Department of Mechanical Engineering

COURSE PLAN 2021-22

V Semester

INSTITUTE VISION

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

INSTITUTE MISSION

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

DEPARTMENT OF MECHANICAL ENGINEERING

VISION

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

MISSION

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

Program Educational Objectives (PEOs)

The Graduates will be able to

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

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

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

Program Specific Outcomes (PSOs)

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

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

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

Program Outcomes (POs)

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

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

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

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

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

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

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

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

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

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

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

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

CONTENTS

Departmental Resources

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

Faculty Position

Sl. No.	Category	No. in position	Average experience
1	Teaching faculty	09	18
2	Technical staff	05	16
3	Helper / Peons	03	12

Major Laboratories

S.N.	Name of the laboratory	Area in Sq. Meters	Amount Invested (Rs.)
1	Basic Workshop Laboratory	170	428093
2	Fluid Mechanics Machinery Laboratory	172	775916.75
3	Energy Conversion Engg. Laboratory	173	1275603.2
4	Machine shop Laboratory	170	1372566.5
5	Foundry & Forging Laboratory	179	321057.11
6	Design Laboratory	73	365861.0
7	Heat & Mass Transfer Laboratory	148	524576.0
8	Metallography & Material Testing Laboratory	149	1102945.2
9	Mechanical Measurements & Metrology Laboratory	95	557593.75
10	CIM & Automation/CAMA Laboratory	66	3720793.1
11	Computer Aided Machine Drawing Laboratory	66	2014136.5
12	Computer Aided Engg Drawing Laboratory	66	1438121.3
13	Department/Other	--	2028039.2
	Total	**1527**	638297
			16563599.61

Teaching Faculty Details

S.N.	Faculty Name	Designation	Qualification	Area of specialization	Teaching Exp (in years)	Contact Nos.
1	Dr. S. C. Kamate	Principal	Ph. D	Thermal(Cogeneration)	31	9480849331
2	Dr. S. N. Topannavar	Assoc. Prof.	Ph. D	Thermal Power Engg.	23	9482440235
3	Prof. K. M. Akkoli	Assoc. Prof.	Ph. D	Thermal Power Engg.	18	9739114856
4	Prof. D. N. Inamdar	Asst. Prof	M Tech.(Ph. D)	Tool Engg	19	9591208980
5	Prof.M.S.Futane	Asst. Prof	M Tech.	Computer Integrated Manufacturing	16	9164105035
6	Prof.S. A. Goudadi	Asst. Prof	M Tech.	Design Engineering	14	9448876682
7	Prof.M.M.Shivashimpi	Asst. Prof	M Tech.(Ph.D)	Thermal Power Engg.	15	9742197173
8	Prof.M.A.Hipparagi	Asst. Prof	M Tech.(Ph.D)	Production Technology	13	7411507405
9	Prof.M. I. Tanodi	Asst. Prof	M Tech. (Ph.D)	Machine design	10	9611998812
10	Prof. B. M. Dodamani	Asst. Prof	M Tech.	Energy System Engg	08	9535447575

Date	Events
01-10-2021	Commencement of V/VII Semester Classes
02-10-2021	Gandhi Jayanthi & Swachh Bharat Abhiyan
18-10-2021	Commencement of III Semester Classes
01-11-2021	Kannad Rajyotsava
20-11-2021	Awareness Program on NEP
25-11-2021 to 27-11-2021	First Internal Assessment for III/V/VII Semester
29-11-2021	Feedback-I on Teaching-Learning
01-12-2021	Display of 1st Internal Assessment Marks and submission of Feedback-I to office
02-12-2021 to 04-12-2021	EDP Activities/ Green Club Activities
11-12-2021	Awareness Program on NEP
27-12-2021 to -12-2021	Second Internal Assessment for III/V/VII Semester
30-12-2021	Feedback-II on Teaching-Learning
03-01-2022	Display of 2nd Internal Assessment Marks and submission of Feedback-II to office
10-01-2022	Sports Day
11-01-2022	HSIT-Quest 2022
12-01-2022	HSIT-Fest 2022
13-01-2022	Blood Donation Camp
24-01-2022 to 25-01-2022	Lab Internal Assessment for V/VII Semester
27-01-2022 to 29-01-2022	Third Internal Assessment for V/VII Semester
31-01-2022	Display of Final Marks of V/VII Semester
31-01-2022	Last working day of V/VII Semester
10-02-2022 to 12-02-2022	Third Internal Assessment for III Semester
14-02-2022 to -02-2022	Lab Internal Assessment for III Semester
17-02-2022	Display of Final Marks of III Semester
19-02-2022	Last working day of III Semester
01-02-2022 to 10-02-2022	Practical Examinations for V/VII Semester
11-02-2022 to 25-03-2022	Theory Examinations for V/ VII Semester
21-02-2022 to 04-03-2022	Practical Examinations for III Semester
07-03-2022 to 25-03-2022	Theory Examinations for III Semester

October-2021

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

2-Gandhi Jayanthi, 6-Mahalaya Amavasya
14-Mahanavami, Ayudhapooja
15-Vijayadashami
20-Valmiki Jayanthi, Eid-Milad

November-2021

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

1-Kannada Rajyotsava, 3-Naraka Chaturdashi
5-Balipadyami Deepavalli
22-kanakadasa Jayanti

December-2021

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

25-Christmas

January-2022

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

14-Makar Sankranti, 26-Republic Day

February-2022

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					

01/10/2021
Dr. B. V. Madiggond
IQAC Coordinator

01/10/21
Dr. S. C. Kamate
Principal

VTU Scheme of Teaching and Examination

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination 2018 – 19
Outcome Based Education(OBE) and Choice Based Credit System
(CBCS) (Effective from the academic year 2018 –19)

V SEMESTER

Sl. No	Course and Course code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	PCC	18ME51	Management and Economics		2	2	--	03	40	60	100	3
2	PCC	18ME52	Design of Machine Elements I		3	2	--	03	40	60	100	4
3	PCC	18ME53	Dynamics of Machines		3	2	--	03	40	60	100	4
4	PCC	18ME54	Turbo Machines		3	--	--	03	40	60	100	3
5	PCC	18ME55	Fluid Power Engineering		3	--	--	03	40	60	100	3
6	PCC	18ME56	Operations Management		3	--	--	03	40	60	100	3
7	PCC	18MEL57	Fluid Mechanics/Machines lab		--	2	2	03	40	60	100	2
8	PCC	18MEL58	Energy Conversion Lab		--	2	2	03	40	60	100	2
9	HSMC	18CIV59	Environmental Studies	Civil/ Environmental [Paper setting: Civil Engineering Board]	1	--	--	02	40	60	100	1
				TOTAL	**18**	**10**	**4**	**26**	**360**	**540**	**900**	**25**

Subject Title	**ENGINEERING MANAGEMENT & ECONOMICS**		
Subject Code	18ME51	**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. M. S. Futane	**Designation:** Asst. Professor	**Experience:** 17Years
No. of times course taught: 01Times	**Specialization:** CIM	

1.0 Prerequisite Subjects:

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

2.0 Course Objectives

1. Explain fundamentals management functions of a manager. Also explain planning and decision making processes.
2. Explain the organizational structure, staffing and leadership process.
3. Describe the understanding of motivation and different control systems in management.
4. Apply the appropriate engineering economics analysis method(s) for problem solving: present worth, annual cost, rate-of-return, payback, break-even, benefit-cost ratio.
5. Evaluate the cost effectiveness of individual engineering projects using the methods learned and draw inferences for the investment decisions.
6. Compare the differences in economic analysis between the private and public sectors. Recognize the limits of mathematical models for factors hard to quantify.

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	A	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.	U	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.

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)

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

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

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.

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	Managing the Automobile, Manufacturing and allied industries.
02	Management concept is using in running and maintaining educational and government organizations.

7.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
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 David A.
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: 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

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
I	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 explain the term and write down its properties. 8. Management as a profession explains and explain its characteristics. **9.** Distinguish between administration and management. 10. Define the term planning and explain its different characteristics. 11. Explain the importance and purpose of planning process. 12. What are the different steps in planning processes explain each step in detail.	20

	13. What are the objectives of planning process? 14. How organizational plans can be broadly classified. 15. What is decision making and write down the characteristics of it. 16. Write notes on a) strategic planning b) tactical planning c) operational planning. **17.** Draw a block diagram showing hierarchy of plans.	
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. Write down the different application of functional organization. 7. List the applications line and staff organization. 8. Write a note on matrix or grid organization. 9. Write down the advantages and disadvantages of departmentation. 10. What are the different types of committees 11. Write a note on centralization and decentralization. **12.** Briefly explain the difference between authority and responsibility. 13. Explain the meaning of directing. What are the different features of directing? 14. What is leader ship and what are the different leader ship styles. 15. What is motivation? Write down its characteristics. 16. Write a note on Maslow's hierarchy of needs theory with a block diagram. 17. Write a note on the two-factor theory. 18. Compare the Maslow's theory and Herzberg theory. 19. Distinguish between theory X and theory Y. 20. 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. Differentiate between tactics and strategy. 5. Explain in brief engineering economic decision maze with help of a neat sketch. 6. 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 should the Rs.1400 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. What are the various conditions for present worth comparisons? 10. Differentiate between present worth equivalence and net present worth with an example. 11. Compare assets with unequal lives and assets with equal lives with an example. 12. With an example differentiate with future worth and payback comparison methods. 13. An investor can make three end-of-year payments of Rs.15000, which are expected to generate receipts of Rs.10000 at the end of year 4 that will increase annually by Rs.2500 for the following 4 years. If the investor can earn a rate of return of 10% on other 8 year investments, is this alternative attractive. 14. 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	20

table. The required interest rate is 8%.

	0	1	2	3
Device A	9000	4500	4500	4500
Device B	14500	6000	6000	8000

15. 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).
16. Explain in brief various equivalent annual worth comparison methods. What are the situations encountered in these methods.
17. What are the considerations of asset life?
18. Compare assets with unequal and equal life with an example.
19. Differentiate between sinking fund method and annuity contract for guaranteed income method.
20. The purchase of a truck with an operator's platform on a telescoping hydraulic boom will reduce labor costs for sign installations by Rs.15000 per year. The price of the boom truck is Rs.93000, and its operating costs will exceed those of present equipment by Rs.250 per month. The resale value is expected to be Rs.18000 in 8 years. Should the boom truck be purchased when the current available interest rate is 7%.
21. Two models of small machines perform the same function. Type 1 machine has a low initial cost of Rs.9500, relatively high operating costs of Rs.1900 per year more than those of the type 2 machines, and a short life of 4 years. The more expensive type 2 machine costs Rs.25100 and can be kept in service economically for 8 years. The scrap value from either machine at the end of its life will barely cover its removal cost. Which is preferred when the minimum attractive rate of return is 8%?
22. What is rate of return? Classify them.
23. Differentiate between minimum acceptable rate of return and internal rate of return.
24. What are the various misconceptions of IRR?
25. Explain in brief various capital concepts.
26. A parcel of land adjacent to a proposed freeway exit is deemed likely to increase in value. It can be purchased now for Rs.80000 and is expected to be worth Rs.150000 within 5 years. During that period it can be rented for pasture at Rs.1500 per year. Annual taxes are presently Rs.850 and will likely remain constant. What rate of return will be earned on the investment if the estimates are accurate?

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. Classify the various components of cost.
6. 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
7. Explain the significance of selling price.

20

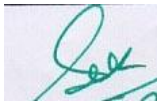
15.0 QUESTION BANK

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. Management as a profession explains and explain its characteristics. **9.** Distinguish between administration and management. 10. Define the term planning and explain its different characteristics. 11. What are the different steps in planning processes explain each step in detail. 12. 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. Write a note on matrix or grid organization. 8. Explain the meaning of directing. What are the different features of directing? 9. What is leader ship and what are the different leader ship styles. 10. What is motivation? Write down its characteristics. 11. Write a note on Maslow's hierarchy of needs theory with a block diagram. 12. Write a note on the two-factor theory. 13. Compare the Maslow's theory and Herzberg theory. 14. Distinguish between theory X and theory Y. 15. 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. Differentiate between tactics and strategy. 5. Explain in brief engineering economic decision maze with help of a neat sketch. 6. 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 should the Rs.1400 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. What are the various conditions for present worth comparisons? 10. Differentiate between present worth equivalence and net present worth with an example.	20

	11. 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 | 12. 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). 13. Explain in brief various equivalent annual worth comparison methods. What are the situations encountered in these methods. 14. What are the considerations of asset life? 15. Compare assets with unequal and equal life with an example. 16. What is rate of return? Classify them. 17. Differentiate between minimum acceptable rate of return and internal rate of return. 18. What are the various misconceptions of IRR? 19. Explain in brief various capital concepts. 20. A parcel of land adjacent to a proposed freeway exit is deemed likely to increase in value. It can be purchased now for Rs.80000 and is expected to be worth Rs.150000 within 5 years. During that period it can be rented for pasture at Rs.1500 per year. Annual taxes are presently Rs.850 and will likely remain constant. What rate of return will be earned on the investment if the estimates are accurate?	
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. Classify the various components of cost. 6. 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 7. Explain the significance of selling price.	20

16.0 University Result

Examination	S+	S	A	B	C	D	E	% Passing
July 2020	00	03	08	16	18	16	4	100
July 2019	01	01	07	14	21	11	3	100

Prepared by	Checked by		
			
Prof. M. S. Futane		**HOD**	**Principal**

Subject Title	**DESIGN OF MACHINE ELEMENTS I**		
Subject Code	18ME52	**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. Mahantesh Tanodi	**Designation:** Asst. Professor	**Experience:** 08Years
No. of times course taught: 05Times	**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

Introduction: Design Process: Definition of design, phases of design, and review of engineering materials and their properties and manufacturing processes; use of codes and standards, selection of preferred sizes. Review of axial, bending, shear and torsion loading on machine components, combined loading, two- and three dimensional stresses, principal stresses, stress tensors, Mohr's circles.

Design for static strength: Factor of safety and service factor. Failure mode: definition and types. , Failure of brittle and ductile materials; even and uneven materials; Theories of failure: maximum normal stress theory, maximum shear stress

theory, distortion energy theory, strain energy theory, Columba –Mohr theory and modified Mohr's theory. Stress concentration, stress concentration factor and methods of reducing stress concentration **(10 Hours)**

MODULE -2

Impact Strength: Introduction, Impact stresses due to axial, bending and torsion loads.

Fatigue loading: Introduction to fatigue failure, Mechanism of fatigue failure, types of fatigue loading, S-N Diagram, Low cycle fatigue, High cycle fatigue, Endurance limit. Modifying factors: size effect, surface effect, Stress concentration effects Notch sensitivity, Soder berg and Goodman relationships, stresses due to combined loading, cumulative fatigue damage, and Miner's equation **(10Hours)**

MODULE -3

Design of shafts: Torsion of shafts, solid and hollow shaft design with steady loading based on strength and rigidity, ASME and BIS codes for power transmission shafting, design of shafts subjected to combined bending, torsion and axial loading. Design of shafts subjected to fluctuating loads

Design of keys and couplings : Keys: Types of keys and their applications, design considerations in parallel and tapered sunk keys, Design of square and rectangular sunk keys. Couplings: Rigid and flexible coupling-types and applications, design of Flange coupling, and Bush and Pin type coupling. **(10 Hours)**

MODULE -4

Design of Permanent Joints: Types of permanent joints-Riveted and Welded Joints.

Riveted joints: Types of rivets, rivet materials, Caulking and fullering, analysis of riveted joints, joint efficiency, failures of riveted joints, boiler joints, riveted brackets.

Welded joints: Types, strength of butt and fillet welds, eccentrically loaded welded joints **(10 Hours)**

MODULE -5

Design of Temporary Joints: Types of temporary joints- cotter joints, knuckle joint and fasteners. Design of Cotter and Knuckle Joint.

Threaded Fasteners: Stresses in threaded fasteners, effect of initial tension, design of threaded fasteners under static, dynamic and impact loads, design of eccentrically loaded bolted joints.

Power screws: Mechanics of power screw, stresses in power screws, efficiency and self-locking, design of power screws.

(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
2. 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	https://www.jstage.jst.go.jp/browse/jamdsm

10.0 Examination Note

CIE : 40 Marks
Assignment marks = 10
Internal Assessment Marks = 30

Semester End Examination: 60 Marks
Question paper pattern:
- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

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:	Design shafts, joints,	Module 3	6	Individual Activity..	Text Book 1&2

	Questions on Design of Shafts, Joints, Couplings and Keys	couplings.				
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
1	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 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 stress at yield = 150 MPa	20

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
2020-21	-	2	4	5	9	9	16	8	88

Prepared by	Checked by		
-Sd-	-Sd-		
Prof. Mahantesh Tanodi	**Prof. D. N. Inamdar**	**HOD**	**Principal**

Subject Title	**DYNAMICS OF MACHINERY**		
Subject Code	18ME53	**IA Marks**	40
No of Lecture Hrs / Week	05	**Exam Marks**	100
Total No of Lecture Hrs	50	**Exam Hours**	03
			Credits – 04

FACULTY DETAILS:		
Name: Mr. S.A Goudadi	**Designation:** Asst. Professor	**Experience: 14** 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	Analyze the mechanisms for static and dynamic equilibrium.	A	1,2,3,4,6,8,11,12
CO2	Carry out the balancing of rotating and reciprocating masses	A	1,2,3,4,6,8,11,12
CO3	Analyze different types of governors used in real life situation.	A	1,2,3,4,6,8,11,12
CO4	Analyze the gyroscopic effects on disks, airplanes, stability of ships, two and four wheelers	A	1,2,3,4,6,8,11,12
C05	Understand the free and forced vibration phenomenon.	U	1,2,3,4,6,8,11,12
C06	Determine the natural frequency, force and motion transmitted in vibrating 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, analysis of four bar mechanism, slider crank mechanism, shaper mechanism.

Dynamic force analysis: D"Alembert"s principle, analysis of four bar and slider crank mechanism, shaper mechanism. **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), V-type engine, Radial engine – direct and reverse crank method. **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, ship, aeroplane, Stability of two wheelers and four wheelers. **10 Hours**

MODULE - 4

Free vibrations: Basic elements of vibrating system, Types of free vibrations, Longitudinal vibrations-Equilibrium method, D"Alembert"s principle, Energy method, Rayleigh"s method. Determination of natural frequency of single degree freedom systems, Effect of spring mass, Damped free vibrations: Under damped, over damped and critically damped systems. Logarithmic decrement. **10 Hours**

MODULE – 5

Forced vibrations: Undamped forced vibration of spring mass system, Damped forced vibrations, Rotating unbalance, Reciprocating unbalance, Vibration isolation, Support motion(absolute and relative motion), Transverse vibration of shaft with single concentrated load, several loads, uniformly distributed load, Critical speed. **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

No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Theory of Machines: Kinematics and Dynamics	Sadhu Singh	Pearson	Third edition 2019.
2	Mechanism and Machine Theory	G. Ambekar	PHI	2009
Reference Books				
1	Theory of Machines	Rattan S.S.	Tata McGraw-Hill Publishing Company	2014
2	Mechanisms and Machines-Kinematics, Dynamics and Synthesis	Michael M Stanisic	Cengage Learning	2016
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	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	
	4	Static Force Analysis of Four Bar Mechanism	

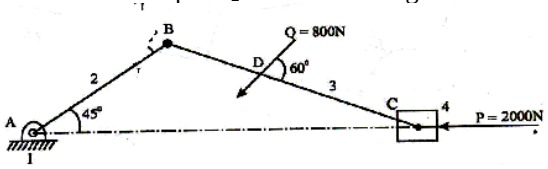
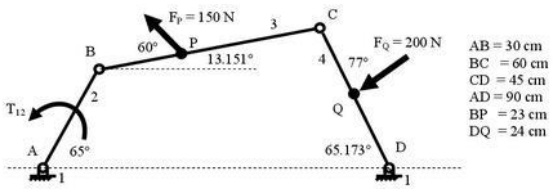
	5	Slider-Crank Mechanism	
	6	Shaper Mechanism	
	7	D'Alembert's Principle,	
	8	Dynamic Force Analysis of Four-Bar Mechanism	
	9	Dynamic Force Analysis of Slider Crank Mechanism	
	10	Shaper Mechanism	
2		**Balancing of Rotating Masses, Balancing of Reciprocating Masses:**	**20**
	1	Static and Dynamic Balancing	
	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	**Balancing of Reciprocating Masses:** Inertia Effect of Crank and Connecting rod,	
	7	Balancing of Single Cylinder Engine,	
	8	Balancing in Multi Cylinder inline engine (Primary & Secondary forces),	
	9	V-type engine,	
	10	Radial engine – direct and reverse crank method.	
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	**Gyroscope:** 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		**Free vibrations:**	**20**
	1	Basic elements of vibrating system, Types of free vibrations,	
	2	Longitudinal vibrations-Equilibrium method,	
	3	D"Alembert"s principle, Energy method,	
	4	Rayleigh"s method.	
	5	Determination of natural frequency of single degree freedom systems,	
	6	Effect of spring mass,	
	7	Damped free vibrations	
	8	Under damped, over damped and	
	9	critically damped systems.	
	10	Logarithmic decrement	
5		**Forced vibrations:**	**20**
	1	Undamped forced vibration of spring mass system,	
	2	Damped forced vibrations,	
	3	Rotating unbalance,	
	4	Reciprocating unbalance,	
	5	Vibration isolation,	
	6	Support motion(absolute and relative motion),	

	7	Transverse vibration of shaft with single concentrated load,	
	8	several loads,	
	9	uniformly distributed load,	
	10	Critical speed.	

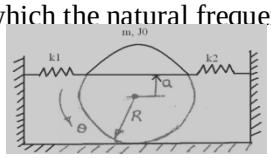
12.0 Assignments, Pop Quiz, Mini Project, Seminars

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 and shaper 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 and Damped free Vibrations (Single Degree of Freedom)	Understand types of vibration, methods of finding natural frequencies of simple Mechanical systems. Determine equation of motion, natural frequency, damping factor, logarithmic decrement ,	Module 4	8	Individual Activity.	Text Book 1,2,3 & 4
5	Assignment 5: Forced Vibrations (Single Degree of Freedom)	Undamped and Damped Forced Vibrations 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
II	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.	20

	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.	
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	20

	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.	
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). 7. 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.	20
5	1. 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. 2. 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	PC	% Passing
2020-21	07	22	09	**73**

Prepared by		
-Sd- Prof. S A Goudadi	HOD	Principal

Subject Title	**TURBOMAHINES**		
Subject Code	18ME54	**IA Marks**	40
Number of Lecture Hrs / Week	04	**Exam Marks**	100
Total Number of Lecture Hrs	50	**Exam Hours**	03
CREDITS – 03			

FACULTY DETAILS:		
Name: Prof. M. M. Shivashimpi	**Designation:** Asst. Professor	**Experience:**13
No. of times course taught: 08	**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
C304.1	Model studies and thermodynamics analysis of turbo machines.	L2	1,2, 12
C304.2	Analyze the energy transfer in Turbo machine with degree of reaction and utilization factor.	L3	1,2, 3,12
C304.3	Classify, analyze and understand various type of steam turbine.	L3	1,2,3, 12
C304.4	Classify, analyze and understand various type of hydraulic turbine.	L3	1,2,3, 12
C304.5	Understand the concept of radial power absorbing machine and the problems involved during its operation.	L3	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, Unit and specific quantities, model studies and its numerical. (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 weight age.)

Thermodynamics of fluid flow: Application of first and second law of thermodynamics to turbo machines, Efficiencies of

turbo machines, Static and Stagnation states, overall isentropic efficiency, stage efficiency (their comparison) and polytropic efficiency for both compression and expansion processes. Reheat factor for expansion process. Simple Numerical on stage efficiency and polytropic efficiency.**10 Hours**

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, , General analysis of axial flow pumps and compressors, degree of reaction, velocity triangles, Numerical 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, Numerical Problems.

Reaction turbine – Parsons's turbine, condition for maximum utilization factor, reaction staging. Numerical Problems **10 Hours**

Module –IV

Hydraulic Turbines: Classification, various efficiencies. **Pelton Wheel** – Principle of working, velocity triangles, design parameters, maximum efficiency, and numerical problems.

Francis turbine – Principle of working, velocity triangles, design parameters, and numerical problems

Kaplan and Propeller turbines - Principle of working, velocity triangles, design parameters and Numerical Problems. Theory and types of Draft tubes.**10 Hours**

Module –V

Centrifugal Pumps: Classification and parts of centrifugal pump, different heads and efficiencies of centrifugal pump, Theoretical head – capacity relationship, 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. **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. Turbomachines, B. U Pai , Wiley First Edition. 3. Turbo Machines, M. S. Govindegowdaand A. M. Nagaraj, M. M. Publications, 7Th Ed, 2012 4. Fundamentals of TurboMachinery, B.K Venkanna, PHI Publishers.
Reference Books
1. Turbines, Compressors & Fans, S. M. Yahya, Tata McGraw Hill Co. Ltd., 2nd edition, 2002 2. Principals of Turbo machines, D. G. Shepherd, The Macmillan Company (1964). 3. Fluid Mechanics & Thermodynamics of Turbo machines, S. L. Dixon, Elsevier (2005).
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

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

12.0 Course Delivery Plan

Module	Lecture No.	Content of Lecturer	% of Portion
I	1	**Introduction:** Definition of turbo machine, parts of turbo machines, Comparison with positive displacement machines,	20
	2	Classification, Dimensionless parameters and their significance,	
	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, 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	
	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 – Principle of working, velocity triangles, design parameters, Maximum efficiency.	
	33	Solving related Numericals	
	34	Solving related Numericals	
	35	**Francis turbine** - Principle of working, velocity triangles, design parameters.	
	36	Solving related Numericals	
	37	Solving related Numericals	
	38	**Kaplan and Propeller turbines** – Principle of working, velocity triangles, design parameters.	
	39	Solving related Numericals	
	40	Draft tubes- Types and functions	
V	41	**Centrifugal Pumps**: Classification and parts of centrifugal pump	100
	42	Different heads and efficiencies of centrifugal pump	
	43	Theoretical head – capacity relationship, Minimum speed for starting the flow	

	44	Maximum suction lift, Net positive suction head, Cavitation, Need for priming, Pumps in series and parallel	
	45	Solving related Numericals	
	46	Solving related Numericals	
	47	Solving related Numericals	
	48	**Centrifugal Compressors:** Stage velocity triangles, slip factor, power input factor, Stage work, Pressure developed, stage efficiency and surging	
	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 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:

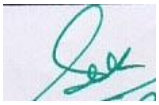
1. A centrifugal pump is running at 100 rpm. The outlet vane angle of the impeller is 30 ^{o} and velocity of flow rate at outlet is 3 m/s. The pump is working against a total head of 30 m and the discharge through the pump is 0.3 m^3 /s. If the man metric efficiency is 75 % determine a) Diameter of 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%.

15.0 University Result

Year	S+,S,A (FCD)	B (FC)	C,D,E (SC)	%age of passing
January /February 2021	03	27	03	63

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

Subject Title	Fluid Power Engineering		
Subject Code	18ME55	IA Marks	40
No of Lecture Hrs + Practical Hrs / Week	03	Exam Marks	60
Total No of Lecture + Practical Hrs	40	Exam Hours	03
CREDITS – 03			

FACULTY DETAILS:		
Name: Prof. B.M.Dodamani	**Designation:** Asst. Professor	**Experience: 08** Years
No. of times course taught: 02	**Specialization:** Energy systems Engineering	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
1	Mechanical Engineering	I/II/III/IV	Engineering Mathematics
2	Mechanical Engineering	III	Basic thermodynamics
3	Mechanical Engineering	IV	Applied thermodynamics
4	Mechanical Engineering	IV	Fluid mechanics

2.0 Course Objectives

- To provide an insight into the capabilities of hydraulic and pneumatic fluid power.
- To understand concepts and relationships surrounding force, pressure, energy and Power in fluid power systems.
- To examine concepts centering on sources of hydraulic power, rotary and linear Actuators, distribution systems, hydraulic flow in pipes, and control components in Fluid power engineering.
- Exposure to build and interpret hydraulic and pneumatic circuits related to Industrial applications.
- To familiarize with logic controls and trouble shooting

3.0 Course Outcomes

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

CO	Course Outcome	Cognitive Level	POs
CO1	Identify and analyze the functional requirements of a fluid power transmission system for a given application.	L2	1,12
CO2	Visualize how a hydraulic/pneumatic circuit will work to accomplish the function.	L2	1,2,3,12
CO3	Design an appropriate hydraulic or pneumatic circuit or combination circuit like electro-hydraulics, electro-pneumatics for a given application.	L3	1,2,3,12
CO4	Select and size the different components of the circuit.	L3	1,2,3,12
CO5	Develop a comprehensive circuit diagram by integrating the components selected for the given application.	L2	1,2,3,12
Total Hours of instruction		**40**	

4.0 Course Content

Module-1

Introduction to fluid power systems

Fluid power system: components, advantages and applications. Transmission of power at static and dynamic states. Pascal's law and its applications.

Fluids for hydraulic system: types, properties, and selection. Additives, effect of temperature and pressure on hydraulic fluid. Seals, sealing materials, compatibility of seal with fluids. Types of pipes, hoses, and quick acting couplings. Pressure drop in hoses/pipes. Fluid conditioning through filters, strainers; sources of contamination and contamination control; heat exchangers.

Module-2

Pumps and actuators

Pumps: Classification of pumps, Pumping theory of positive displacement pumps, construction and working of Gear pumps, Vane pumps, Piston pumps, fixed and variable displacement pumps, Pump performance characteristics, pump selection factors, problems on pumps.

Accumulators: Types, and applications of accumulators. Types of Intensifiers, Pressure switches /sensor, Temperature switches/sensor, Level sensor.

Actuators: Classification cylinder and hydraulic motors, Hydraulic cylinders, single and double acting cylinder, mounting arrangements, cushioning, special types of cylinders, problems on cylinders.

Construction and working of rotary actuators such as gear, vane, piston motors, and Hydraulic Motor. Theoretical torque, power, flow rate, and hydraulic motor performance; numerical problems. Symbolic representation of hydraulic actuators (cylinders and motors).

Module-3

Components and hydraulic circuit design Components:

Classification of control valves, Directional Control Valves-symbolic representation, constructional features of poppet, sliding spool, rotary type valves solenoid and pilot operated DCV, shuttle valve, and check valves.

Pressure control valves - types, direct operated types and pilot operated types.

Flow Control Valves -compensated and non-compensated FCV, needle valve, temperature compensated, pressure compensated, pressure and temperature compensated FCV, symbolic representation.

Hydraulic Circuit Design: Control of single and Double -acting hydraulic cylinder, regenerative circuit, pump unloading circuit, counter balance valve application, hydraulic cylinder sequencing circuits, hydraulic circuit for force multiplication; speed control of hydraulic cylinder- metering in, metering out and bleed off circuits. Pilot pressure operated circuits.

Module-4

Pneumatic power systems

Introduction to Pneumatic systems: Pneumatic power system, advantages, limitations, applications, Choice of working medium. Characteristics of compressed air and air compressors. Structure of pneumatic control System, fluid conditioners-dryers and FRL unit.

Pneumatic Actuators: Linear cylinder – types of cylinders, working, end position cushioning, seals, mounting arrangements, and applications. Rotary cylinders- types, construction and application, symbols.

Pneumatic Control Valves: DCV such as poppet, spool, suspended seat type slide valve, pressure control valves, flow control valves, types and construction, use of memory valve, Quick exhaust valve, time delay valve, shuttle valve, twin pressure valve, symbols

Module-5

Pneumatic control circuits

Simple Pneumatic Control: Direct and indirect actuation pneumatic cylinders, speed control of cylinders - supply air throttling and exhaust air throttling.

Signal Processing Elements: Use of Logic gates - OR and AND gates in pneumatic applications. Practical examples involving the use of logic gates.

Multi- Cylinder Application: Coordinated and sequential motion control, motion and control diagrams. Signal elimination methods, Cascading method- principle, Practical application examples (up to two cylinders) using
cascading method (using reversing valves).

Electro- Pneumatic Control: Principles - signal input and output, pilot assisted solenoid control of directional

control valves, use of relay and contactors. Control circuitry for simple signal cylinder application.

5.0 Relevance to future subjects/Area

SL. No	Semester	Subject	Topics / Relevance
01	VII	Hydraulics and Pneumatics	Industry

6.0 Relevance to Real World

SL. No	Real World Mapping
01	Earth Moving Equipments
02	Civil Aviation/ Transport vehicles
03	Industry automation lines

7.0 Books Used and Recommended to Students

Text Books

1. Fluid Power with applications, Anthony Esposito, Fifth edition pearson education, Inc. 2000.
2. Pneumatics and Hydraulics, Andrew Parr. Jaico Publishing Co. 2000.

Reference Books

1. Oil Hydraulic Systems - Principles and Maintenance, S.R. Majumdar, Tata Mc Graw Hill publishing company Ltd. 2001.
2. Pneumatic Systems, S.R. Majumdar, Tata Mc Graw Hill publishing Co., 1995.
3. Industrial Hydraulics, Pippenger, Hicks, McGraw Hill, New York.

Additional Study material & e-Books

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

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

Website and Internet Contents References

. http://www.nptel.ac.in
) https://en.wikipedia.org/wiki/fluid flow

9.0 Magazines/Journals Used and Recommended to Students

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

Examination Note

10.0

Internal Assessment: 40Marks

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 models two questions from each module
- Student has to answer any five full questions, choosing one full question from each module
- Max. Marks: 60 Marks

11.0 Course Delivery Plan

Module No.	Lecture No.	Content of Lecture	% of Portion
1		**Introduction to fluid power systems**	20
	1	Fluid power system: components, advantages and applications. Transmission of power at static and dynamic states. Pascal"s law and its applications	
	2	Fluids for hydraulic system: types, properties, and selection. Additives	
	3	Effect of temperature and pressure on hydraulic fluid. Seals,	
	4	Sealing materials, compatibility of seal with fluids. Types of pipes, hoses	
	5	Quick acting couplings. Pressure drop in hoses/pipes	
	6	Fluid conditioning through filters, strainers	
	7	Sources of contamination and contamination control;	
	8	Heat exchangers	
2		**Pumps and actuators**	40
	9	Pumps: Classification of pumps, Pumping theory of positive displacement pumps, construction and working of Gear pumps	
	10	Vane pumps, Piston pumps, fixed and variable displacement pumps, Pump performance characteristics,	
	11	Pump selection factors, problems on pumps.	
	12	Accumulators: Types, and applications of accumulators. Types of Intensifiers, Pressure switches /sensor, Temperature switches/sensor, Level sensor	
	13	Actuators: Classification cylinder and hydraulic motors, Hydraulic cylinders, single and double acting cylinder, mounting arrangements, cushioning, special types of cylinders, problems on cylinders	
	14	Construction and working of rotary actuators such as gear, vane, piston motors, and Hydraulic Motor. Theoretical torque, power	
	15	flow rate, and hydraulic motor performance; numerical problems	
	16	Symbolic representation of hydraulic actuators (cylinders and motors).	
3		**Components and hydraulic circuit design Components**	60
	15	Classification of control valves, Directional Control Valves-symbolic representation,	
	16	Constructional features of poppet, sliding spool	
	17	Rotary type valves solenoid and pilot operated DCV, shuttle valve, and check valves	
	18	**Pressure control valves** - types, direct operated types and pilot operated types	
	19	**Flow Control Valves** -compensated and non-compensated FCV, needle valve,	

		temperature compensated	
	20	pressure compensated, pressure and temperature compensated FCV, symbolic representation	
	20	**Hydraulic Circuit Design**: Control of single and Double -acting hydraulic cylinder, regenerative circuit, pump unloading circuit	
	21	Counter balance valve application, hydraulic cylinder sequencing circuits, hydraulic circuit for force multiplication	
	22	Speed control of hydraulic cylinder- metering in	
	23	Metering out and bleed off circuits..	
	24	Pilot pressure operated circuits	
4		**Pneumatic power systems**	**80**
	25	Introduction to Pneumatic systems**:** Pneumatic power system, advantages, limitations, applications, Choice of working medium	
	26	Characteristics of compressed air and air compressors	
	27	Structure of pneumatic control System, fluid conditioners-dryers and FRL unit.	
	28	Pneumatic Actuators**:** Linear cylinder – types of cylinders, working, end position cushioning, seals, mounting arrangements, and applications	
	29	Pneumatic Control Valves**:** DCV such as poppet, spool, suspended seat type slide valve	
	30	pressure control valves, flow control valves, types and construction,	
	31	use of memory valve, Quick exhaust valve,	
	32	time delay valve, shuttle valve, twin pressure valve, symbols	
5		**Pneumatic control circuits**	**100**
	33	**Simple Pneumatic Control:** Direct and indirect actuation pneumatic cylinders	
	34	Speed control of cylinders - supply air throttling and exhaust air throttling.	
	35	**Signal Processing Elements:** Use of Logic gates - OR and AND gates in pneumatic applications. Practical examples involving the use of logic gates	
	36	Multi- Cylinder Application**:** Coordinated and sequential motion control, motion and control diagrams	
	37	Signal elimination methods, Cascading method- principle,	
	38	Practical application examples (up to two cylinders) using cascading method	
	39	**Electro- Pneumatic Control:** Principles - signal input and output,	
	40	Pilot assisted solenoid control of directional control valves, use of relay and contactors. Control circuitry for simple signal cylinder application	

12.0 Assignments, Pop Quiz, Mini Project, Seminars

Sl.No.	Title	Outcome expected: students able to	Allied study	Week No.	Individual / Group activity	Reference: book/website /Paper
1	The seminar will be conducted on uncovered portion of the subject after the II IA and evaluated the activity.					
2	Group A: Experiments on hydraulic trainer: Group B: Experiments on pneumatic trainer: Students should build up the above circuits on computer using software and simulate the flow of fluid during the operation. Afterwards, they themselves can physically connect the circuit on the hydraulic/pneumatic trainer and run the circuit. Record of experiments shall be submitted in the form of journal. Due credit must be given for					

	this assignment (5 Marks). List of Open Source Software/learning website: 1. Simulink 2. SimHydraulics

12.0 QUESTION BANK

Sample Questions	Questions
III	**Module 1** 1. State Pascal's law. Explain briefly its applications. 2. List the merits and demerits of hydraulic system. 3. State the application of hydraulics and pneumatics in a hydraulic press a force of 100N is exerted on the smaller piston (area is 50 cm^2) Determine the Upward force on the large piston whose area is 500 cm^2. 4. Explain the principle of working of a positive displacement pump 5. With the aid of neat sketch, explain the operation and performance characteristics of a variable delivery pump.How are the mechanical efficiency of a positive displacement pump determined? With neat sketch explain operation of Piston Pumps. 6. A pump has a displacement volume of 100 cm^3 delivering 0.015 m^3/s of oil at 1000 rpm and 70 bars. If the prime mover input torque is 120 N-m. What is the overall efficiency of pump and theoretical torque required to operate the pump? What is theoretical flow rate of a fixed displacement, axial piston pump with a nine bore cylinder operating at 2000rpm? Each bore has a 15 mm diameter and a stroke of 20 mm.
IV	**Module 2** 1.Explain the importance of actuators in hydraulic system 2.Know the working principle of actuators 3. Explain various types of actuators with a neat sketch. 4.Determine design torque and power delivered by hydraulic motors.? 5. Explain single rod accumulator 6.Explain cautioned type of accumulators 7.differentiate actuators and accumulators 8.Explain vane motor 9.explain gear motor 10.Explain telescopic type of cylinder 11.Explain single acting cylinder 12.Explain double acting cylinder with a neat sketch 13.Explain types of actuators with symbolic representations
V	**Module 3** 1. What are the main advantages of gear motors? 2. What is hydrostatic transmission? What are its main advantages? 3. What type of Hydraulic motors is generally efficient? 4. A hydrostatic transmission operating at 70 bar has following characteristics Pump (VD=82cm3, N=500 rpm, volumetric efficiency=82%, mechanical efficiency=88%) Motor (N=400 rpm, volumetric efficiency=92%, mechanical efficiency=90%) Determine displacement of motor and motor output torque. 5. A hydraulic motor has a displacement of 164 cm3 and operates with a pressure of 70 bars at a speed of 2000 rpm. If the actual flow rate consumed by the motor is 0.006m3/S and the actual torque delivered by the motor is 170 N-m. Determine volumetric efficiency, mechanical efficiency, overall efficiency and the actual power delivered by the motor.
	1.Discuss with a neat sketch the working of a 4/2 DC valve. 2.Distinguish between pressure relief valve and unloading valve. 3. With the aid of a neat sketch explain briefly the following Inline check valve ii) Sequence valve 4. What is the purpose a directional control valve? Sketch and explain check valve Sketch and explain poppet valve, Spool type directional control valve. What is the purpose of Pressure control valve? Sketch and explain any two types of pressure control valve. 5.With a neat sketch needle valve, Gate valves for flow control in fluid power system?
VI	**Module-4**

	1. What is fire resistant fluid? Name any four and list out advantages and disadvantages 2. Identify eight recommendations that should be followed for properly maintaining and disposing of hydraulic fluid. 3. Differentiate between a) Internal and external leaks b) Positive and non positive seal c) Static and dynamic seal 4. Explain various types of filtering? 5. Write an explanatory note on preventive maintenance of valves, pumps and filters. 6. What are the advantages of pneumatic system? Distinguish between hydraulic and pneumatic system. What are the characteristics of compressed air? Explain. 7. Give complete classification of pneumatic actuators. 8. Sketch and explain a cushion assembly for a pneumatic cylinder. Explain the typical air cylinder with a neat sketch? What are the factors affecting piston speed. 9. Explain the typical air cylinder applications 10. Explain different types of seals used in Pneumatic systems. **11. Explain the design and constructional details of rotary cylinder.**
V	**Module-5** 1. With the aid of suitable sketches, explain briefly the following: Open center, closed center & Tandem center configurations as applied to 3 positions – 4-way valve. 2. Explain the working of two way valve and shuttle valve 3. With a neat sketch explain working principles of Poppet Valves. 4. With *a neat sketch* explain working principles of Spool valve. 5. Explain Non return type flow control valve with neat sketch 6. Explain Memory valve with neat sketch mention its uses 7. Explain Quick exhaust valve with neat sketch. 8. Explain the following i) AND function ii) OR function iii) NOR function iv) NAND function
	With a sketch explain any one practical application of multi-cylinder pneumatic system. Explain advantages of cascading method of design of a pneumatic system Explain steps involved in cascading method of design of a pneumatic system. Explain clearly the following as applied to electro-pneumatic controls: Normally closed Relay switch ii) Normally open Relay switch What is an electrical relay? How does it work? With a neat sketch explain Control circuitry for simple single cylinder application. Mention the advantages of compressed air as a signal transmission agent. Sketch and explain briefly the following: Pneumatic pressure regulator. ii) Air-Filter for pneumatic systems. Describe the elements of FRL unit.). How compressed air is produced? Explain different types of compressors

13.0 University Result

Examination	S+	S	A	B	C	D	E	F	% Passing
AUG 2020	00	02	25	35				1	99.00

Prof. B.M.Dodamani	Dr. K.M.Akkoli	Dr. S.N.Topannavar	
Course coordinator	Module coordinator	HOD	Principal

Subject Title	**Operations Management**		
Subject Code	18ME56	**IA Marks**	40
No of Lecture Hrs + Practical Hrs / Week	03	**Exam Marks**	60
Total No of Lecture + Practical Hrs	40	**Exam Hours**	03
CREDITS – 03			

FACULTY DETAILS:		
Name: Prof. M. A Hipparagi	**Designation:** Asst. Professor	**Experience:**13 Years
No. of times course taught: 02	**Specialization:** Production Technology	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
1	Mechanical Engineering	V	Project Management

2.0 Course Objectives

- To provide role and importance of the operations function in organizations.
- To provide the roles and responsibilities of operations managers in different organizational contexts..
- To impart The decision process, characteristics of operations decisions, use of models, decision making in analysis and trade-offs and how to draw and analyze a decision tree.
- To provide The location decisions relate to decision of value chains, identify factor affecting location choices..
- To provide MRP principles to the provision of services and distribution inventories.
- To provide The nature of supply chain for service providers as well as for manufactures.

3.0 Course Outcomes

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

CO	Course Outcome	Cognitive Level	POs
C306.1	Explain the concept and scope of operations management in a business context	U	1,6,12
C306.2	Recognize the role of Operations management among various business functions and its role in the organizations' strategic planning and gaining	U	1,6,12
C306.3	Analyze the appropriateness and applicability of a range of operations management systems/models in decision making.	U	1,2,5,6,12
C306.4	Assess a range of strategies for improving the efficiency and effectiveness of organizational operations.	U	1,2,3,6,12
C306.5	Evaluate a selection of frameworks used in the design and delivery of operations	U	1,2,3,5,6,12
Total Hours of instruction		**40**	

4.0 Course Content

Module-1

Introduction, Functions within business organizations, the operation management function, Classification of production systems, Productivity, factors affecting productivity. Decision Making: The decision process, characteristics of operations decisions, use of models, decision making environments, graphical linear programming, analysis and trade-offs.

Module-2

Forecasting: Steps in forecasting process, approaches to forecasting, forecasts based on judgment and opinion, analysis

Module-3

Capacity & Location Planning: Importance of capacity decisions, defining and measuring capacity, determinants of effective capacity, determining capacity requirement, developing capacity alternatives, evaluating alternatives, Need for location decisions, nature of locations decisions, general procedure for making locations decisions, evaluating locations decisions, facilities layout – need for layout decisions, types of processing.

Module-4

Aggregate Planning & Master Scheduling: Aggregate planning – Nature and scope of aggregate planning, strategies of aggregate planning, techniques for aggregate planning – graphical and charting techniques, mathematical techniques. The master production schedule, Master scheduling process, Master scheduling methods.

Module-5

Material Requirement Planning (MRP): Dependent versus independent demand, an overview of MRP – MRP inputs and outputs, MRP processing, ERP capacity requirement planning, benefits and limitations of MRP. **Purchasing and Supply Chain Management (SCM):** Introduction, Importance of purchasing and SCM, the procurement process, Concept of tenders, Approaches to SCM, Vendor development.

5.0 Relevance to future subjects/Area

SL. No	Semester	Subject	Topics / Relevance
01	VII	Total Quality Management	Industry

6.0 Relevance to Real World

SL. No	Real World Mapping
01	Operations Research
02	Production Planning and control

7.0 Books Used and Recommended to Students

Text Books

1. Production and Operations Management, William J Stevenson, Tata McGraw Hill,8th Edition
2. Operations Management-Theory and Practice, B Mahadevan, Pearson Education,2007

Reference Books

1.Production and Operations Management, Norman Gaither & Greg Frazier,
2. Operations Management for Competitive Advantage, R.B.Chase, N.J.Aquilino, F.Roberts Jacob; McGraw Hill Companies Inc., Ninth Edition.
3. Production & Operations Management, Everett E.Adams, Ronald J.Ebert, Prentice Hall of India Publications, Fourth Edition.
4. Production / Operations Management, Joseph G Monks, McGraw Hill Books

Additional Study Material & e-Books

- Nptel.ac.in

- VTU, E- learning
- MOOCS
- Open courseware

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

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

9.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	Science Direct	http://www.sciencedirect.com

10.0 Examination Note

- The question paper will have ten questions.
- Each full question consisting of 20 marks.
- There will be 2 full questions (with a maximum of 4 sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

11.0 Course Delivery Plan

Module	Lecture No.	Content of Lecturer	% of Portion
1	1	Production and Operation Management; Introduction	20%
	2	Functions within business organizations	
	3	The operation management function	
	4	Classification of production systems	
	5	Productivity, factors affecting productivity	
	6	contemporary issues and development	
	7	Decision Making: The decision process	
	8	Characteristics of operations decisions	
2	9	Forecasting: Steps in forecasting process,	40%
	10	Approaches to forecasting	
	11	Forecasts based on judgment and opinion	
	12	Analysis of time series data	
	13	Accuracy and control of forecasts	
	14	Choosing a forecasting technique	
	15	Elements of a good forecast.	
	16	Forecasting: Steps in forecasting process,	
3	17	Capacity & Location Planning: Importance of capacity decisions, defining and measuring capacity	60%
	18	Determinants of effective capacity, determining capacity requirement	
	19	Developing capacity alternatives, evaluating alternatives	

	20	Need for location decisions, nature of locations decisions	
	21	General procedure for making locations decision evaluating locations decisions	
	22	Facilities layout – need for layout decisions	
	23	Types of processing	
	24	Capacity & Location Planning: Importance of capacity decisions, defining and measuring capacity	
4	25	Aggregate Planning & Master Scheduling: Aggregate planning – Nature and scope of aggregate planning	80%
	26	Strategies of aggregate planning	
	27	Techniques for aggregate planning	
	28	Graphical and charting techniques	
	29	Mathematical techniques	
	30	The master production schedule	
	31	Master scheduling process	
	32	Master scheduling methods	
5	33	Material Requirement Planning (MRP):	100%
	34	An overview of MRP	
	35	MRP inputs and outputs,	
	36	MRP processing	
	37	An overview of MRP-II	
	38	ERP capacity requirement planning	
	39	Benefits and limitations of MRP	
	40	Purchasing and Supply Chain Management (SCM): . Introduction, Importance of purchasing and SCM	

12.0 Assignments, Pop Quiz, Mini Project, Seminars

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

		practice to solve university questions.				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

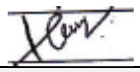
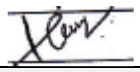
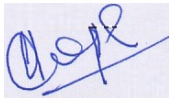
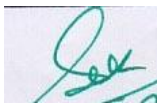
13.0 QUESTION BANK

Sample Questions	Questions
VII	**MODULE 1** 1. Define operation management 2. What is productivity? 3. Explain the meaning of terms a) resources b) system. 4. Explain the factors affecting productivity. 5. Explain the classification of production system. 6. How does the production and operations management function distinguish itself from the other function of management? 7. List the steps in a systematic decision making process. 8. Identify some major advantages of using models. 9. What types of models are most useful for operations management decision making. 10. What is break even analysis? 11. What is decision tree? 12. What is contribution?
VIII	MODULE 2 1. What are forecasts? 2. What are the costs associated with forecasting or not forecasting. 3. Summarize the key features of the more commonly used forecasting methods. 4. What is time series? 5. What are the components of a time series? 6. What steps are involved in using time series data to make a forecast? 7. What is exponential smoothing?
IX	**MODULE 3** 1. How does an organization go about selecting an optimal facility location? 2. What location alternatives exist for firms to respond to changing demand? 3. What are the steps should be included in making a facility location decision?. 4. What is capacity requirement planning? 5. What are the essential inputs and outputs in CRP system? 6. What characteristics of goods influence facility location 7. What characteristics of services influence facility location
X	**MODULE 4** 1. What is aggregate planning? 2. What is master scheduling and does it differ from aggregate planning. 3. What are the major inputs the master production schedule. 4. What are the strategies are employed by production planners to meet non uniform demand. 5. What is meant by the terms a) demand time fence b) planning time fence. 6. How do firms accommodate changes in their master schedule?
XI	**MODULE 5** 1. What is material requirement planning? 2. What are essential inputs and outputs in an MRP system? **3.** What are the three essential sources of data for an MRP program?

	4. Explain ERP capacity requirement planning? 5. Explain benefits of MRP 6. Explain limitation of MRP 7. What is material management? 8. What is purchasing and who does it 9. What are the major responsibilities of purchasing department 10. Explain the types of buying. 11. Explain the measures of purchasing and SCM.

14.0 University Result

Examination	S+	S	A	B	C	D	E	F	% Passing
Jan 2021	11	23	06	--	--	--	--	--	78

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

Subject Title	**Fluid Mechanics & Machinery Lab**		
Subject Code	18MEL57	**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: Dr. K.. M. Akkoli	**Designation:** Associate Professor	**Experience: 18** Years
No. of times course taught: 10 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 Pumps a. Single stage and Multi stage centrifugal pumps b. Reciprocating 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?
16. List out the components of pelton turbine?
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?
39. List the parts of 2 stage air compressor?

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?	40. Define the losses in flow through pipe.

13.0 University Result

Examination	S+	S	A	B	C	D	E	% Passing
2020-21							-	100
2019-20							-	100

Prepared by -Sd-	Checked by		
Dr. K. M. Akkoli	Prof. M. M. Shivashimpi	HOD	Principle

Subject Title	**ENERGY CONVERSION LAB**		
Subject Code	**18MEL58**	**CIE Marks**	**40**
Teaching Hours /Week	**08**	**SEE Marks**	**60**
CREDITS	**02**	**Exam Hours**	**03**

FACULTY DETAILS:		
Name: Prof. M.M. Shivashimpi	**Designation:** Asst. Professor	**Experience:** 13 Years
No. of times course taught: 12 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
C308.1	Perform experiments to determine the properties of fuels and oils.	L2	1,2,7,12
C308.2	Conduct experiments on engines and draw characteristics.	L3	1,2,7,12
C308.3	Test basic performance parameters of I.C. Engine and implement the knowledge in industry.	L3	1,2,7,12
C308.4	Identify exhaust emission, factors affecting them and exhibit his competency towards preventive maintenance of IC engines.	L3	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. Valve Timing/port opening diagram of an I.C. Engine

PART B

6. 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.
7. Measurements of Exhaust Emissions of Petrol engine.
8. Measurements of Exhaust Emissions of Diesel engine.

PART – C (Optional)

9. Visit to Automobile Industry/service stations.
10. Demonstration of pθ , pV plots using Computerized IC engine test rig.

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, 9t^{h} edition.

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

Website and Internet Contents References
8. http://www.nptel.ac.in
9. 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.

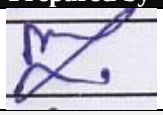
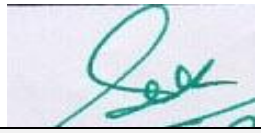
12.0 QUESTION BANK

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?
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
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?
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

24. Discuss on the calibration of following instruments i. Thermometer ii. Orifice iii. Thermocouple	matter and fixed carbon in a given sample?

13.0 University Result

Year	S+,S,A (FCD)	B (FC)	C,D,E (SC)	% age of passing
January /February 2021	50	00	00	100

Prepared by	Checked by		
	-Sd-		
Prof. M. M.Shivashimpi	**Dr. K.M.Akkoli**	**HOD**	**Principal**