specialization:** Machine Design	
Name: Prof. S B Awade	**Designation:** Asst. Professor	**Experience:** 06Years
No. of times course taught: 04Times	**Specialization:** Machine Design	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
1	Mechanical Engineering	I/II	EME
2	Mechanical Engineering	I/II/III/IV	Engg Mathematics
3	Mechanical Engineering	III	MOM

2.0 Course Objectives

1. Able to understand mechanical design procedure, materials, codes and use of standards.
2. Able to design machine components for static, impact and fatigue strength.
3. Able to design fasteners, shafts, joints, couplings, keys, threaded fasteners riveted joints, welded joints and power screws.

3.0 Course Outcomes

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

CO	Course Outcome	Cognitive Level	POs
CO1	Recognize types of stress, mechanical behavior of engineering materials, material codes and standards for design of machine elements.	A	1,2,3,5,6,8,11,12
CO2	Analyze the behavior of machine components under static, impact, fatigue loading using failure theories.	A	1,2,3,5,6,8,11,12
CO3	Design shafts, joints, couplings.	A	1,2,3,5,6,8,11,12
C04	Design of riveted and welded joints.	U	1,2,3,5,6,8,11,12
C05	Design of threaded fasteners and power screws	U	1,2,3,5,6,8,11,12
Total Hours of instruction		**50**	

4.0 Course Content

MODULE -1

Fundamentals of Mechanical Engineering Design

Mechanical engineering design, Phases of design process, Design considerations, Engineering Materials and their Mechanical properties, Standards and Codes, Factor of safety, Material selection.
Static Stresses: Static loads .Normal, Bending, Shear and Combined stresses. Stress concentration and determination of stress concentration factor**.** 10 Hours

MODULE -2

Design for Impact and Fatigue Loads

Impact stress due to Axial, Bending and Torsional loads.
Fatigue failure: Endurance limit, S-N Diagram, Low cycle fatigue, High cycle fatigue, modifying factors: size effect, surface effect. Stress concentration effects, Notch sensitivity, fluctuating stresses, Goodman and Soderberg relationship, stresses due to combined loading, cumulative fatigue damage.
10Hours

MODULE -3

Design of Shafts, Joints, Couplings and Keys

Torsion of shafts, design for strength and rigidity with steady loading, ASME codes for power transmission shafting, shafts under combined loads.
Design of Cotter and Knuckle joints, Rigid and flexible couplings, Flange coupling, Bush and Pin type coupling and Oldham's coupling. Design of keys-square, saddle, flat and father. **10 Hours**

MODULE -4

Riveted Joints and Weld Joints

Rivet types, rivet materials, failures of riveted joints, Joint Efficiency, Boiler Joints, Lozanze Joints, Riveted Brackets, eccentrically loaded joints.
Types of welded joints, Strength of butt and fillet welds, welded brackets with transverse and parallel fillet welds, eccentrically loaded welded joints. **10 Hours**

MODULE -5

Threaded Fasteners and Power Screws

Stresses in threaded fasteners, Effect of initial tension, Design of threaded fasteners under static loads, Design of eccentrically loaded bolted joints.
Types of power screws, efficiency and self-locking, Design of power screw, Design of screw jack: (Complete Design). 10 Hours

5.0 Relevance to future subjects

SL. No	Semester	Subject	Topics / Relevance
01	VI	Design Of machine element II	Gears/Cams
02	VIII	Project Work	Design of parts

6.0 Relevance to Real World

SL. No	Real World Mapping
01	Industrial drawings and design of various components
02	Design of Automobile ,Boilers, Heat exchangers and other industrial components

7.0 Books Used and Recommended to Students

Text Books

1.Design of Machine Elements, V.B. Bhandari, Tata McGraw Hill Publishing Company Ltd.,New Delhi, 2nd Edition 2007.

2.Ambekar A. G., Mechanism and Machine Theory, PHI, 2009.

3.Mechanical Engineering Design, Joseph E Shigley and Charles R. Mischke. McGraw Hill International edition, 6th Edition, 2009.

Reference Books

1. Machine Design, Robert L. Norton, Pearson Education Asia, 2001.
2. Engineering Design, George E. Dieter, Linda C Schmidt, McGraw Hill Education, Indian Edition, 2013.
3. Design of Machined Elements, S C Pilli and H. G. Patil, I. K. International Publisher, 2017.
4. Machine Design, Hall, Holowenko, Laughlin (Schaum′s Outline series) adapted by S.K Somani, tata McGraw Hill Publishing company Ltd., New Delhi, Special Indian Edition, 2008

Design Data Hand Book

1. Design Data Hand Book, K. Lingaiah, McGraw Hill, 2nd Ed.
2. Data Hand Book, K. Mahadevan and Balaveera Reddy, CBS Publication
3. Design Data Hand Book, S C Pilli and H. G. Patil, I. K. International Publisher,

Additional Study material & e-Books

- Nptel.ac.in
- VTU, E- learning

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

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

9.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	Journal of Machine Design	**https://www.**journals**.elsevier.com/**mechanism**-and-**machine**-**theory
2	Journal of Advanced Mechanical Design, Systems, and Manufacturing	tmm.spbstu.ru/english.html

10.0 Examination Note

Internal Assessment: 20 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 (Better of the two Tests):20marks.

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: 80Marks

11.0 Course Delivery Plan

Module No.	Lecture No.	Content of Lecture	% of Portion
1		**Fundamentals of Mechanical Engineering Design**	20
	1	Mechanical engineering design, Phases of design process.	
	2,3	Design considerations, Engineering Materials and their Mechanical properties	
	4	Standards and Codes, Factor of safety	
	5	Material selection.	
		Static Stresses:	
	6,7	Normal, Bending, Shear and Combined stresses.	
	8	Stress concentration	
	9,10	Determination of stress concentration factor.	
2		**Design for Impact and Fatigue Loads**	20
	1	Impact stress due to Axial, Bending and Torsional loads.	
	2	Fatigue failure: Endurance limit, S-N Diagram,	
	3	Low cycle fatigue	
	4	High cycle fatigue,.	

	5	Modifying factors: size effect, surface effect	
	6	Stress concentration effects, Notch sensitivity	
	7	Fluctuating stresses, Goodman and Soderberg relationship,	
	8,9	Stresses due to combined loading,	
	10	Cumulative fatigue damage.	
3		**Design of Shafts, Joints, Couplings and Keys**	**20**
	1,2	Torsion of shafts, design for strength and rigidity with steady loading,	
	3	ASME codes for power transmission shafting	
	4	Shafts under combined loads.	
	5,6	Design of Cotter and Knuckle joints,	
	7	Rigid and flexible couplings, Flange coupling	
	8,9	Bush and Pin type coupling and Oldham′s coupling	
	10	Design of keys-square, saddle, flat and father.	
4		**Riveted Joints and Weld Joints**	**20**
	1,2	Rivet types, rivet materials, failures of riveted joints,	
	3,4	Joint Efficiency, Boiler Joints, Lozanze Joints	
	4	Riveted Brackets, eccentrically loaded joints	
	5,6	Types of welded joints, Strength of butt and fillet welds	
	7,8,9	welded brackets with transverse and parallel fillet welds	
	10	Eccentrically loaded welded joints	
5		**Threaded Fasteners and Power Screws**	**20**
	1,2	Stresses in threaded fasteners, Effect of initial tension,	
	3,4	Design of threaded fasteners under static loads	
	5	Design of eccentrically loaded bolted joints.	
	6	Types of power screws,	
	7,8	efficiency and self-locking, Design of power screw	
	9,10	Design of screw jack: (Complete Design).	

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 Fundamentals of Mechanical Engineering Design	Describe the design process, choose materials.	Module 1	2	Individual Activity.	Text Book 1&2
2	Assignment 2: Questions on Design for Impact and Fatigue Loads	Analyze the behavior of machine components under static, impact, fatigue loading using failure theories.	Module 2	4	Individual Activity.	Text Book 1&2
3	Assignment 3: Questions on Design of Shafts, Joints, Couplings	Design shafts, joints, couplings.	Module 3	6	Individual Activity..	Text Book 1&2

	and Keys					
4	Assignment 4: Questions on Riveted Joints and Weld Joints	Design of riveted and welded joints.	Module 4	8	Individual Activity.	Text Book 1&2
5	Assignment 5: Threaded Fasteners and Power Screws	Design of threaded fasteners and power screws	Module 5	8	Individual Activity.	Text Book 1&2

12.0 QUESTION BANK

Module No	Questions	Marks
3.	1. Discuss the factors influencing selection of an appropriate material for a machine element. 2 .Define Standardization. State the standards used in machine design. 3. A weight of 1 KN is dropped from a height of 50 mm at the free end of a cantilever beam of effective length 300 mm. Determine the cross section of the cantilever beam of square cross – section if the allowable stress in the material of the beam is limited to 80MPa. 4. A round steel bar having σ_y = 800 MPa is subjected to the loads producing the calculated stresses of P/A = 70MPa, TR/Jp = 200 MPa, M_y/J = 300 MPa and 4V/3A = 170MPa, (i) Determine the safety factor with respect to initial yielding according to maximum shear stress theory and maximum distortion energy theory (ii) Draw the sketch showing the location of maximum normal stress and maximum (iii) shear stress planes.	20
2.	1. A 5 Kg block is dropped from a height of 200 mm on to a beam shown in figure 4.The material has an allowable yield stress of 50 MPa. Determine the dimensions of the rectangular section, whose depth is 1.5 times of the width. Take E= 70MPa. 2. Explain the influence of stress raiser on impact strength. 3. A stepped shaft with its diameter reduced from 1.2 d to d has a fillet radius of 0.1d. Determine the diameters of the shaft and the radius of fillet to transmit a power of 60 KW at a rated of 1000 RPM limiting the maximum shear stress induced to 65MPa. 4. A shaft of circular cross section is subjected to a turning moment that fluctuates between 800 KNm and 600 KNm and also a bending moment that fluctuates between + 500 KNm and – 300KNm. The material selected for the shaft has a shear stress value of 100 MPa at endurance limit and a shear stress value of 120 MPa of the yield limit. Determine the diameter of the solid circular shaft taking a value of 2.50 for the factor of safety. Surface factor, size factor and load factor can be taken as 0.90, 0.85and 1.0 respectively. Shear stress concentration factor is 1.80 and the notch sensitivity is 0.95.	20
3.	1. A 1.2 m hollow shaft is subjected to bending moment 900N-m and turning moment600 N-m. The shaft is also subjected to an end thrust 1.2KN. Taking d_i/d_o = 0.7 and material of the shaft to be cold rolled steel, determine the inner and outer diameters of the shaft. Consider heavy shock condition. 2. Design a cast Iron flange coupling (protected type) to connect two shafts and transmits a torque a 5000 Nm. The following permissible stresses may be used. Permissible shear stress for shaft, bolt and key material = 50 MPa. Permissible shear stress for CI = 16MPa. 3. Design a knuckle joint to transmit an axial load of 120 KN. The allowable stresses for the material of the joint are as follows: σ_t = 120 MPa and τ = 80 MPa 4. Design a cotter joint to sustain an axial load of 80 KN.Material selected for the joint has has the following mechanical properties.Normal stress at yield = 300 MPa Shear	20

	stress at yield = 150 MPa	
4.	1. A triple-riveted butt-joint with equal cover plates is used to connect two plates 16 mm thick. Design the joint if the allowable crushing stress for rivet and plates is 60 MN/m^2. Find the joint efficiency. Allowable shear stress for rivets: 45 MN/m^2. Draw to scale two views of the designed joint giving all dimensions. 2. A bracket supporting a load is welded to a stanchion by four fillet welds of 6mm size as shown in the figure 28. What is the maximum value of P if the normal stress on the throat section is not to exceed 98 MN/m^2? 3. Design and draw a fully dimensioned neat sketch in two view of a double riveted butt joint with double cover plates for the longitudinal seam of a boiler 1.5m in diameter when working pressure is 1 MPa. Use the following data: a. Allowable stress in tension for steel plate = 80MPa b. Allowable stress in shear for rivets = 60 MPa c. Allowable stress in crushing for rivets = 120 MPa.	20
5.	1. What are power screws? State their applications. 2. A machine weighing 20KN is to be raised by a single start square threaded 50mm diameter, 8mm pitch screw jack at a maximum speed of 600m/min. If the coefficient of friction between the threads is 0.2, determine the power required to lift the machine. The thrust collar of the screw has inside diameter of 30mm and out side diameter of 60mm. The coefficient of collar friction is 0.1. 3. Design the following parts of 20 KN screw jack selecting suitable materials and assuming appropriate values and the factors of safety, for a travel of 200mm (i) Screw rod (ii) Nut (iii) The hand lever	20

13.0 University Result

Examination	S$^+$	S	A	B	C	D	E	F	% passing
2018-19	-	1	4	5	13	9	16	18	74
2017-18	1	2	6	12	11	7	8	14	79

Prepared by	Checked by		
			
Prof. S B Awade	**Prof. T S Vandali**	**HOD**	**Principal**

Subject Title	NON TRADITIONAL MACHINING		
Subject Code	17ME554	**IA Marks**	40
Number of Lecture Hrs / Week	03	**SEE**	60
Total Number of Lecture Hrs	40	**Exam Hours**	03
CREDITS – 03			

FACULTY DETAILS:		
Name: Prof. R. K. Chitgopkar	**Designation:** Asst.Professor	**Experience:**30
No. of times course taught:02	**Specialization:** Thermal Engineering	
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	III / IV	MTO

2.0 Course Objectives

1. Non-conventional machining process & its importance in metal working.
2. Different variety of equipments, tool used, tool size.
3. Application of specific equipment for specific machining
4. Writing the USM, AJM, ECM, their procedure, applications, advantage and disadvantages
5. Writing the CHM, EDM, PAM LBM, EBM, their procedure, applications, advantage and disadvantages
6. Comparative advantages and disadvantages of NTM & TM

3.0 Course Outcomes

On completion of the course, the students will be able to;

1. Understand the compare traditional and non-traditional machining process and recognize the need for Non-traditional machining process.
2. Understand the constructional features, performance parameters, process characteristics, applications, advantages and limitations of USM, AJM and WJM.
3. Identify the need of Chemical and electro-chemical machining process along with the constructional features, process parameters, process characteristics, applications, advantages and limitations.
4. Understand the constructional feature of the equipment, process parameters, process characteristics, applications, advantages and limitations EDM & PAM.
5. Understand the LBM equipment, LBM parameters, and characteristics. EBM equipment and mechanism of metal removal, applications, advantages and limitations LBM & EBM.

4.0 Course Content

MODULE – 1

INTRODUCTION

Introduction to Non-traditional machining, Need for Non-traditional machining process, Comparison between traditional and non-traditional machining, general classification Nontraditional machining processes, classification based on nature of energy employed in machining, selection of non-traditional machining processes, Specific advantages, limitations and applications of non-traditional machining processes. **08 hours**

MODULE 2

Ultrasonic Machining (USM): Introduction, Equipment and material process, Effect of process parameters: Effect of amplitude and frequency, Effect of abrasive grain diameter, effect of slurry, tool & work material. Process characteristics: Material removal rate, tool wear, accuracy, surface finish, applications, advantages & limitations of USM.
Abrasive Jet Machining (AJM): Introduction, Equipment and process of material removal, process variables: carrier gas, type of abrasive, work material, stand-off distance (SOD).Process characteristics-Material removal rate, Nozzle wear, accuracy & surface finish. Applications, advantages & limitations of AJM.
Water Jet Machining (WJM): Equipment & process, Operation, applications, advantages and limitations of WJM.

08 hours

MODULE 3

ELECTROCHEMICAL MACHINING (ECM)
Introduction, Principle of electro chemical machining: ECM equipment, elements of ECM operation, Chemistry of ECM. ECM Process characteristics: Material removal rate, accuracy, surface finish.
Process parameters: Current density, Tool feed rate, Gap between tool & work piece, velocity of electrolyte flow, type of electrolyte, its concentration temperature, and choice of electrolytes. ECM Tooling: ECM tooling technique & example Tool & insulation materials. Applications ECM: Electrochemical grinding and electrochemical honing process. Advantages, disadvantages and application of ECG, ECH.
CHEMICAL MACHINING (CHM)
Elements of the process: Resists (maskants), Etchants. Types of chemical machining process chemical blanking process, chemical milling process. Process characteristics of CHM: material removal rate, accuracy, surface finish, advantages, limitations and applications of chemical machining process. **10 hours**

MODULE 4

ELECTRICAL DISCHARGE MACHINING (EDM)
Introduction, mechanism of metal removal, EDM equipment: spark erosion generator (relaxation type), dielectric medium-its functions & desirable properties, electrode feed control system. Flushing types; pressure flushing, suction flushing, side flushing, pulsed flushing. EDM process parameters: Spark frequency, current & spark gap, surface finish, Heat Affected Zone. Advantages, limitations & applications of EDM, Electrical discharge grinding, Traveling wire EDM.
PLASMA ARC MACHINING (PAM)
Introduction, non-thermal generation of plasma, equipment mechanism of metal removal, Plasma torch, process parameters, process characteristics. Safety precautions. Safety precautions, applications, advantages and limitations.

08 hours

MODULE 5

LASER BEAM MACHINING (LBM)
Introduction, generation of LASER, Equipment and mechanism of metal removal, LBM parameters and characteristics, Applications, Advantages & limitations.
ELECTRON BEAM MACHINING (EBM)
Introduction, Principle, equipment and mechanism of metal removal, applications, advantages and limitations. **08 hours**

5.0 Relevance to future subjects

Sl No	Semester	Subject	Topics
01	VIII	Project work	Machining of different materials

6.0 Relevance to Real World

SL.No	Real World Mapping
01	Unconventional machining
02	Machining of high strength to low weight ratio materials.
03	Machining of difficult to machine materials.

7.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
01	Tutorial	Topic: Machining of difficult to machine materials

8.0 Books Used and Recommended to Students

Text Books
'1. Modern machining process, Pandey and Shan, Tata McGraw Hill 2000 2. New Technology, Bhattacharya 2000
Reference Books
1. Production Technology, HMT Tata McGraw Hill. 2001. 2. Modern Machining Process, Aditya. 2002 3. Non-Conventional Machining, P.K.Mishra, The Institution of Engineers (India) Test book series, Narosa Publishing House – 2005. 4. 4. Metals Handbook: Machining Volume 16, Joseph R. Davis (Editor), American Society of Metals (ASM)
Additional Study material & e-Books
1. "Workshop Technology vol II" .Hazra Choudary

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

Website and Internet Contents References
1) https://www.scribd.com/doc/210082935/**non-conventional** *2)* https://ec.europa.eu/.../sites/.../cross-cutting-kets-roadmap-innovation-fields-manufac*turing.* *3)* https://www.smec.ac.in/**sites**/default/files/courses/mech/4-1/UCMP 4) *https://en.wikipedia.org/wiki/Advanced_**manufacturing***

10.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	Journal of Manufacturing system	http://www.sciencedirect.com/science/journal/02786125
2	Production and Manufacturing research	http://www.tandfonline.com/doi/full/10.1080/21693277.2014.938276
3	Journal machining and grinding engineers	http://www.in-situ.co.uk/in-situ-journal-machining?gclid=CM-o-pqYgtECFROVaAodwbkN2w
4	International journal of material forming and machining processes	http://www.igi-global.com/journal/international-journal-materials-forming-machining/69666

11.0 Examination Note

Internal Assessment: 20 Marks

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

Scheme of Evaluation for Internal Assessment

Internal Assessment test in the same pattern as that of the main examination (Better of the two tests)

Semester End Examination: 60 Marks

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

INSTRUCTION FOR NON TRADITIONAL MACHINING 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.

12.0 Course Delivery Plan

Module	Lecture No.	Content of Lecturer	% of Portion
Module 1:	1	Introduction to Non-traditional machining	19.04
	2	Need for Non-traditional machining process	
	3	Comparison between traditional and non-traditional machining	
	4	General classification Nontraditional machining processes,	
	5	Classification based on nature of energy employed in machining	
	6	Selection of non-traditional machining processes	
	7	Specific advantages, limitations	
	8	Applications of non-traditional machining processes	
Module 2:	9	**Ultrasonic Machining (USM):** Introduction, Equipment and material process,	19.04
	10	Effect of process parameters: Effect of amplitude and frequency, Effect of abrasive grain diameter, effect of slurry, tool & work material.	
	11	Process characteristics: Material removal rate, tool wear, accuracy, surface finish,	
	12	Applications, advantages & limitations of USM. **Abrasive Jet Machining (AJM):** Introduction	
	13	Equipment and process of material removal, process variables: carrier gas, type of abrasive, work material, stand-off distance (SOD).	
	14	Process characteristics-Material removal rate, Nozzle wear, accuracy & surface finish. Applications, advantages & limitations of AJM.	
	15	**Water Jet Machining (WJM):** Equipment & process, Operation	
	16	Applications, advantages and limitations of WJM.	
Module 3:	17	**ELECTROCHEMICAL MACHINING (ECM)** Introduction	23.8
	18	Principle of electro chemical machining: ECM equipment, elements of ECM operation,	
	19	Chemistry of ECM. ECM Process characteristics: Material removal rate, accuracy, surface finish.	
	20	Process parameters: Current density, Tool feed rate, Gap between tool & work piece, velocity of electrolyte flow, type of electrolyte, its concentration temperature, and choice of electrolytes.	
	21	ECM Tooling: ECM tooling technique & example Tool & insulation materials. Applications	
	22	ECM: Electrochemical grinding and electrochemical honing process. Advantages, disadvantages and application of ECG, ECH.	
	23	**CHEMICAL MACHINING (CHM)** Elements of the process: Resists (maskants), Etchants.	
	24	Types of chemical machining process chemical blanking process, chemical milling process.	
	25	Process characteristics of CHM: material removal rate, accuracy, surface finish	
	26	Advantages, limitations and applications of chemical machining process.	
Module 4:	27	**ELECTRICAL DISCHARGE MACHINING (EDM) :** Introduction	19.04
	28	Mechanism of metal removal, EDM equipment: spark erosion generator (relaxation type),	
	29	Dielectric medium-its functions & desirable properties, electrode feed control system.	
	30	Flushing types; pressure flushing, suction flushing, side flushing, pulsed flushing. EDM	
	31	Process parameters: Spark frequency, current & spark gap, surface finish, Heat Affected Zone. Advantages, limitations & applications of EDM,	
	32	Electrical discharge grinding, Traveling wire EDM. **PLASMA ARC MACHINING (PAM) :** Introduction, non-thermal generation of plasm	
	33	Equipment mechanism of metal removal, Plasma torch, process parameters, process characteristics. Safety precautions. Safety precautions	
	34	Applications, advantages and limitations	
Module 5:	35	**LASER BEAM MACHINING (LBM)**	19.04
	36	Introduction, generation of LASER	
	37	Equipment and mechanism of metal removal	
	38	LBM parameters and characteristics	
	39	Applications, Advantages & limitations	

	40	**ELECTRON BEAM MACHINING (EBM)** Introduction,	
	41	Principle, equipment and mechanism of metal removal	
	42	Applications, advantages and limitations.	

13.0 Assignments, Pop Quiz, Mini Project, Seminars

Sl.No.	Title	Outcome expected	Allied study	Week No.	Individual / Group activity	Reference: book /website /Paper
1	Assignment 1:	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 1 of the syllabus	2	Individual Activity.	Books 1 and 3 of the text book list
2	Assignment 2:	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 2 of the syllabus	4	Individual Activity.	Books 1 and 3 of the text book list
3	Assignment 3:	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 3 of the syllabus	6	Individual Activity.	Books 1 and 3 of the text book list
4	Assignment 4:	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 4 of the syllabus	8	Individual Activity.	Books 1 and 3 of the text book list
5	Assignment 5:	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 5 of the syllabus	10	Individual Activity.	Books 1 and 3 of the text book list

14.0 QUESTION BANK

Module 1

1. Justify the need of unconventional manufacturing process in todays industries.
2. Distinguish between conventional and unconventional manufacturing process.
3. Explain the parameters to select to employ the new machining methods.

Module 2

1. Explain with sketch the working principle of ultrasonic machining process.
2. Explain how various process parameters influence on machining performance in ultrasonic machining process. . Mention its advantages, disadvantages and Applications.
3. Explain the methods to increase ultrasonic machining rates.
4. Write a note on abrasive slurry used in AJM indicating types of abrasive and their properties, sizes used and liquid media with functions and characteristics.
5. With neat sketch explain AJM. Mention its advantages, disadvantages and Applications
6. Explain influence of various parameters on the metal removal rate in abrasive jet machining process.
7. Explain the desired properties of abrasive materials used in abrajive jet machining
8. Which are the abrasive materials used in abrasive jet machining

Module 3

1. With neat sketch explain the metal removal mechanism in electro chemical grinding. Mention its advantages, disadvantages and Applications
2. Why are chemical machining and elctro chemical machining considered as chipless machining? Explain the mechanism of metal removal on both cases and compare it with conventional grinding process.

3. Explain . a. Maskants b. Etchents.
4. With sketch explain the different steps involved in chemical blanking.
5. Mention advantages, disadvantages and Applications of CHM.

Module 4

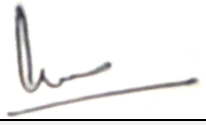
1. Discuss the factors influencing the choice of electrod material in EDM.
2. Explain witch sketch different types of flushing.
3. Explain with sketch mechanism of metal removal in EDM process. Mention its advantages, disadvantages and Applications.
4. With neat sketch explain PAM. Mention its advantages, disadvantages and Applications.
5. Which are the important considerations are to be made in the design of plasma torch?

Module 5

1. With neat sketch explain LBM. Mention its advantages, disadvantages and Applications.
2. With neat sketch explain EBM. Mention its advantages, disadvantages and Applications.
3. Explain how electron beam is generated in EBM process.

15.0 University Result

Examination	S+	S	A	B	C	D	E	% Passing
2018-19	02	36	37	43	11	01	0	100
2017-18	02	28	43	37	08	0	0	100

Prepared by	Checked by		
			
Prof. M A Hipparagi	**Prof. R. K. Chitgopkar**	**HOD**	**Principal**

Subject Title	ENERGY AND ENVIRONMENT		
Subject Code	17ME562	IA Marks	40
No of Lecture Hrs + Tutorial Hrs / Week	03	Exam Marks	60
Total No of Lecture + Tutorial Hrs	48	Exam Hours	03
			CREDITS – 03

FACULTY DETAILS:		
Name: Prof. R.K.Chitgopar	**Designation:** Asst. Professor	**Experience:** 31Years
No. of times course taught: 02Times	**Specialization:** Thermal Power Engineering	
Name: Prof. A.M.BIRADAR	**Designation:** Asst. Professor	**Experience:** 11Years
No. of times course taught: 02Times	**Specialization:** Machine Design	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
1	Mechanical Engineering	----	----------

2.0 Course Objectives

1. Understand energy scenario, energy sources and their utilization
2. Learn about methods of energy storage, energy management and economic analysis
3. Have proper awareness about environment and eco system.
4. Understand the environment pollution along with social issues and acts.

3.0 Course Outcomes

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

CO	Course Outcome	RBT level	POs
CO1	Summarize the basic concepts of energy, its distribution and general Scenario.	L1	1,6,7,8,9,10,11,12
CO2	Explain different energy storage systems, energy management, audit and economic analysis.	L2	1,2,3,6,7,8,9,10,11,12
CO3	Summarize the environment eco system and its need for awareness.	L1	1,6,7,8,10,12
C04	Identify the various types of environment pollution and their effects.	L1	1,6,7,8,10,12
C05	Discuss the social issues of the environment with associated acts.	L2	1,6,7,8,10,12
Total Hours of instruction		**50**	

4.0 Course Content

MODULE – 1

Basic Introduction to Energy: Energy and power, forms of energy, primary energy sources, energy flows, world energy production and consumption, Key energy trends in India: Demand, Electricity, Access to modern energy, Energy production and trade, Factors affecting India's energy development: Economy and demographics Policy and institutional framework, Energy prices and affordability, Social and environmental aspects, Investment. **8 Hours**

MODULE – 2

Energy storage systems: Thermal energy storage methods, Energy saving, Thermal energy storage systems

Energy Management: Principles of Energy Management, Energy demand estimation, Energy pricing

Energy Audit: Purpose, Methodology with respect to process Industries, Characteristic method employed in Certain Energy Intensive Industries

Economic Analysis: Scope, Characterization of an Investment Project **10 Hours**

MODULE -3

Environment: Introduction, Multidisciplinary nature of environmental studies**-** Definition, scope and importance, Need for public awareness.

Ecosystem: Concept, Energy flow, Structure and function of an ecosystem. Food chains, food webs and ecological pyramids, Forest ecosystem, Grassland ecosystem, Desert ecosystem and Aquatic ecosystems, Ecological succession. **8 Hours**

MODULE -4

Environmental Pollution: Definition, Cause, effects and control measures of - Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution and Nuclear hazards , Solid waste Management, Disaster management Role of an individual in prevention of pollution, Pollution case studies. **8 Hours**

MODULE -5

Social Issues and the Environment: Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case-Studies. Wasteland reclamation, Consumerism and waste products, Environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation. **8 Hours**

5.0 Relevance to future subjects

SL. No	Semester	Subject	Topics / Relevance
01	VI	**Energy Auditing**	**Energy Audit Concepts, Principles and Objectives of Energy Management, Thermal Energy Management**
02	VII	**Energy Engineering**	**Thermal Energy conversion system**

6.0 Relevance to Real World

SL. No	Real World Mapping
01	Electrical engineering
02	Power plant engineering, thermal power plant
03	Environmental Science

7.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
01	Nptel.ac.in	E- Learning
02	VTU, E- learning	E- Learning
03	Open courseware	E- Learning

8.0 Books Used and Recommended to Students

Text Books

1. Textbook for Environmental Studies For Undergraduate Courses of all Branches of Higher Education by University grant commission and Bharathi Vidyapeeth Institute of environment education and Research ,Pune
2. De, B. K., Energy Management audit & Conservation, 2nd Edition, Vrinda Publication, 2010.

Reference Books

1. Turner, W. C., Doty, S. and Truner, W. C., Energy Management Hand book, 7th edition, Fairmont Press, 2009.
2. Murphy, W. R., Energy Management, Elsevier, 2007.
3. Smith, C. B., Energy Management Principles, Pergamum, 2007
4. Environment pollution control Engineering by C S rao, New Age International, 2006, reprint 2015, 2nd edition
5. Environmental studies, by Benny Joseph, Tata McGraw Hill, 2008, 2nd edition.

Additional Study material & e-Books

- Nptel.ac.in
- VTU, E- learning
- India Energy Outlook 2015(www.iea.org/.../IndiaEnergyOutlook_WEO2015.pdf)
- Open courseware

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

Website and Internet Contents References	
4.	http://www.nptel.ac.in
5.	www.iea.org

10.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	Elsevier	https://www.journals.elsevier.com/renewable-energy
2	Environmental Sciences Journals	https://www.omicsonline.org/environmental-sciences-journals

11.0 Examination Note

Internal Assessment: 40 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 (Better of the two Tests):40marks.

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

12.0 Course Delivery Plan

Module No.	Lecture No.	Content of Lecture	% of Portion
1		**Basic Introduction to Energy:**	20
	1	Energy and power, forms of energy, primary energy sources	
	2	Energy flows, world energy production and consumption	
	4	Key energy trends in India: Demand	
	5	Electricity, Access to modern energy,	
	6	Energy production and trade, Factors affecting India's energy development	
	7	Economy and demographics Policy and institutional framework	
	8	Energy prices and affordability, Social and environmental aspects, Investment	
2		**Energy storage systems, Energy Management, Energy Audit,**	20

		Economic Analysis	
	1	Thermal energy storage methods,	
	2	Energy saving, Thermal energy, storage systems	
	3	Principles of Energy Management,	
	4	Energy demand.	
	5	Energy estimation, Energy pricing	
	6	Energy Audit: Purpose	
	7	Methodology with respect to process Industries,	
	8	Characteristic method employed in Certain Energy Intensive Industries.	
	9	Economic Analysis: Scope	
	10	Characterization of an Investment Project	
3		**Environment, Ecosystem:**	**20**
	1	Environment**:** Introduction, Multidisciplinary nature of environmental studies**-** Definition, scope and importance.	
	2	Need for public awareness.	
	3	Ecosystem**:** Concept, Energy flow Structure and function of an ecosystem.	
	4	Food chains, food webs and ecological pyramids	
	5	Forest ecosystem, Grassland ecosystem,	
	6	Desert ecosystem and Aquatic ecosystems,	
	7	Desert ecosystem and Aquatic ecosystems	
	8	Ecological succession	
4		**Environmental Pollution:**	**20**
	1	Environmental Pollution definition, Cause and effects	
	2	Control measures of - Air pollution,	
	3	Water pollution, Soil pollution,	
	4	Marine pollution, Noise pollution.	
	5	Thermal pollution and Nuclear hazards ,	
	6	Solid waste Management, Disaster management	
	7	Role of an individual in prevention of pollution	
	8	Pollution case studies	
5		**Social Issues and the Environment:**	**20**
	1	Climate change, global warming, acid rain, ozone layer depletion	
	2	Nuclear accidents and holocaust. Case Studies.	
	3	Wasteland reclamation, Consumerism and waste products	
	4	Environment Protection Act	
	5	Air (Prevention and Control of Pollution) Act	
	6	Water (Prevention and control of Pollution) Act, Wildlife Protection Act,	
	7	Forest Conservation Act,	
	8	Issues involved in enforcement of environmental legislation	

13.0 Assignments, Pop Quiz, Mini Project, Seminars

Sl.No.	Title	Outcome expected	Allied study	Week No.	Individual / Group activity	Reference: book/website /Paper
1	Assignment 1:	Students study the	Module	3	Individual Activity	Book 1 and

	University Questions	Topics and write the Answers. Get practice to solve university questions.	1 syllabus		and submission of hard copy.	all the reference book
2	Assignment 2: University Questions	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 2 syllabus	6	Individual Activity and submission of hard copy.	Book 1 and all the reference book
3	Assignment 3: University Questions	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 3 syllabus	9	Individual Activity and submission of hard copy.	Book 1 and all the reference book
4	Assignment 3: University Questions	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 4 syllabus	12	Individual Activity and submission of hard copy.	Book 1 and all the reference book
5	Assignment 3: University Questions	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 5 syllabus	15	Individual Activity and submission of hard copy.	Book 1 and all the reference book

15.0 QUESTION BANK

S.No	Questions
Unit-I	1. Interpret World Energy Scenario with respect to production and consumption using relevant statistics 2. Define Energy and Power. Differentiate the same. 3. Outline the factors that affect India's energy development. 4. Explain the various key energy trends in India. 5. With relevant statistics, enumerate the primary energy production trend for India
Unit-II	1. Explain in the detail the various phases of energy audit methodology. 2. List the various thermal energy storage methods. Explain sensible heat and latent heat storage methods. 3. Define Energy audit. Explain the need for energy audit. 4. Write a short note on energy demand estimation. 5. Calculate the cost of generation per kWh for a power station having the following data: Installed capacity of the plant = 200 MW Capital cost = Rs 400 crores Rate of interest and depreciation = 12% Annual cost of fuel, salaries and taxation = Rs 5 crores Load factor = 50% Also estimate the saving in cost per kWh if the annual load factor is raised to 60%. 6. Explain in the detail the various phases of energy audit

	methodology. 7. Elaborate the benefits of thermal energy storage.
Unit-III	1. What is an ecosystem? Discuss forest ecosystem. Explain how conservation of forest can be done. 2. Discuss how oxygen cycle is utilized in the ecosystem. 3. Write a short note on (i) ecological succession (ii) food chain, food web and ecological pyramid. 4. Elaborate how the nitrogen cycle ecosystem operates. 5. Enumerate the utilization of carbon in ecosystem. 6. Describe grassland ecosystem. What are its types? How conservation of grassland can be made. 7. Discuss how oxygen cycle is utilized in the ecosystem. 8. Define Environment. Mention its scope. Discuss the need for public awareness
Unit-IV	1. Discuss briefly the causes, effects and control measures of air pollution. 2. Discuss Solid Waste Management techniques. 3. Elaborate the causes, effects and control measures of (i) Soil Pollution (ii) Noise Pollution (iii) Thermal Pollution 4. Enumerate the role of an individual in prevention of pollution. 5. Enumerate the water pollution causes and its effects. Mention the control measures that can be initiated for mitigating the same. 6. Discuss any two case studies related to pollution of environment in detail. 7. Elaborate the causes, effects and control measures of (i) Soil Pollution (ii) Noise Pollution (iii) Thermal Pollution 8. Discuss Solid Waste Management techniques.
Unit-V	1. What is acid rain? What are its effects? 2. Explain the salient features of Air Pollution act. 3. Explain about Environment Impact Assessment (EIA). 4. Discuss (i) Wildlife Protection act (ii) Forest Conservation act 5. Write a note on ozone layer depletion. 6. Express the need for reclaiming the wasteland and its development 7. What are the regulations governing water pollution prevention act? 8. Enumerate the impact of global warming on our mother nature.

16.0 University Result

Examination	S+	S	A	B	C	D	E	F	% Passing
2018-19	--	9	42	45	21	4	5	01	**99.18**

Prepared by	Checked by		
Prof. A. M. Biradar	Prof. R.K.Chitgopar	HOD	Principal

Subject Title	**Fluid Mechanics & Machinery Lab**		
Subject Code	17MEL57	**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. R V Nyamagoud	**Designation:** Asst. Professor	**Experience: 0**6 Years
No. of times course taught: 03 Times	**Specialization:** Thermal Power Engineering	
Name: Prof. Jagadeesh A	**Designation:** Asst. Professor	**Experience:** 07 Years
No. of times course taught: 04 Times	**Specialization:** Thermal Power Engineering	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Mechanical Engineering	I/II	Elements of Mechanical Engineering
02	Mechanical Engineering	III/IV	Fluid Mechanics

2.0 Course Objectives

1. This course will provide a basic understanding of flow measurements using various types of flow measuring devices, calibration and losses associated with these devices.
2. Energy conversion principles, analysis and understanding of hydraulic turbines and pumps will be discussed. Application of these concepts for these machines will be demonstrated. Performance analysis will be carried out using characteristic curves.

3.0 Course Outcomes

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

CO	Course Outcome	Cognitive Level	POs
C307.1	Perform experiments to determine the coefficient of discharge of flow measuring devices	U	1,2,7,12
C307.2	Conduct experiments on hydraulic turbines and pumps to draw characteristics.	A	1,2,7,12
C307.3	Test basic performance parameters of hydraulic turbines and pumps and execute	A	1,2,7,12
C307.4	Identify exhaust emission, factors affecting them and report the remedies.	A	1,2,7,12
C307.5	Determine the energy flow pattern through the hydraulic turbines and pumps	U	1,2,7,12
C307.6	Exhibit his competency towards preventive maintenance of hydraulic machines	U	1,2,7,12
Total Hours of instruction			**52**

4.0 Course Content

PART – A

1. Lab layout, calibration of instruments and standards to be discussed
2. Determination of coefficient of friction of flow in a pipe.
3. Determination of minor losses in flow through pipes.
4. Application of momentum equation for determination of coefficient of impact of jets on flat and curved blades
5. Calibration of flow measuring devices.
6. Orifice meter
   a. Nozzle

b. Venturimeter
c. V-notch

PART – B

7. Performance on hydraulic Turbines
a. Pelton wheel
b. Francis Turbine
c. Kaplan Turbines
8. Performance hydraulic Pumps
   a. Single stage and Multi stage centrifugal pumps
   b. Reciprocating pump
9. Performance test on a two stage Reciprocating Air Compressor
10. Performance test on an Air Blower

PART – C (Optional)

11. Visit to Hydraulic Power station/ Municipal Water Pump House and Case Studies
12. Demonstration of cut section models of Hydraulic turbines and Pumps.

5.0 Relevance to future subjects

SL. No	Semester	Subject	Topics / Relevance
01	VIII	Project work	Project on Fluid Machines

6.0 Relevance to Real World

SL. No	Real World Mapping
01	Awareness of hydraulic power plant and water resources.
02	Compare the Performance analysis of hydraulic turbines.
03	Knowledge regarding pumps and their usage.

7.0 Books Used and Recommended to Students

Reference Books
1. K.L.Kumar."Engineering Fluid Mechanics" Experiments, Eurasia Publishing House, 1997 2. Jagdish Lal, Hydraulic Machines, Metropolitan Book Co, Delhi, 1995 3. George E. Totten , Victor J. De Negri "Handbook of Hydraulic Fluid Technology, Second Edition, 2011.

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

Website and Internet Contents References
1.http://www.nptel.ac.in 2.http://fluidmechanics.howstuffworks.com/

9.0 Magazines/Journals Used and Recommended to Students

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

10.0 Examination Note

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

11.0 Course Delivery Plan

Expt No	Lecture / Practical No	Name of the Experiment	% Of Portion
1	1	Discussion on Lab layout, calibration of instruments and standards to be discussed	47.62
2	2	Determination of coefficient of friction of flow in a pipe.	
3	3	Determination of minor losses in flow through pipes.	
4	4	Application of momentum equation for determination of coefficient of impact of jets on flat and curved blades	
5	5	Calibration of flow measuring devices.	
6	6	Orifice meter a.Nozzle b.Venturimeter c. V-notch	
7	7	Performance on hydraulic Turbines a.Pelton wheel b .Francis Turbine c.Kaplan Turbines	40.19
8	8		
9	9		
10	10	Performance hydraulic Pumpsa. Single stage and Multi stage centrifugal pumpsReciprocating pump	
11	11	Performance test on a two stage Reciprocating Air Compressor	
12	12	Performance test on an Air Blower	12.19
13	12	1. Visit* to Hydraulic Power station/ Municipal Water Pump House and Case Studies 2. Demonstration of cut section models of Hydraulic turbines and Pumps.	

12.0 QUESTION BANK

1. Define fluid?
2. Name the different types of fluid properties.
3. Define fluid statics?
4. Explain fluid pressure?
5. Define lift force?
6. Define drag force?
7. Define orifice meter.
8. Explain the venture meter.
9. Define notch?
10. Differentiate between notch and orifice meter.
11. Explain hydraulic turbine?
12. Define compounding in steam turbines?
13. Define compressor?
14. Explain manometric height?
15. What do you mean by power producing machines?
24. Define positive displacement devices?
25. What is turbine?
26. Define impulse turbine?
27. Explain reaction turbine?
28. Classify turbines?
29. Define impact force?
30. Define brake power?
31. Define discharge?
32. Define stream line flow?
33. Define turbulent flow?
34. Define critical Reynolds number?
35. Draw velocity triangle for pelton turbine?
36. Explain air compressor?
37. Define intercooling?
38. Define HP compressor?

16. List out the components of pelton turbine?
17. List out the components of francis turbine?
18. List out the components of kaplan turbine?
19. List out the components of centrifugal pump?
20. List out the components of reciprocating pump?
21. Explain velocity triangles?
22. Define minor losses?
23. Define friction loss through pipe?
39. List the parts of 2 stage air compressor?
40. Define the losses in flow through pipe.

13.0 University Result

Examination	S+	S	A	B	C	D	E	% Passing
2018-19	15	45	33	16	14	4	-	**100**
2017-18	08	21	54	24	09	01	00	**99.19**

Prepared by	Checked by		
Prof. R V Nyamagoud	**Prof. Jagadeesh A**	**HOD**	**Principle**

Subject Title	**ENERGY LAB**		
Subject Code	**17MEL58**	**IA Marks**	40
No of Lecture Hrs + Practical Hrs / Week	01+02	**Exam Marks**	100
Total No of Lecture + Practical Hrs	50	**Exam Hours**	03
			CREDITS – 02

FACULTY DETAILS:		
Name: Prof. M.M. Shivashimpi	**Designation:** Asst. Professor	**Experience:** 11 Years
No. of times course taught: 10 Times	**Specialization:** Thermal Power Engineering	
Name: Prof. M.R. Ingalagi	**Designation:** Asst. Professor	**Experience:** 06 Years
No. of times course taught: 04 Times	**Specialization:** Thermal Power Engineering	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Mechanical Engineering	III	Basic Thermodynamics
02	Mechanical Engineering	IV	Applied Thermodynamics

2.0 Course Objectives

1. This course will provide a basic understanding of fuel properties and its measurements using various types of measuring devices.
2. Energy conversion principles, analysis and understanding of I C Engines will be discussed. Application of these concepts for these machines will be demonstrated. Performance analysis will be carried out using characteristic curves.
3. Exhaust emissions of I C Engines will be measured and compared with the standards.

3.0 Course Outcomes

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

CO's	Course Outcome	Cognitive Level	POs
C316.1	Perform experiments to determine the properties of fuels and oils.	U	1,2,7,12
C316.2	Conduct experiments on engines and draw characteristics.	A	1,2,7,12
C316.3	Test basic performance parameters of I.C. Engine and implement the knowledge in industry.	A	1,2,7,12
C316.4	Identify exhaust emission, factors affecting them and report the remedies.	A	1,2,7,12
C316.5	Determine the energy flow pattern through the I C Engine.	U	1,2,7,12
C316.6	Exhibit his competency towards preventive maintenance of IC engines.	U	1,2,7,12
Total Hours of instruction		**50**	

4.0 Course Content

PART A

1. Lab layout, calibration of instruments and standards to be discussed
2. Determination of Flash point and Fire point of lubricating oil using Abel Pensky and Marten's (closed) / Cleveland's (Open Cup) Apparatus.
3. Determination of Calorific value of solid, liquid and gaseous fuels.
4. Determination of Viscosity of a lubricating oil using Redwoods, Sayboltand Torsion Viscometers.
5. Analysis of moisture, volatile matter, ash content and fixed carbon of solid and liquid fuel samples
6. Valve Timing/port opening diagram of an I.C. Engine

PART B

7. Performance Tests on I.C. Engines, Calculations of IP, BP, Thermal efficiency, Volumetric efficiency, Mechanical efficiency, SFC, FP, A:F Ratio, heat balance sheet for a. Four stroke Diesel Engine b. Four stroke Petrol Engine c. Multi Cylinder Diesel/Petrol Engine, (Morse test) d. Two stroke Petrol Engine e. Variable Compression Ratio I.C. Engine.
8. Measurements of Exhaust Emissions of Petrol engine.
9. Measurements of Exhaust Emissions of Diesel engine.
10. Demonstration of pθ , pV plots using Computerized IC engine test rig

PART – C (Optional)

11. Visit to Automobile Industry/service stations.
12. CFD Analysis of design, development, performance evaluation and process optimization in I C Engines.

5.0 Relevance to future subjects

SL. No	Semester	Subject	Topics / Relevance
01	VIII	Project work	Project on I.C. Engine

6.0 Relevance to Real World

SL. No	Real World Mapping
01	Awareness of Safety about fuels and oils
02	Compare the Performance analysis of the I.C. engines
03	Awareness of Environmental Emission norms of I.C. Engine

7.0 Books Used and Recommended to Students

Reference Books

1. E. F. Obert, Internal combustion engines and air pollution in text educational publishers (1973). John Heywood, Internal combustion engine fundamentals, McGraw- Hill (1988) - USA.
2. Colin R Ferguson and Allan T. Kirkpatrick Internal combustion engines Applied Thermodynamics, John Wiley & sons – 2001.
3. Richard stone, Introduction to internal combustion engines, MacMillan (1992) – USA.
4. M. L. Mathur And R.P. Sharma A course in internal combustion engines, Dhanpat Rai& sons- India.
5. C. F. Taylor The internal combustion engines in theory and practice, 2 vols. by:, pub.:Wily.
6. C. F. Taylor The internal combustion engines in theory and practice, 2 vols. by:, pub.:Wily.
7. Ganesan, V., Fundamentals of IC Engines, Tata McGraw Hill, 2003.
8. Bosch, Automotive hand book, 9th edition.

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

Website and Internet Contents References

6. http://www.nptel.ac.in
7. http://auto.howstuffworks.com/

9.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	Energy Conversion and Management	https://www.journals.elsevier.com/energy-conversion-and-management
2	fuel	https://www.journals.elsevier.com/fuel

3	Auto-India Magazines	https://www.magzter.com/IN/Business-India-Publications-Ltd/Auto-India/Automotive/

10.0 Examination Note

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

11.0 Course Delivery Plan

Expt. No	Lecture / Practical No.	Name of the Experiment	% of Portion
-	13	Discussion on Lab layout, calibration of instruments and standards	100
1,2,3	14	Determination of Flash point and Fire point of lubricating oil using Abel Pensky and Marten's (closed) / Cleveland's (Open Cup) Apparatus.	
4,5,6	15	Determination of Viscosity of lubricating oil using Redwoods, Saybolt and Torsion Viscometers.	
7,8	16	Determination of Calorific value of solid, liquid and gaseous fuels.	
09	17	Analysis of moisture, volatile matter, ash content and fixed carbon of solid and liquid fuel samples	
10	18	i)Valve Timing ii) port opening diagrams of an I.C. Engine	
11	19	Single cylinder two stroke petrol engine with eddy current dynamometer	
12	20	Single cylinder four stroke petrol engine with D.C generator	
13	21	Single cylinder four stroke diesel engine with Rope brake dynamometer	
14	22	Multi cylinder diesel engine with hydraulic dynamometer	
15	23	Measurement of Exhaust Emissions of Diesel engine and petrol engine	
16	24	Demonstration of pθ , pV plots using Computerized IC engine test rig.	

12.0 QUESTION BANK

1. What is rotometer ?
2. Define engine.
3. What is the difference between Pensky and Clveland apparatus?
4. Define viscosity of oil.
5. What are the properties of oil?
6. Difference between flash point and fire point.
7. What is the relation between viscosity of oil and temperature?
8. What is the purpose to determine the flash point and fire point of given oil?
9. What do mean by dynamometer and explain its types.
10. Difference between hydraulic and rope brake dynamometer.
11. What do you mean by cubic capacity?
12. What is the use of air box?
25. Explain the Motoring and Morse test.
26. Explain Willan's line method.
27. What is the relation between BP and Specific .Fuel Consumption?
28. What do mean by calorimeter and mention its different types.
29. Explain the different types of oils used in the IC engines.
30. Explain the different types of Dynamometers.
31. Define i) volumetric efficiency ii) mech. efficiency iii) break thermal efficiency iv) indicated thermal efficiency v) compression ratio vi) sfc vii) break thermal sfc viii) Indicated thermal sfc.
32. Explain the heat balance sheet.
33. What is the difference between generator and motor?

13. What are the performance parameters of IC engine?
14. Explain the difference between SI engine and CI engine.
15. Explain the difference between two strokes and four strokes.
16. Explain the valve timing diagram of different engines.
17. What is use of inlet valve opening before BDC?
18. What do you mean by knocking and detonation in IC engine and explain its effect on the performance.
19. Explain the difference between Bomb calorimeter and gas calorimeter.
20. Define Calorific value of fuel and explain the difference between HCV and LCV.
21. Why calorific value is more for diesel compare to petrol?
22. Explain the application of petrol and diesel engine.
23. Discuss the computerized test rig parts
24. Discuss on the calibration of following instruments
    i. Thermometer ii. Orifice iii. Thermocouple
34. Explain the difference between Otto, Diesel and Dual cycles with PV diagrams.
35. What do mean blow down process.
36. What is IC engine and explain its classification.
37. Explain the parts of the IC engine.
38. What is an internal combustion engine? Classify I.C. Engines With reference to an IC Engine define the following terms with a neat sketch) Bore b) Stroke c) Top or Inner dead center d) Bottom or Outer dead center e) Clearance volume f) Swept volume g) Compression ratio.
39. With a neat sketch of an IC Engine list its major components and state their function.
40. What is the importance of emission measurements in IC engines
41. Discuss environmental emission norms
42. What are the factors affect for emissions of IC engines
43. Discuss the layout of Energy Lab
44. How do you measure ash content, evaporative matter and fixed carbon in a given sample?

13.0 University Result

Examination	S+	S	A	B	C	D	E	% Passing
December/January 2019	12	57	42	13	02	00	00	100
December 2017	23	62	25	07	01	00	00	100

Prepared by	Checked by		
Prof. M.R. Ingalagi	Prof. M. M.Shivashimpi	HOD	Principal