Department of Mechanical Engineering

COURSE PLAN 2021-22

VII 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)

VII 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	18ME71	Control Engineering		3	--	--	03	40	60	100	3
2	PCC	18ME72	Computer Integrated Design and Manufacturing		3	--	--	03	40	60	100	3
3	PEC	18ME73X	Professional Elective - 2		3	--	--	03	40	60	100	3
4	PEC	18ME74X	Professional Elective - 3		3	--	--	03	40	60	100	3
5	OEC	18ME75X	Open Elective -B		3	--	--	03	40	60	100	3
6	PCC	18MEL76	Computer Integrated Manufacturing Lab		--	2	2	03	40	60	100	2
	PCC	18MEL77	Design Lab		--	2	2	03	40	60	100	2
7	Project	18MEP78	Project Work Phase - 1		--	--	2	--	100	--	100	1
8	Internship	--	Internship	(If not completed during the vacation of VI and VII semesters, it shall be carried out during the vacation of VII and VIII semesters)								
				TOTAL	**15**	**4**	**6**	**18**	**340**	**360**	**700**	**20**

Subject Title	**CONTROL ENGINEERING**		
Subject Code	18ME71	**IA Marks**	40
Number of Lecture Hrs / Week	04	**Exam Marks**	60
Total Number of Lecture Hrs	50	**Exam Hours**	03
			CREDITS – 03

FACULTY DETAILS:		
Name: Prof. S. A. Goudadi	**Designation:** Asst. Professor	**Experience:** 14 Years
No. of times course taught: 01	**Specialization:** Design Engg.	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Mechanical Engg.	I/II/III/IV	Engg Mathematics
02	Mechanical Engg.	V	Dynamics of Machines

2.0 Course Objectives

- To develop comprehensive knowledge and understanding of modern control theory, industrial automation, and systems analysis.
- To model mechanical, hydraulic, pneumatic and electrical systems.
- To represent system elements by blocks and its reduction techniques.
- To understand transient and steady state response analysis of a system.
- To carry out frequency response analysis using polar plot, Bode plot.
- To analyse a system using root locus plots.
- To study different system compensators and characteristics of linear systems.

3.0 Course Outcomes

On successful completion of this course, the students will be able to

	Course Outcome	Cognitive Level	POs
C401.1	Identify the type of control and control actions.	L3	1,2,6,7,12
C401.2	Develop the mathematical model of the physical systems.	L3	1,2,6,7,12
C401.3	Estimate the response and error in response of first and second order systems subjected standardinput signals.	L3	1,2,6,7,12
C401.4	Represent the complex physical system using block diagram and signal flow graph and obtaintransfer function.	L3	1,2,6,7,12
C401.5	Analyse a linear feedback control system for stability using Hurwitz criterion, Routh‟s criterion and root Locus technique in complex domain.	L3	1,2,6,7,12
C401.6	Analyse the stability of linear feedback control systems in frequency domain using polar plots, Nyquist and Bode plots.	L3	1,2,6,7,12

Total Hours of instruction	50

4.0 Course Content

Module-1

Introduction: Components of a control system, Open loop and closed loop systems.

Types of controllers: Proportional, Integral, Differential, Proportional-Integral, and Proportional- Integral-Differential controllers.

Modelling of Physical Systems: Mathematical Models of Mechanical, Electrical, Thermal, HydraulicSystems.

Module-2

Time domain performance of control systems: Typical test signal, Unit step response and time domain specifications of first order, second order system. Steady state error, error constants.

Module-3

Block diagram algebra, Reduction of block diagram, Signal flow graphs, Gain formula for signal flow graphs, State diagram from differential equations.

Module-4

Stability of linear control systems: Routh‟s criterion, Root locus, Determination of phase margin and gain margin using root locus.

Module-5

Stability analysis using Polar plot, Nyquist plot, Bode plot, Determination of phase margin and gain margin using Bode plot.

5.0 Relevance to future subjects

Sl No	Semester	Subject	Topics
01	VII	Advance Control System	Observability, Controllability, State variables.

6.0 Relevance to Real World

Sl. No	Real World Mapping
01	Design of various components
02	Conduct investigations of complex Problems
03	Development of prototype models

7.0 Gap Analysis and Mitigation

Sl No	Delivery Type	Details
01	Tutorial	Introduction, Feedback, Mathematical Models, Modelling of Mechanical Systems, Electrical Analogies of Mechanical Systems, Block Diagrams etc

02	NPTEL	Control Engineering: The Control Problem· Different Kinds of Control Systems· History of Feedback · Modern Control Problems

8.0 Books Used and Recommended to Students

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Automatic Control Systems	Farid G., Kuo B. C	McGraw Hill Education	10th Edition,2018
2	Control systems	Manik D. N	Cengage	2017
Reference Books				
1	Modern control Engineering	K. Ogeta	Pearson	5th Edition, 2010
2	Control Systems Engineering	Norman S Nice		Fourth Edition, 2007
3	Modern control Systems	Richard C Dorf	Pearson	2017
4	Control Systems Engineering	I J Nagrath, M Gopal	New Age International (P) Ltd	2018
5	Control Systems Engineering	S Palani	Tata McGraw Hill Publishing Co Ltd	ISBN-13 97800706719

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

Website and Internet Contents References
VSSUT, Smartzworld, Scribd, NPTEL.

10.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	**IEEE Xplore: IEEE Control Systems Magazine**	www.ieeexplore.ieee.org
2	Journal of Control Theory and Applications, Journal of Real-Time Image Processing etc	www.Springer.com

11.0 Examination Note

Assignment marks: 10 marks.

Question paper pattern IA exam:

Answer two full questions Q1 or Q2 and Q3 or Q4 (15marks each). Total 30 Marks.

Question paper pattern Main exam:

- 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
Module 1	1	**Introduction:**	20
	2	Components of a control system,	
	3	Open loop and closed loop systems.	
	4	Proportional, Integral, Differential,	
	5	Proportional-Integral,	
	6	Proportional- Integral-Differential controllers.	
	7	**Modelling of Physical Systems:** Mathematical Models of Mechanical,	
	8	Electrical,	
	9	Thermal,	
	10	HydraulicSystems.	
Module 2	11	Time domain performance of control systems	20
	12	Typical test signal,	
	13	Unit step response	
	14	Problems	
	15	time domainspecifications of first order,	
	16	Second order system.	
	17	Steady state error,	
	18	Error constants.	
	19	Problems	
	20	Problems	
Module 3	21	Block diagram algebra,	20
	22	Reduction of block diagram,	
	23	Problems	
	24	Signal flow graphs,	
	25	Problems	
	26	Gain formula for signal flow graphs,	
	27	Problems	
	28	State diagram from differential equations.	
	29	Problems	
	30	Problems	
Module 4	31	**Stability of linear control systems:** Routh‟s criterion,	20
	32&33	Root locus,	
	34&35	Problems	
	36&37	Determination of phase margin and gain	
	38&39	Problems	
	40	margin using root locus.	
Module 5	41&42	Stability analysis using Polar plot,	20
	43 & 44	Nyquist plot,	

	45 & 46	Bode plot,
	47 & 48	Determination of phase margin and
	49 & 50	gain margin using Bode plot.

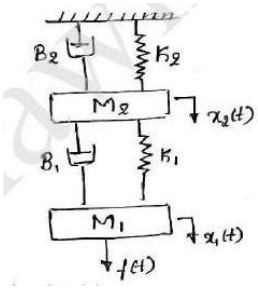
13.0 Assignments, Pop Quiz, Mini Project, Seminars

Sl. No	Title	Outcome expected	Allied study	Week No.	Individual / Group activity	Reference: book/website /Paper
1	Assignment 1: Questions on module 1	Students study the Topics and write the Answers. Get practice to solve questions.	Module 1 of the syllabus	3	Individual Activity.	Farid G., Kuo B.C and Katsuhiko Ogata
2	Assignment 2: Questions on module 2	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 2 of the syllabus	5	Individual Activity.	Farid G., Kuo B. C and Katsuhiko Ogata
3	Assignment 3: Questions on module 3	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 3 of the syllabus	8	Individual Activity.	Farid G., Kuo B. C and Katsuhiko Ogata
4	Assignment 4: Questions on module 4	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 4 of the syllabus	10	Individual Activity.	Farid G., Kuo B. C and Katsuhiko Ogata
5	Assignment 5: Questions on module 5	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 5 of the syllabus	12	Individual Activity.	Farid G., Kuo B. C and Katsuhiko Ogata

14.0 QUESTION BANK

MODULE 1

1) Define control system
2) Explain control system with block diagram and examples.
3) Explain Open loop control system
4) Explain Closed loop control system
5) Explain the components of control system
6) Explain the following controllers with block diagrams
   i) Proportional controller
   ii) Integral controller
   iii) Proportional controller plus Integral controller
   iv) Proportional controller plus Integral plus differential controller
7) Write the force-voltage and force- current analogous circuit for the mechanical system shown in figure.



MODULE 3

1) Define the following for an under damped second order system.
   a) Rise Time b) Peak overshoot c) Settling Time.
2) Define the following terms
   a) Transient response b) steady state response.
3) Derive the expression for peak time.
4) The loop transfer function of transfer function is given by
   i) Determine the static error coefficients
   ii) Determine steady state error coefficients for the input r(t) = $2t_2$ + 5t +10

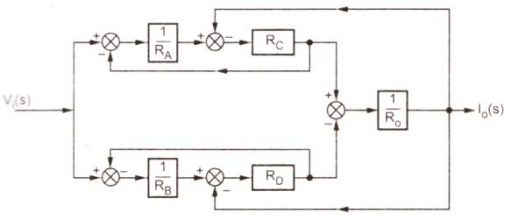
$$G(s)H(s) = \frac{100}{s^2(s+4)(s+12)}$$

5) Derive expressions for peak response time $t_p$and maximum overshoot M_p of an under damped second order control system subjected to step input
6) For a unity feedback control system with G(s) = 10(S+2) / S_2 (S+1). Find
   i) The static error coefficients
   ii) Steady state error when the input transform is

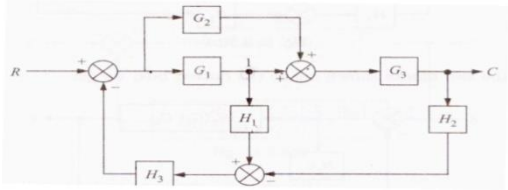
$$R(s) = \frac{3}{s} - \frac{2}{s^2} + \frac{1}{3s^2}$$

MODULE 3

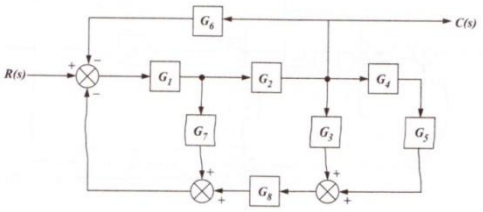
1) Determine the transfer function C(s)/R(s) of the system shown below by block diagram reduction method.



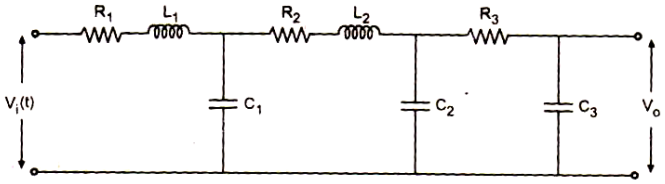
2) Determine the transfer function C(s)/R(s) of the system shown below by block diagram reduction method.



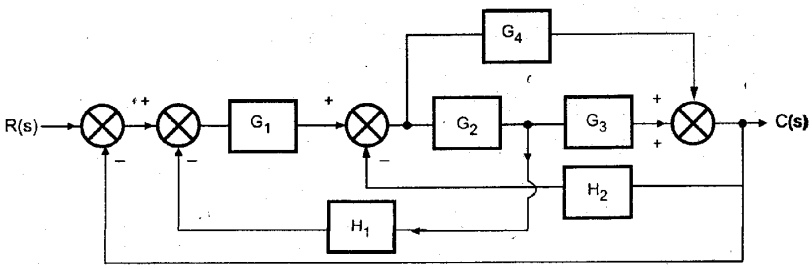
3) Determine the transfer function C(s)/R(s) of the system shown below by block diagram reduction method.



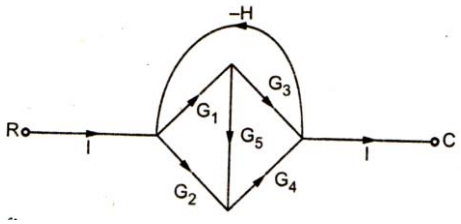
4) Discuss rule of block reduction technique in detail.
5) Draw a block diagram to describe the electrical circuit given in the Fig.



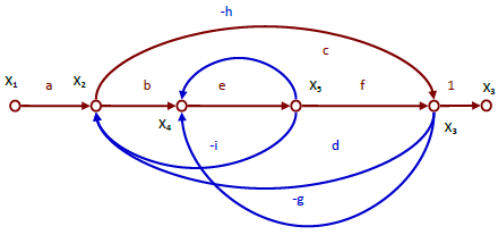
6) Obtain the overall transfer function for the block diagram shown below by the block diagram reduction technique.



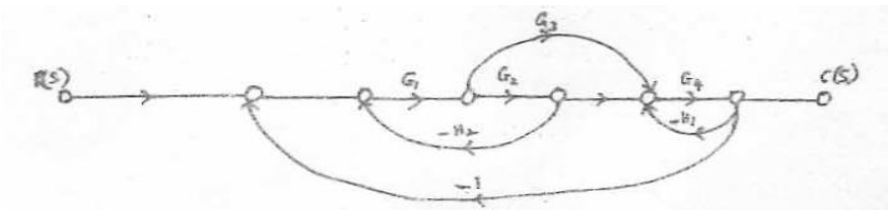
7) Obtain MGF.



8) For the system described by the signal flow graph shown in fig, obtain the closed loop transfer function C(s) / R(s) , using Mason's gain formula.



9) For the system shown in Fig.3 below determine $\frac{C(s)}{R(s)}$ using Mason's gain formula.



10)Obtain the closed loop transfer function of the block diagram shown in Fig. 3 (a).

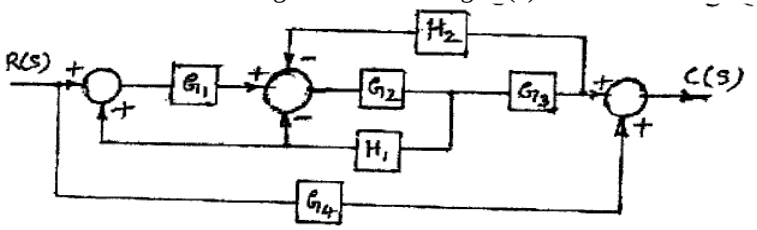


Fig. Q3 (a)

11) For the signal flow graph shown in Fig. 3 (b), determine C/R using mason's gain formula.

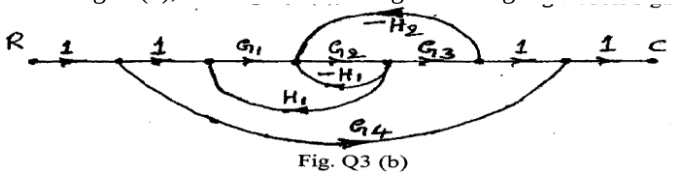


Fig. Q3 (b)

MODULE 4

1) Sketch the root locus plot for the system, whose open loop transfer function is given byG(s)H(s)=K/(S(S+2)(S2+8S+20)).
2) State the different rules for the construction of root locus.
3) Sketch the root locus diagram of a control system having unity feedback with G(s) = K(s+1)/s(s-1)(s +4s+16) and Comment on the stability of the system. Also find the frequency of oscillation.
4) Draw the root locus plot using guidelines for the OLTFG(s)H(s)=K(S + 2)/(S(S2+2S+2)) Discuss stability of the system as a function of K.
5) Sketch the root locus for the system having G(s) =k(s+1)/s2(s+2).
6) Sketch the Bode plot for G(s)H(s) =2/((S(S+1)(1+0.2S)) Also obtain gain margin and phase margin and crossover frequencies.
7) A unity feedback system has G(S)= K/(S(S+l)(S+10)) .

MODULE 5

1) Draw Bode plot and determine the value of K so that the gain margin of the system is 20db.
2) Construct bode dig for a feedback control system having its open loop transfer function.
   GH 100(10s+1)/(s(s+0.4)(s+1)(s+10)). Also determine gain margin and phase margin if the system is stable.
3) Sketch the polar plot for GH(S)=1/((S+P1)(S+P2)) where P1, P2> 0.
4) The OLTF of a system is given by $GH(S) = \frac{K(T_1S+1)}{S^2(T_2S+1)}$; $K, T_1, T_2 > 0$. Sketch the Nyquist plot for T1< T2and ascertain system stability.
5) Sketch the polar plot for the transfer function G(S)=10/(S(S + 1)(S + 2))
6) Apply Nyquist stability criterion to the system with transfer function G(s)H(s) = 4S+1/((S2(1+S)(1+2S)) and ascertain its stability.
7) Determine stability of the system with GH=(s+6)/((s+2)(s-1)) using nyquist stability criterion.

8) Draw polar plot for the following system GH=20(s+5)/((s+1)(s+2)(s+8))

Prepared by	Checked by		
-Sd- S. A. Goudadi	-Sd- M. S. Futane	HOD	Principal

Subject Title	COMPUTER AIDED DESIGN & MANUFACTURING		
Subject Code	18ME72	CIA Marks	40
No of Lecture Hrs + Practical Hrs / Week	04	Exam Marks	60
Total No of Lecture + Practical Hrs	50	Exam Hours	03
CREDITS – 04			

FACULTY DETAILS:		
Name: Prof. M S Futane	**Designation:** Asst. Professor	**Experience:** 17Years
No. of times course taught: 11 Times	**Specialization:** Computer Integrated Manufacturing	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
1	Common to all	I/II	Elements of Mechanical Engg
2	Mechanical Engineering	III/IV	MCW, MCF

2.0 Course Objectives

- To impart knowledge of CIM and Automation and different concepts of automation by developing mathematical models.
- To make students to understand the Computer Applications in Design and Manufacturing [CAD / CAM) leading to Computer integrated systems. Enable them to perform various transformations of entities on display devices.
- To expose students to automated flow lines, assembly lines, Line Balancing Techniques, and Flexible Manufacturing Systems.
- To expose students to computer aided process planning, material requirement planning, capacity planning etc.
- To expose the students to CNC Machine Tools, CNC part programming, and industrial robots.
- To introduce the students to concepts of Additive Manufacturing, Internet of Things, and Industry 4.0 leading to Smart Factory.

3.0 Course Outcomes

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

CO	Course Outcome	Cognitive Level	POs
CO1	Define Automation, CIM, CAD, CAM and explain the differences between these concepts. And Explain the basics of automated manufacturing industries through mathematical models and analyze different types of automated flow lines	L1, L2	PO1,PO6, PO10, PO11, PO12
CO2	Solve simple problems of transformations of entities on computer screen and Categorize CAPP, MRP, PPC and CRP in Manufacturing system	L1,L2, L3	PO2,PO5, PO10, PO12

CO3	Understand the overall FMS and Solve the manual assembly line balancing problem	L2, L3	PO1,PO2,PO3, PO5, PO11, PO12
C04	Explain the use of different computer applications in manufacturing, and prepare part programs for simple jobs on CNC machine tools and robot programming.	L2, L3	PO1,PO2,PO3, PO5, PO10, PO11, PO12
C05	Visualize and appreciate the modern trends in Manufacturing like additive manufacturing, Industry 4.0 and applications of Internet of Things leading to Smart Manufacturing	L1, L2	PO1,PO2,PO3, PO5, PO10, PO11, PO12
Total Hours of instruction		**50**	

4.0 Course Content

Module - 1

1. Introduction to CIM and Automation:
Automation in Production Systems, automated manufacturing systems- types of automation, reasons for automating, Computer Integrated Manufacturing, computerized elements of a CIM system, CAD/CAM and CIM. Mathematical models and matrices: production rate, production capacity, utilization and availability, manufacturing lead time, work-in- process, numerical problems. **5 Hours**

2. Automated Production Lines and Assembly Systems: Fundamentals, system configurations, applications, automated flow lines, buffer storage, control of production line, analysis of transfer lines, analysis of flow lines without storage, partial automation, analysis of automated flow lines with storage buffer, fundamentals of automated assembly systems, numerical problems. **5 Hours**

Module – 2

3. CAD and Computer Graphics Software: The design process, applications of computers in design**,** software configuration, functions of graphics package, constructing the geometry. Transformations: 2D transformations, translation, rotation and scaling, homogeneous transformation matrix, concatenation, numerical problems on transformations.
5 Hours

4. Computerized Manufacture Planning and Control System: Computer Aided Process Planning, Retrieval and Generative Systems, benefits of CAPP, Production Planning and Control Systems, typical activities of PPC System, computer integrated production management system, Material Requirement Planning, inputs to MRP system, working of MRP, outputs and benefits, Capacity Planning, Computer Aided Quality Control, Shop floor control. **5 Hours**

Module - 3

5. Flexible Manufacturing Systems: Fundamentals of Group Technology and Flexible Manufacturing Systems, types of FMS, FMS components, Material handling and storage system, applications, benefits, computer control systems, FMS planning and design issues, Automated Storage and Retrieval Systems, AS/RS and Automatic parts identification systems and data capture. **5 Hours**

6. Line Balancing: Line balancing algorithms, methods of line balancing, numerical problems on largest candidate rule, Kilbridge and Wester method, and Ranked Positional Weights method, Mixed Model line balancing, computerized line balancing methods. **5 Hours**

Module - 4.

7. Computer Numerical Control: Introduction, components of CNC, CNC programming, manual part programming, G Codes, M Codes, programming of simple components in turning, drilling and milling systems, programming with canned cycles. Cutter radius compensations. **5 Hours**

8. Robot Technology: Robot anatomy, joints and links, common robot configurations, robot control systems, accuracy and repeatability, end effectors, sensors in robotics.Robot programming methods: on-line and off-line methods.Robot industrial applications: material handling, processing and assembly and inspection.**5 Hours**

Module – 5

9. Additive Manufacturing Systems: Basic principles of additive manufacturing, slicing CAD models for AM, advantages and limitations of AM technologies, Additive manufacturing processes: Photo polymerization, material jetting, binder jetting, material extrusion, Powder bed sintering techniques, sheet lamination, direct energy deposition techniques, applications of AM. Recent trends in manufacturing, Hybrid manufacturing. **5 Hours**

10. Future of Automated Factory: Industry 4.0, functions, applications and benefits. Components of Industry 4.0, Internet of Things (IOT), IOT applications in manufacturing, Big-Data and Cloud Computing for IOT, IOT for smart manufacturing, influence of IOT on predictive maintenance, industrial automation, supply chain optimization, supply-chain & logistics, cyber-physical manufacturing systems. **5 Hours**

5.0 Relevance to future subjects

SL. No	Semester	Subject	Topics / Relevance
01	V	Additive Manufacturing	all
02	VIII	Project Work	Implementation of Mechanisms,automation

6.0 Relevance to Real World

SL. No	Real World Mapping
01	Industrial design & mechanisms of various components
02	Various setups for analysis
03	Development of a software applications

7.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
01	Tutorial	Topic: Automated Transfer lines and Assembly system

7.0 Books Used and Recommended to Students

Text Books

1. Automation, Production Systems and Computer-Integrated Manufacturing, by Mikell P Groover, 4th Edition, 2015, Pearson Learning.
2. CAD / CAM Principles and Applications by P N Rao, 3rd Edition, 2015, Tata McGraw-Hill.
3. CAD/CAM/CIM, Dr. P. Radhakrishnan, 3rd edition, New Age International Publishers, New Delhi.

Reference Books

1. "CAD/CAM" by Ibrahim Zeid, Tata McGraw Hill.
2. "Principles of Computer Integrated Manufacturing", S.Kant Vajpayee, 1999, Prentice Hall of India, New Delhi.
3. "Work Systems And The Methods, Measurement And Management of Work", Groover M. P.,Pearson/Prentice Hall, Upper Saddle River, NJ, 2007.
4. "Computer Automation in Manufacturing", Boucher, T. O., Chapman & Hall, London, UK, 1996.
5. "Introduction to Robotics: Mechanics And Control", Craig, J. J., 2nd Ed., Addison-Wesley Publishing Company, Readong, MA, 1989.
6. Internet of Things (IoT): Digitize or Die: Transform your organization. Embrace the digital evolution. Rise above the competition, by Nicolas Windpassinger, Amazon.
7. "Internet of Things: A Hands-on Approach", by Arshdeep Bahga and Vijay Madisetti (Universities Press)
8. Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, 2nd Ed. (2015), Ian Gibson, David W. Rosen, Brent Stucker

9. "Understanding Additive Manufacturing", Andreas Gebhardt, Hanser Publishers, 2011
10. Industry 4.0: The Industrial Internet of Things, Apress, 2017, by Alasdair Gilchrist

Additional Study material & e-Books

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

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

Website and Internet Contents References
1.http://www.nptel.ac.in
2.www.journals.elsevier.com
3.www.youtube.com
4.https://www.researchgate.net/journal
5.https://books.google.co.in/books?isbn

9.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	**Robotics and Computer-Integrated Manufacturing - ScienceDirect.com**	www.sciencedirect.com/science/journal/07365845
2	**Manufacturing, Modelling, Management and Control 2004**	https://books.google.co.in/books?isbn=0080445624
3	**International Journal of Computer Integrated Manufacturing**	www.tandfonline.com/toc/tcim20
4	**Computer Integrated Manufacturing**	manufacturingscience.asmedigitalcollection.asme.org

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 :40marks.

SCHEME OF EXAMINATION:
There are five modules two questions from each module
Student has to answer any five question choosing at least one questions from each module.
Max. Marks: 100Marks

11.0 Course Delivery Plan

Module No.	Lecture No.	Content of Lecture	% of Portion
1		**Introduction to CIM and Automation & Automated Production Lines and Assembly Systems**	20
	1	Automation definition, advantages of automation, types of automation.	
	2	Levels of Automation, Automation strategies.	

	3	CIM processing in manufacturing.	
	4	Mathematical Models- CT, Production rate, Production capacity, MLT,,WIP, & TIP ratio	
	5	Problems using mathematical models	
	6	Introduction, Automated flow line, objectives	
	7	Flow line configurations, work part transport methods	
	8	Work part transfer mechanisms	
	9	Need for buffer storage, Automation for machining	
	10	Quality ,Automation for machining operation	
2		**CAD and Computer Graphics Software & Computerized Manufacture Planning and Control System**	**20**
	11	The design process.	
	12	software configuration, functions of graphics package	
	13	Transformations: 2D transformations, translation, rotation and scaling	
	14	homogeneous transformation matrix, concatenation	
	15	numerical problems on transformations	
	16	Velocity Analysis by Instantaneous Center Method: Definition, Kennedy's theorem,	
	17	Introduction, CAPP, Retrieval CAPP	
	18	Generative CAPP, Advantages/Benefits of CAPP,MRP concepts & Terminology	
	19	Stricture/Flow chart of MRP, Inputs to MRP	
	20	MRP system output, BOM, Parameters in MRP system	
3		**Flexible Manufacturing Systems & Line Balancing**	**20**
	21	Fundamentals of Group Technology and Flexible Manufacturing Systems	
	22	types of FMS, FMS components, Material handling and storage system,	
	23	FMS planning and design issues	
	24	Automated Storage and Retrieval Systems, AS/RS	
	25	Automatic parts identification systems and data capture	
	26	Line balancing algorithms	
	27	Different terms involved in Assembly line balancing problem: Precedence diagram, Balance delay, Balance efficiency	
	28	Assembly line balancing by largest candidate rule method	
	29	Assembly line balancing by Kilbridge & Westers method	
	30	Assembly line balancing by Ranked positional weight method, computerized line balancing	
4		**Computer Numerical Control & Robot Technology**	**20**
	31	NC terminology, Basic components of NC system	
	32	NC coordinate systems. NC motion control systems,	
	33	Applications of NC system, Advantages & Limitations of NC systems	
	34	CNC, need for CNC, different functions of CNC system, Advantages of CNC systems. CNC Machining centres steps in CNC programming.	
	35	Different codes used in the development of NC part programming. The fundamental steps involved in the development of milling part program.	
	36	Basic Robot motions	
	37	Technical features of Robots, Power supply or drive systems for robots	
	38	End effectors, Work cell control	
	39	Robot programming, Robot programming languages	
	40	Robot Applications ,Application areas for Robots	
5		**Additive Manufacturing Systems & Future of Automated Factory**	**20**
	41	Basic principles of additive manufacturing, slicing CAD models for AM, advantages and limitations of AM technologies,	
	42	Additive manufacturing processes: Photo polymerization, material jetting, binder jetting,	
	43	material extrusion, Powder bed sintering techniques, sheet lamination,	
	44	direct energy deposition techniques, applications of AM.	
	45	Recent trends in manufacturing, Hybrid manufacturing	

	46	Industry 4.0, functions, applications and benefits	
	47	Components of Industry 4.0, Internet of Things (IOT), IOT applications in manufacturing,	
	48	Big-Data and Cloud Computing for IOT, IOT for smart manufacturing,	
	49	influence of IOT on predictive maintenance, industrial automation,	
	50	supply chain optimization, supply-chain & logistics, cyber-physical manufacturing system	

12.0 Assignments, Pop Quiz, Mini Project, Seminars

Sl.No.	Title	Outcome expected: students able to	Allied study	Week No.	Individual / Group activity	Reference: book/website /Paper
1	*Assignment -1*: Questions on Introduction to CIM and Automation & Automated Production Lines and Assembly Systems	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 1	2	Individual Activity.	Books or Website of the Reference list
2	*Assignment-2:* Questions on CAD and Computer Graphics Software & Computerized Manufacture Planning and Control System	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 2	4	Individual Activity.	Books or Website of the Reference list
3	*Assignment-3:* Questions on Flexible Manufacturing Systems & Line Balancing	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 3	6	Individual Activity.	Books or Website of the Reference list
4	*Assignment-4:* Questions on Computer Numerical Control & Robot Technology	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 4	8	Individual Activity.	Books or Website of the Reference list
5	*Assignment-5:* Questions on Additive Manufacturing Systems & Future of Automated Factory	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 5	8	Individual Activity.	Books or Website of the Reference list

13.0 QUESTION BANK

MODULE-1:

1) Define Automation.
2) What are the benefits of Automation?
3) Differentiate between Fixed Automation & Programmable Automation.
4) Explain Flexible Automation, write down its applications.
5) Explain the different levels of Automation.
6) Briefly explain the Automation strategies.
7) Write a note on Automation approach.
8) In manufacturing activity how the cycle time is calculated?
9) Explain in detail production rate & batch processing time with mathematical equations
10) Explanation Production capacity with mathematical equations
11) With a neat diagram explain the Information processing in Manufacturing.
12) The average part produced in a certain batch manufacturing plant must be processed through an average six machines. 20 new batches are launched each week. Average operation time is 6 min, average set-up time is 5 h, average batch size is 25 parts, and average non-operation time per batch is 10 h/machine. There are 18 machines in the plant. The plant operates an average of 70 production hours per week. Scarp rate is negligible. Determine:
a)Manufacturing lead time for an average part. b) Production rate c) Plant capacity d) Plant utilization e)WIP f)WIP ratio g)TIP ratio
13) A certain part is produced in the batch size of 100 units. The batch must be routed through 5 operations to complete the proceeding of the plant. Average setup time is 3hrs per operation &avg operation time is 6mins. Avg. non-operation time due to handling, delays, inspections etc is 7hrs for each operation. Determine how many days it will take to complete the batch, assuming the plant runs one 8hrs shift per day.

14) An average 20 new orders are started each month in a factory. On an avg. an order consist of 50 parts to be processed through 10 m/cs. Avg. Operation time is 15min,avg setup time is 4hrs, average non operation time per order is 8hr per m/c. There are 25 m/c in the plant.80% of which are operational at any time (20% in repair) the plant operates an average of 160 production hrs per month. However the plant manager complaints that a total of 100 over time m/c hrs must be authorized each month in order to keep up with the production schedule. Determine MLT for an average order, PC & why overtime is authorized, U, average level of WIP, the operation time per m/c for each part=15min.
15) Explain the following terms related to manufacturing: i) WIP & TIP ratio, ii) Production rate & MLT, iii) Utilization & Availability.
16) Define cycle time, draw the sketch showing all the details, write down the mathematical equation to calculate the cycle time
17) How line efficiency of a flow line is calculated?
18) What is meant by cost per piece & production rate
19) Explain Upper bound approach in detail
20) Explain Lower bound approach in detail
21) A machine tool builder submits a proposal for a 20 station transfer line to machine a certain component produced by conventional methods. The proposal starts that the line will operates at a production rate of 50 pieces per hour at 100% efficiency. On similar transfer lines, the probability of station break downs per cycle is equal for all stations & p=.005 breakdowns/ cycle. It is also estimated that average down time per line stop will be 8 min. The starting casting that is machined on the line costs $3 per part. The line operates of $75 per hour. The 20 cutting tools (one tool per station) last foe 50 parts each,& the average cost per tool $2 per cutting edge. Based on this data, compute i)production rate ii)line efficiency & iii)cost per unit piece produced
22) What is meant by blocking or starving in the flow line
23) A 10 station automated flow line has 2 stages of 5 stations each. The ideal cycle time of each stage is 1.5min. The average constant down time is 10min. 7 all the stations have the same probability of stopping, which is 0.005.Determine i) line efficiency ii)production rates with buffer storage capacity of a)b=0 b)b= □ iii)b=50.
A 20 station transfer flow line is divided into 2 stages of 10 stations each. The ideal cycle of each stage is Tc =1.2 min. All of stations in the line have the same probability of stopping, p=0.005.We assume the down time is constant when a break down occurs, Td=8 min. Compute the line efficiency for the following buffer capacities I)b=o ii)b= □ iii) b=10 iv) b=100.
24) Using the lower bound approach analyze the transfer lines with & without storage cases.
25) With suitable assumptions, determine the line performance for the single & three stages cases.

Station	P_i	Station	P_i
1	0.01	9	0.03
2	0.02	10	0.01
3	0.01	11	0.02
4	0.03	12	0.02
5	0.02	13	0.02
6	0.04	14	0.01
7	0.01	15	0.03
8	0.01	16	0.01

26) Give the reasons for the down time, on an automated production line.
27) Discuss the limits of storage buffer effectiveness.
28) Discuss the striving & blocking of stations with respect to automated flow lines.
29) Compare on the basis of cost/ unit & suggest whether the performance of 10 stations transfer line having 6 automated & 4 manual stations with an automated station. Cost for the existing line: i) C_m= Rs 0.5/ unit, ii) T_c= 30 seconds, iii) C_o= Rs 0.15/ minute, iv) Rs 0.10/ minute, v) C_{at}= Rs 0.10/ minute & vi) Ct= Rs 0.08/ minute.
30) What is the purpose of buffer storage? Mention 2 extreme cases of buffer effectiveness automated flow lines.
31) What are the 2 reasons for partial automation? Analyze the performance of partial automation along the suitable assumptions.
32) Differentiate between upper bound & lower bound approach.

MODULE-2:

1) **Explain in detail** functions of graphics package
2) What is 2D transformations? Explain the procedure of translation, rotation and scaling
3) **What is** homogeneous transformation matrix
4) What is CAPP? Explain briefly.
5) Explain Retrieval CAPP with a neat sketch.
6) Explain Generative CAPP with a neat sketch.
7) Write down the advantages/Benefits of CAPP.
8) What is MRP? Explain briefly.

9) Explain the important terminology used in MRP.
10) Explain with a neat sketch Flow chart of MRP system.
11) Explain the main inputs to MRP.
12) Sketch the typical MRP report & explain its important uses.
13) What is BOM.
14) Explain Intended BOM with a block diagram.
15) List the parameters of BOM & explain Calculation of demand with an example.
16) What is capacity Requirements Planning, How Rated capacity is calculated?
17) Explain brifly Long Range Decisions.
18) Draw the flow chart showing the details of CRP system.
19) Write a note on Infinite & Finite Loading.
20) A work centre operates 6 days a week on a 2-shift per day basis with each shift of 8 hrs.It has 5 machines of same capacity. If machines utilized 80% of the time of a system efficiency of 95%, determine the rated capacity in standard hrs/week.

MODULE-3:

1) Explain the Fundamentals of Group Technology and Flexible Manufacturing Systems
2) **Explain in detail** types of FMS & FMS components
3) What is Automated Storage and Retrieval Systems(AS/RS),explain.
4) **Explain the procedure of** Automatic parts identification systems and data capture
5) Define the following with mathematical equations i) Total work content time ii) Work station process time iii) Cycle time iv) line efficiency) Precedence constrains vi) Precedence diagram vii) Balance delay
6) Explain the methods with different steps involved in the Assembly line balancing.
7) Example with an example any one method of line balancing.
8) Write a note on computerized line balancing.
9) Explain the reasons for partially automating the production line.
10) The table below shows precedence relations & element time for a new part, Ideal cycle time is 10 seconds. Construct the precedence diagram, using all methods, compute the balance delay & line efficiency.

Element No.	Predecessors Element	Time (sec)	Element No.	Predecessors Element	Time (sec)
1	-	5	7	6	2
2	1	3	8	7	6
3	2	4	9	6	1
4	1	3	10	6	4
5	4	6	11	10	4
6	3,5	5	12	8,9,11	7

11) Explain with mathematical expression the different terms in line balancing.

MODULE-4:

1) Draw the block diagram showing the basic components of NC system & explain each in detail.
2) Sketch& explain NC coordinate system for drilling & milling.
3) Sketch & explain NC coordinate system for turning.
4) Explain fixed zero & floating zero method.
5) Explain Absolute coordinate system with a sketch.
6) What is NC motion control systems & explain contouring system with a neat sketch.
7) List the different Applications of NC system.
8) What are the advantages & limitations of NC system?
9) What is CNC
10) What are the different functions of CNC system & explain Diagnostics in detail.
11) Explain vertical machining centre (VMC) with a neat sketch.
12) With a block diagram explain the steps involved in part programming.
13) What is word address format, briefly explain it.
14) Write down the different G & M codes with their function.
15) What is canned cycle explain it with an appropriate example.
16) Define an industrial Robot.
17) Sketch& explain the physical configurations of Robot.

18) What is degree of freedom, sketch& explain showing the degrees of freedom of robot.
19) Explain point to point method.
20) Explain continuous path method.
21) Show the different joints in Robot.
22) What is degree of freedom, sketch& explain showing the degrees of freedom of robot.
23) Explain point to point method .
24) Explain continuous path method.
25) Show the different joints in Robot.
26) Explain the function to be performed by the work cell controller of an industrial robot.
27) Explain the basic power sources or drive system of an industrial Robot
28) List the important types of sensors used in robot. Explain each in detail.
29) Explain briefly what End effector is, sketch & explain the different types of grippers.
30) Explain briefly Robot programming.
31) List the various Robot programming methods.
32) Explain briefly Walkthrough method.
33) Write down commonly used monitor commands.
34) Write in brief about lead through & offline programming used in Robots.
35) Briefly explain General applications of an industrial robot.
36) List the different industrial applications of an industrial Robot & explain any 4 applications briefly

MODULE-5:

1) What is the Basic principles of additive manufacturing
2) List the advantages and limitations of AM technologies
3) Explain the process of Photo polymerization, material jetting
4) Explain the process of Powder bed sintering techniques, sheet lamination
5) Explain the process of binder jetting & direct energy deposition technique
6) What is Industry 4.0? Explain its functions.
7) List the applications and benefits of Industry 4.0 .
8) Explain the Components of Industry 4.0.
9) What is Internet of Things (IOT),
10) List the IOT applications in manufacturing,
11) What is Big-Data and Cloud Computing for IOT,
12) Explain in detail the IOT for smart manufacturing,
13) What are the influences of IOT on predictive maintenance,
14) What is industrial automation?
15) What is supply chain management ? optimize it.
16) Write a short note on supply-chain & logistics.
17) What is cyber-physical manufacturing systems

14.0 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	98.72

-Sd- Faculty :M S Futane	-Sd- Module co-Sordinator	-Sd- Class Teacher	HOD	Principal

Subject Title	TOTAL QUALITY MANAGEMENT		
Subject Code	18ME734	IA Marks	40
Number of Lecture Hrs / Week	03	Exam Marks	60
Total Number of Lecture Hrs	40	Exam Hours	03
CREDITS – 03			

FACULTY DETAILS:		
Name: Prof. M. M. Shivashimpi	**Designation:** Asst. Professor	**Experience:**13
No. of times course taught: 01	**Specialization:** Thermal Power Engineering	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
1	Mechanical Engineering	V	Management & Entrepreneurship

2.0 Course Objectives

1. Understand various approaches to TQM
2. Understand the characteristics of quality leader and his role.
3. Develop feedback and suggestion systems for quality management.
4. Enhance the knowledge in Tools and Techniques of quality management

3.0 Course Outcomes

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

CO	Course Outcome	Cognitive	POs
C406.1	Explain the various approaches of TQM	L1,L2	1,5,6,11,12
C406.2	Infer the customer perception of quality	L2,L3	1,5,6,11,12
C406.3	Analyze customer needs and perceptions to design feedback systems.	L2,L3	1,5,6,11,12
C406.4	Apply statistical tools for continuous improvement of systems	L2,L3	1,5,6,11,12
C406.5	Apply the tools and technique for effective implementation of TQM.	L2,L3	1,5,6,11,12

4.0 Course Content

Module - 1

Principles and Practice: Definition, basic approach, gurus of TQM, TQM Framework, awareness, defining quality, historical review, obstacles, benefits of TQM. Quality Management Systems: Introduction, benefits of ISO registration, ISO 9000 series of standards, ISO 9001 requirements. **(08 hours)**

Module - 2

Leadership: Definition, characteristics of quality leaders, leadership concept, characteristics of effective people, ethics, the Deming philosophy, role of TQM leaders, implementation, core values, concepts and framework, strategic planning communication, decision making. **(08 hours)**

Module - 3

Customer Satisfaction and Customer Involvement: Customer Satisfaction: customer and customer perception of quality, feedback, using customer complaints, service quality, translating needs into requirements, customer retention, case studies. Employee Involvement – Motivation, employee surveys, empowerment, teams, suggestion system, recognition and reward, gain sharing, performance appraisal, unions and employee involvement, case studies. **(08 hours)**

Module - 4

Continuous Process Improvement: process, the Juran trilogy, improvement strategies, types of problems, the PDSA Cycle, problem-solving methods, Kaizen, reengineering, six sigma, case studies.

Statistical Process Control : Pareto diagram, process flow diagram, cause and effect diagram, check sheets, histograms, statistical fundamentals, Control charts, state of control, out of control process, control charts for variables, control charts for attributes, scatter diagrams, case studies. **(08 hours)**

Module - 5

Total Productive Maintenance (TPM): Definition, Types of Maintenance, Steps in introduction of TPM in an organization, Pillars of TPM – 5S, Jishu Hozen, Quality Maintenance, Planned Maintenance. Quality by Design (QbD): Definition, Key components of QbD, Role of QbD in Pharmaceutical Industry, Benefits and Challenges of QbD. Environmental Management Systems (EMS): Definition, Basic EMS, EMS under ISO 14001, Costs and Benefits of EMS. **(08 hours)**

5.0 Relevance to future subjects/Area

SL. No	Semester	Subject	Topics / Relevance
1	8	Operations management	Problem solving skills
2	7	Human resource management	HRM Skills

6.0 Relevance to Real World

SL. No	Real World Mapping
01	Industry, Educational institutions, Public and Private sectors and Government Organizations

7.0 Books Used and Recommended to Students

Text Books

1.Total Quality Management: Dale.H.Bester field, Publisher- Pearson Education India, ISBN:8129702606
2.Total Quality management for Engineers: M. Zairi, ISBN- 1855730243 Publisher- Wood head publishing

Reference Books

1. Managing for Quality and Performance Excellence by James R.Evans and Williuam M Lindsay, 9th edition, Publisher Cengage Learning.
2 A New American TQM, four revolutions in management, Shoji Shiba, Alan Graham, David Walden, Productivity press, Oregon, 1990
3. Organizational Excellence through TQM, H. Lal, New age Publications, 2008
4. Engineering Optimization Methods and Applications, A Ravindran, K, M. Ragsdell, Willey India Private Limited, 2nd Edition,2006
5. Introduction to Operations Research- Concepts and Cases F.S. Hillier. G.J. LiebermanTata McGraw HillTata McGraw Hill

Additional Study material & e-Books

- Nptel.ac.in
- VTU, E-learning
- MOOCs
- Open course ware

8.0 Relevant Websites (Reputed Universities and Others) for

Notes/Animation/Videos Recommended

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

9.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	International Journal for Quality Research	www.ijqr.net/journal/v4-n2/8.pdf
2	Emerald The TQM Journal information - Emerald Group Publishing	www.emeraldgrouppublishing.com/tqm.htm

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 three tests) 30 Marks.
Assignment Marks: 10
Total Internal Marks: 40

SCHEME OF EXAMINATION:
There are five modules two questions from each module
Student has to answer any five question choosing at least one questions from each module.
Max. Marks: 100 Marks

11.0 Course Delivery Plan

Unit No.	Lecture No.	Content of Lecture	% of Portion
1	1	**Principles And Practices:** Definition, basic approach,	20% (8 Hrs)
	2	Gurus of TQM,	
	3	TQM Framework, Awareness of TQM	
	4	Defining quality, historical review,	
	5	Obstacles, benefits of TQM	
	6	Quality Management Systems: Introduction, benefits of ISO registration	
	7	ISO 9000 series of standards,	
	8	ISO 9001 requirements.	
2	9	**Leadership:** Definition, characteristics of quality leaders.	40% (8 Hrs)
	10	Leadership concept, characteristics of effective people	
	11	Ethics	
	12	Deming philosophy, role of TQM leaders.	
	13	Implementation, core values,	
	14	concepts and frame work Strategic planning,	
	15	communication,	
	16	decision making	
3	17	**Customer satisfaction and employee involvement**: **Customer Satisfaction:** customer and customer perception of quality,	60% (8 Hrs)
	18	Feedback, using customer complaints, service quality,	
	19	Translating needs into requirements, customer retention, and case studies.	
	20	Employee Involvement: Motivation, employee surveys empowerment.	
	21	Teams, suggestion system,	
	22	recognition and reward	
	23	Gain sharing, performance appraisal	

	24	Unions and employee involvement, case studies.	
4	25	**Continuous Process Improvement**: process, Juran Trilogy, improvement strategies	80% (8Hrs)
	26	Types of problems, PDSA cycle,	
	27	Problem solving methods, Kaizen, Reengineering, Six sigma, case studies.	
	28	**Statistical Process Control :** Pareto diagram, process flow diagram	
	29	cause and effect diagram, check sheets, histograms,	
	30	statistical fundamentals, Control charts, state of control, out of control process,	
	31	control charts for variables, control charts for attributes	
	32	Scatter diagrams, case studies	
5	33	**Total Productive Maintenance (TPM):** Definition, Types of Maintenance,	100% (8 Hrs)
	34	Steps in introduction of TPM in an organization	
	35	Pillars of TPM – 5S, Jishu Hozen, Quality Maintenance, Planned Maintenance	
	36	**Quality by Design (QbD):** Definition, Key components of QbD,	
	37	Role of QbD in Pharmaceutical Industry	
	38	Benefits and Challenges of QbD.	
	39	**Environmental Management Systems (EMS):** Definition, Basic EMS	
	40	EMS under ISO 14001, Costs and Benefits of EMS.	

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*: Principles and Practice & QMS	Explain the various approaches of TQM	Module 1	2	Individual Activity.	Text Book
2	*Assignment-2:* Leadership	Infer the customer perception of quality	Module 2	4	Individual Activity.	Text Book
3	*Assignment-3:* Customer Satisfaction and Customer Involvement	Analyse customer needs and perceptions to design feedback systems.	Module 3	6	Individual Activity.	Text Book
4	*Assignment-4:* Continuous Process Improvement	Apply statistical tools for continuous improvement of systems	Module 4	8	Individual Activity.	Text Book
5	*Assignment-5:* Total Productive Maintenance, Quality by Design and Environmental Management Systems	Apply the tools and technique for effective implementation of TQM.	Module 5	10	Individual Activity.	Text Book

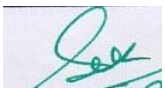
13.0 Question Bank

Sample Questions	Questions

I	**Module 1** 1) Explain TQM frame work with the help of neat sketch. 2) Define quality and explain contributions of gurus of TQM 3) List out six basic concepts of TQM and briefly explain them. 4) List out tangible and intangible benefits of TQM. 5) Discuss ISO 9000 and ISO 9001 Series of standards.
II	**Module 2** 1. List & Explain the characteristics of Quality Leaders 2. Briefly explain the seven steps to strategic planning. 3. Why quality council is established? What are the duties of quality council? 4. Explain in brief i) Vision Statement ii) Mission Statement iii) Quality Policy 5. List out seven characteristics or habits of effective people.
III	**Module 3** 1. Who is a customer? What is his role in developing organization? 2. What actions organization takes to handle customer complaints? 3. Define the term team? Why team work? 4. Define customer, what are the two types of customer. Explain with an example. 5. How does employee involvement can assist in growth of an organization?
IV	**Module 4** 1 Explain Juran Trilogy with a neat sketch. 2 Explain the concept of quality function deployment. 3 List and explain 7 tools of Quality and benefits of QFD. 4 Explain the process of Re-engineering, Kaizen and its benefits and applications 5 Discuss the meaning of Six Sigma and as a tool to improve the quality and 5S Principles. 6 Discuss the process of Bench marking and its advantages 7 Write a short note on control charts for variables and attributes.
V	**Module 5** 1 What is bench marking? Explain. 2 Write a note on QMS and EMS 3 What is QFD? Explain the house of quality with neat sketch. 4 Discuss quality by design and TPM concepts. 5 With an example explain FMEA concept.

15.0 University Result

Year	S+,S,A (FCD)	B (FC)	C,D,E (SC)	%age of passing
August/ September 2020	27	00	00	100

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

Subject Title	MECHATRONICS		
Subject Code	18ME744	IA Marks	40
Number of Lecture Hrs / Week	03	Exam Marks	60
Total Number of Lecture Hrs	50	Exam Hours	03
CREDITS – 03			

FACULTY DETAILS:		
Name: Prof. M S Futane	Designation: Asst.Professor	Experience:17
No. of times course taught:02	Specialization: CIM	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Mechanical Engineering	I/II	Basics of electronics
02	Mechanical Engineering	I/II	C Programming

2.0 Course Objectives

1. Hardware and software aspects of mechatronic systems.
2. Practical applications of mechatronic components and systems .

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3.0 Course Outcomes

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

	Course Outcome	Cognitive Level	POs	RBT level
C411.1	Explain the basics of theory, operation, design and application of sensors and actuators.	U	PO1, PO7, PO10,	L2

C411.2	Explain the basics of architecture, programming and application of microcontrollers and microprocessors.	U	PO1, PO7, PO10,	L2
C411.3	Explain the PLC,basic structure, principle of operations and integration of different elements	U	PO1, PO7, PO10,	L2
C411.4	Apply knowledge of mechanical & electrical actuation systems.	U	PO1, PO7, PO10,	L1
C411.5	Explain the pneumatic and hydraulic actuation system	U	PO1, PO7, PO10,	L2
Total Hours of instruction		**50**		

4.0 Course Content

MODULE -1

Introduction: Scope and elements of mechatronics, mechatronics design process, measurement system, requirements and types of control systems, feedback principle, Basic elements of feedback control systems, Classification of control system. Examples of Mechatronics Systems such as Automatic Car Park system, Engine management system, Antilock braking system (ABS) control, Automatic washing machine.

Transducers and sensors: Definition and classification of transducers, Difference between transducer and sensor, Definition and classification of sensors, Principle of working and applications of light sensors, Potentiometers, LVDT, Capacitance sensors, force and pressure sensors, Strain gauges, temperature sensors, proximity switches and Hall Effect sensors.

MODULE -2

Signal Conditioning: Introduction – Hardware – Digital I/O, Analog to digital conversions, resolution, Filtering Noise using passive components – Registers, capacitors, amplifying signals using OP amps. Digital Signal Processing – Digital to Analog conversion, Low pass, high pass, notch filtering. Data acquisition systems (DAQS), data loggers, Supervisory control and data acquisition (SCADA), Communication methods.

Electro Mechanical Drives: Relays and Solenoids – Stepper Motors – DC brushed motors – DC brushless motors – DC servo motors – 4-quadrant servo drives, PWM's – Pulse Width Modulation.

MODULE -3

Microprocessor & Microcontrollers: Introduction, Microprocessor systems, Basic elements of control systems, Microcontrollers, Difference between Microprocessor and Microcontrollers.

Microprocessor Architecture: Microprocessor architecture and terminology-CPU, memory and address, I/O and Peripheral devices, ALU, Instruction and Program, Assembler, Data Registers, Program Counter, Flags, Fetch cycle, write cycle, state, bus interrupts. Intel's 8085A Microprocessor.

MODULE -4

Programmable Logic Controller: Introduction to PLCs, Basic structure of PLC, Principle of operation, input and output processing, PLC programming language, ladder diagram, ladder diagrams circuits, timer counters, internal relays, master control, jump control, shift registers, data handling, and manipulations, analogue input and output, selection of PLC for application.

Application of PLC control: Extending and retracting a pneumatic piston using latches, control of two pneumatic pistons, control of process motor, control of vibrating machine, control of process tank, control of conveyer motor etc.

MODULE -5

Mechatronics in Computer Numerical Control (CNC) machines: Design of modern CNC machines - Machine Elements: Different types of guide ways, Linear Motion guideways. Bearings: anti-friction bearings, hydrostatic bearing and hydrodynamic bearing. Re-circulating ball screws. Typical elements of open and closed loop control systems. Adaptive

controllers for machine tools.

Mechatronics Design process: Stages of design process – Traditional and Mechatronics design concepts – Case studies of Mechatronics systems – Pick and place Robot – Automatic car park barrier.

5.0 Relevance to future subjects

Sl No	Semester	Subject	Topics
01	VIII	Project work	Sensors
02	VIII	Control Engineering	Control systems

6.0 Relevance to Real World

SL.No	Real World Mapping
01	Automation and Robotics
02	Sensing and Control system
03	Servo Mechanics

7.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
01	Tutorial	Topic: Electrical systems, Mechanical switches, solid-state switches, solenoids

8.0 Books Used and Recommended to Students

Text Books
1. 'Mechatronics', W.Bolton, Longman, 2Ed, Pearson Publications, 2007.
2. Microprocessor Architecture, Programming And Applications With 8085/8085A, R.S. Ganokar, Wiley Eastern
3.Nitaigour Premchand Mahalik , Mechatronics-Principles, Concepts and Applications, Tata McGraw Hill,1stEdition, 2003 ISBN.No. 0071239243, 9780071239240.
Reference Books
1.Mechatronics by HMT Ltd. – Tata McGrawHill, 1stEdition, 2000. ISBN:9780074636435.
2. Mechatronics: Integrated Mechanical Electronic Systems, K.P. Ramachandran, G.K. Vijayaraghavan, M.S. Balasundaram, Wiley India Pvt. Ltd. New Delhi, 2008
3. Introduction to Mechatronics and Measurement Systems, David G. Aldatore, Michael B. Histand, McGraw-Hill Inc USA, 2003
4. Introduction to Robotics: Analysis, Systems, Applications., Saeed B. Niku, Person Education, 2006
5. Mechatronics System Design, Devdas Shetty, Richard A. kolk, Cengage publishers, second edition
Additional Study material & e-Books
1. Mechatronics by K R Gopalkrishna&Mahilik

9.0 Relevant Websites (Reputed Universities and Others) for

Notes/Animation/Videos Recommended

Website and Internet Contents References
1) http://www.vtuupdates.com/2016/09/download-vtu-mech-mam-notes-question-papers.html
2) http://www.mechatronics2u.in/2014/05/microprocessor-overall-notes-for-all-5.html
3) http://www.slideshare.net/AbhijithAugustine/microprocessors-and-microcontrollers-short-answer-questions-and-answers

10.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	Journal of Mechatronics	https://www.journals.elsevier.com/mechatronics
2	IEEE/ASME Transactions on Mechatronics	http://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=3516
3	Journals of mechanical and mechatronics engineering	http://ait.libguides.com/c.php?g=280063&p=1866373

11.0 Examination Note

Internal Assessment: 40 Marks
Theoretical aspects as well as relevant sketches should be drawn neatly.

Scheme of Evaluation for Internal Assessment (40 Marks)
(a) Internal Assessment test in the same pattern as that of the main examination (Better of the two Tests):25marks.

SCHEME OF EXAMINATION:
Student has to answer any five question choosing at least one questions from each module .

INSTRUCTION FOR MECHATRONICS AND MICRO PROCESSOR (10ME65) EXAMINATION

1. Draw the neat sketches for relevant theory. The total duration is 3 hours.
2. Draw the Block diagrams required for control systems.

2.0 Course Delivery Plan

Module No.	Lecture No.	Content of Lecture	% of Portion
		PART - A	
1	1	Definition, Multidisciplinary Scenario.	20%
	2	Evolution of Mechatronics,	
	3	Design of Mechatronics system	
	4	Objectives of Mechatronics system	
	5	Advantages and disadvantages of Mechatronics.	

	6	Definition and classification of transducers and sensor	
	7	Definition and classification of sensors	
	8	Principle of working and applications of light sensors	
	9	Principle of working and applications proximity switches.	
	10	Principle of working and applications Hall Effect sensors	
2	11	Introduction – Hardware – Digital I/O, Analog to digital conversions	40%
	12	Filtering Noise using passive components – Registers, capacitors, amplifying signals using OP amps	
	13	Digital Signal Processing	
	14	Data acquisition systems (DAQS), data loggers, Supervisory control and data acquisition (SCADA)	
	15	Communication methods	
	16	Relays and Solenoids	
	17	Stepper Motors – DC brushed motors	
	18	DC servo motors – 4-quadrant servo drives	
	19	PWM's – Pulse Width Modulation	
	20	DC brushless motors	
3	21	Intel's 8085A Microprocessor.	60%
	22	Introduction of Microprocessor systems, Basic elements of control systems, Microcontrollers	
	23	Difference between Microprocessor and Microcontrollers.	
	24	Microprocessor architecture and terminology	
	25	About CPU, memory and address, I/O and Peripheral devices	
	26	Explanation of ALU, Instruction and Program	
	27	Assembler, Registers	
	28	Explanation of Program Counter, Flags	
	29	Fetch cycle, write cycle	
	30	Explanation of bus interrupts.	
4	31	Introduction to PLCs, Basic structure of PLC	80 %
	32	Principle of operation, input and output processing	
	33	PLC programming language, ladder diagram, ladder diagrams circuits	
	34	timer counters, internal relays, master control, jump control	
	35	shift registers, data handling, and manipulations, ,	
	36	analogue input and output	
	37	selection of PLC for application.	
	38	Application of PLC control Extending and retracting a pneumatic piston using latches	
	39	control of two pneumatic pistons, control of process motor	
	40	control of vibrating machine, control of process tank, control of conveyer motor etc.	
5	41	Introduction of Mechatronics in Computer Numerical Control (CNC) machines	100%
	42	Design of modern CNC machines -	
	43	Machine Elements: Different types of guide ways,	
	44	Linear Motion guideways.	
	45	Bearings: anti-friction bearings, hydrostatic bearing and hydrodynamic bearing. Re-circulating ball screws.	
	46	Typical elements of open and closed loop control systems.	

	47	Adaptive controllers for machine tools.	
	48	Mechatronics Design process, Stages of design process	
	49	Traditional and Mechatronics design concepts	
	50	Case studies of Mechatronics systems – Pick and place Robot – Automatic car park barrier.	

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: Transducers and sensors	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 1	3	Individual Activity.	Book 1, of the reference list. Website of the Reference list
2	Assignment 2: Signal Conditioning	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 2	6	Individual Activity.	Book 1,2 of the reference list. Website of the Reference list
3	Assignment 3: Microprocessor & Microcontrollers	Students study the Topics and write the Answers. Get practice to solve university questions.	Module3	12	Individual Activity.	Book 1, of the reference list. Website of the Reference list
4	Assignment 4: Programmable logic controller	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 4	15	Individual Activity.	Book 1,2 of the reference list. Website of the Reference list
5	Assignment 5: Mechatronics in CNC	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 5	18	Individual Activity.	Book 1,2, of the reference list. Website of the Reference list

14.0 QUESTION BANK

MODULE – 1

1. What are the objectives of Mechatronics?
2. Explain five areas of application of mechatronics.
3. What are the advantages and disadvantages of Mechatronic systems?
4. Write a note on microprocessor based controllers.
5. Explain the mechatronic based engine management system with a block diagram.
6. Define sequential controller and explain with a block diagram the working of domestic washing machine.
7. State the functions of basic elements of a closed loop control system with a block diagram.
8. With a neat sketch explain any one of the best examples of the closed loop control system.
9. With a block diagram briefly explain the generalized measurement system.
10. Enumerate the differences between open loop and closed loop control systems.
11. Explain how microprocessors are useful in automatic cameras.
12. Explain the working of a eddy current proximity sensor.
13. List the different types of internal and external sensors used in mechatronic system and briefly explain.
14. State in general, the principle of operation of transducers and highlight their difference with sensors.

15. Briefly explain any two types of transducers.
16. Explain the following terminology related to transducers. (a) Accuracy (b) Repeatability (c) Stability (d) Sensitivity (e) Drift (f) Speed of response
17. What is the basic principle of a light sensor?
18. Explain the different types of sensors.
19. Explain the following: (a) Primary and secondary transducer (b) Active and passive transducer (c) Analog and digital transducer
20. Explain how a proximity sensor can be used in a closed loop to detect the presence of an object.
21. Distinguish between (a) Input transducers and Output transducers (b) Mechanical transducers andElectrical transducers.

MODULE – 2

1. Explain briefly Analog to digital converter
2. Explain with sketch Registers & capacitors
3. Explain with sketch Low pass, high pass, notch filtering
4. Explain Data acquisition systems (DAQS)
5. Explain Supervisory control and data acquisition (SCADA)
6. What are Relays
7. Explain Solenoids
8. Stepper Motors
9. Explain DC brushed motors & DC brushless motors
10. Write note on 4-quadrant servo drives
11. Discuss about the Pulse Width Modulation.

MODULE – 3

12. Explain briefly evolution of microprocessor
13. List any five application areas of microprocessor
14. Write the truth tables of OR,NOR,AND & NAND gates
15. What is meant by malty core design? What are its features &advantages.
16. Explain the laws of Boolean algebra with illustration.
17. State & explain Demorgan theorem. Write its truth table
18. What are logic gates? What is its function?
19. Explain memory representation of positive and negative integers.
20. What is floating point notation? Explain accuracy and range in floating point representation.
21. Write the architecture of 8085 m
22. What is micro controller?
23. Write note on classification of.
24. Discuss about the memory & address related to the micro controller.
25. Explain the following 1) Fetch cycle 2) State 3) Bus

MODULE – 4

1. What is PLC?
2. Explain the PLC structure..
3. Explain briefly the ladder diagram..
4. Discuss PLC programming language
5. Write a note on timer counters, internal relays, master control
6. Write a note on jump control, shift registers, data handling, and manipulations
7. Explain briefly the selection of PLC for application.

MODULE –5

1. Explain Different types of guide ways.
2. Write a note on anti-friction bearings, hydrostatic bearing and hydrodynamic bearing
3. With a neat sketch explain Re-circulating ball screws
4. Discuss Adaptive controllers for machine tools
5. Explain Stages of design process
6. Explain briefly Traditional and Mechatronics design concepts

7. Explain any one Case studies of Mechatronics systems

16.0 University Result

Examination	S+	S	A	B	C	D	E	% Passing
2020-21	00	04	21	48	27	06	2	100

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

Subject Title	ENERGY ENGINEERING		
Subject Code	15ME71/17ME71	CIE Marks	40
Number of Lecture Hrs / Week	04	SEE Marks	60
Total Number of Lecture Hrs	50	Exam Hours	03
		CREDITS – 04	

FACULTY DETAILS:		
Name: Prof. M. M. Shivashimpi	Designation: Asst. Professor	Experience:13
No. of times course taught: 02	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
03	Mechanical Engineering	VI	Heat & Mass Transfer

2.0 Course Objectives

1. Understand energy scenario, energy sources and their utilization.
2. Learn about energy conversion methods and their analysis.
3. Study the principles of renewable energy conversion systems.
4. Understand the concept of green energy and zero energy.

3.0 Course Outcomes

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

	Course Outcome	Cognitive Level	POs
C401.1	Summarize the basic concepts of thermal energy conversion systems	L2	PO1,PO6

C401.2	Understand the basic concept of diesel power plant and estimation of hydro-electrical energy potential	L1	PO1,PO2,PO4, PO11
C401.3	Understand the basic concepts of solar radiation and analyze the working of solar PV and thermal systems	L3	PO1,PO2,PO4, PO11
C401.4	Understand the conversion principles of wind and tidal energy	L1	PO1,PO2,PO6, PO11
C401.5	Understand the basic principles of biomass energy and green energies	L2	PO1,PO2,PO6, PO11
	Total Hours of instruction	**50**	

4.0 Course Content

Module 1

Thermal Energy conversion system: Review of energy scenario in India, General Philosophy and need of Energy ,Different Types of Fuels used for steam generation, Equipment for burning coal in lump form, strokers, different types, Oil burners, Advantages and Disadvantages of using pulverized fuel, Equipment for preparation and burning of pulverized coal, unit system and bin system. Pulverized fuel furnaces, cyclone furnace, Coal and ash handling, Generation of steam using forced circulation, high and supercritical pressures. Chimneys: Natural, forced, induced and balanced draft, Calculations and numerical involving height of chimney to produce a given draft. Cooling towers and Ponds. Accessories for the Steam generators such as Super heaters, De-super heater, control of super heaters, Economizers, Air preheaters and re-heaters.

10**hours**

Module 2

Diesel Engine Power System: Applications of Diesel Engines in Power field. Method of starting Diesel engines. Auxiliaries like cooling and lubrication system, filters, centrifuges, Oil heaters, intake and exhaust system, Layout of diesel power plant.

Hydro-Electric Energy: Hydrographs, flow duration and mass curves, unithydrograph and numerical. Storage and pondage, pumped storage plants, low, medium and high head plants, Penstock, water hammer, surge tanks,gates and valves. General layout of hydel power plants.

10 hours

Module 3

Solar Energy: Fundamentals; Solar Radiation; Estimation of solar radiation on horizontal and inclined surfaces; Measurement of solar radiation data, Solar Thermal systems: Introduction; Basics of thermodynamics and heat transfer; Flat plate collector; Evacuated Tubular Collector; Solar air collector; Solar concentrator; Solar distillation; Solar cooker; Solar refrigeration and air conditioning; Thermal energy storage systems, Solar Photovoltaic systems: Introduction; Solar cell Fundamentals; Characteristics and classification; Solar cell: Module, panel and Array construction; Photovoltaic thermal systems.

10 hours

Module 4

Wind Energy: Properties of wind, availability of wind energy in India, wind velocity and power from wind; major problems associated with wind power,wind machines; Types of wind machines and their characteristics, horizontal and vertical axis wind mills, coefficient of performance of a wind mill rotor(Numerical Examples).

Tidal Power: Tides and waves as energy suppliers and their mechanics; fundamental characteristics of tidal power, harnessing tidal energy, limitations.

10 hours

Module 5

Biomass Energy: Introduction; Photosynthesis Process; Biofuels; Biomass Resources; Biomass conversion technologies; Urban waste to energy conversion; Biomass gasification.

Green Energy: Introduction: Fuel cells: Overview; Classification of fuel cells; Operating principles; Fuel cell thermodynamics Nuclear, ocean, MHD, thermoelectric and geothermal energy applications; Origin and their types; Working principles, Zero energy Concepts. **10 hours**

5.0 Relevance to future subjects

Sl No	Semester	Subject	Topics
01	VIII	Project work and related activities	Design and Development of Energy conversion systems through the projects and related activities

6.0 Relevance to Real World

SL.No	Real World Mapping
01	Addressing issues related to Green energy production & transformation for all sectors, Energy cost, Energy sustainability, Environmental Pollution, Energy Utilization etc.

7.0 Gap Analysis and Mitigation

Sl. No	Gap identified	Mitigation Details
1	Present Energy Crisis	May be mitigated through seminars/workshops etc.
2	Experiencing Real time and complex energy related problems	May be mitigated through seminars/workshops etc. projects and activities
3	Realization of the concepts	May be mitigated through Industrial visits and field trips etc.

8.0 Books Used and Recommended to Students

Text Books

1. B H Khan, Non conventional energy resources, 3rd Edition, McGraw Hill Education.
2. Principles of Energy conversion, A. W. Culp Jr., McGraw Hill. 1996.

Reference Books

1. S.P. Sukhatme, Solar Energy: principles of Thermal Collection and Storage, Tata McGraw- Hill (1984).
2. C. S. Solanki, "Solar Photovoltaic's: Fundamental Applications and Technologies, Prentice Hall of India, 2009.
3. L.L. Freris, Wind Energy Conversion Systems, Prentice Hall, 1990.

Additional Study material & e-Books

1. G.D. Rai, "Non-conventional Energy Sources"
2. E-book URL: https://www.pdfdrive.com/non-conventional-energy-sources-e10086374.html
3. E-book URL:https://www.pdfdrive.com/non-conventional-energy-systems-nptel- d17376903.html
4. E-book URL: https://www.pdfdrive.com/renewable-energy-sources-and-their-applications- e33423592.html
5. E-book URL: https://www.pdfdrive.com/lecture-notes-on-renewable-energy-sources- e34339149.html

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

Website and Internet Contents References

1. **www.nptel.ac.in**

https://onlinecourses.nptel.ac.in/noc18_ge09/preview
https://onlinecourses.nptel.ac.in/noc18_ge14/preview
https://nptel.ac.in/courses/121106014/4
https://nptel.ac.in/courses/108108078/
https://onlinecourses.nptel.ac.in/noc18_ge09/announcements

2. www.vtu.ac.in

https://lecturenotes.in/materials/66-non-conventional-energy-systems?utm_source=subjectpage&utm_medium=web&utm_campaign=materialpage
http://www.library.vtu.ac.in/?page_id=611/

10.0 Magazines/Journals Used and Recommended to Students

Sl. No.	Magazines/Journals	website
1	Journal Publications	https://www.journals.elsevier.com/renewable-energy
2	Journal Publications	https://www.journals.elsevier.com/energy-for-sustainable-development
3	Journal Publications	https://www.journals.elsevier.com/renewable-energy/recent-articles
4	Journal Publications	https://www.journals.elsevier.com/renewable-energy/special-issues
5	Journal Publications	https://www.springer.com/energy/renewable+and+green+energy?SGWID=0-1721214-12-812104-0
6	Journal Publications	https://www.springer.com/engineering/electronics/journal/11949
7	Journal Publications	https://www.springer.com/in/energy/renewable-green-energy
8	Journal Publications	https://www.springer.com/in/energy
9	Journal Publications	https://www.tandfonline.com/toc/gsol20/current
10	Journal Publications	https://www.tandfonline.com/toc/ueso20/current
11	Journal Publications	https://www.taylorfrancis.com/books/9781498760485
12	Magazine	https://www.renewableenergyworld.com/magazines.html

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 Lecture	% of Portion
I	1	Review of energy scenario in India, General Philosophy and need of Energy	20
	2	Different Types of Fuels used for steam generation, Equipment for burning coal in lump form, strokers, different types, Oil burners	
	3	Advantages and Disadvantages of using pulverized fuel, Equipment for preparation and burning of pulverized coal, unit system and bin system	
	4	Pulverized fuel furnaces, cyclone furnace, Coal and ash handling	
	5	Generation of steam using forced circulation, high and supercritical pressures.	
	6	Chimneys: Natural, forced, induced and balanced draft, Calculations	
	7	Numerical involving height of chimney to produce a given draft Cooling towers and	

		Ponds	
	8	Accessories for the Steam generators such as Super heaters	
	9	Accessories for the Steam generators such as De-super heater, control of super heaters	
	10	Accessories for the Steam generators such as Air preheaters and re-heaters	
II	11	**Diesel Engine Power System**: Applications of Diesel Engines in Power field	40
	12	Method of starting Diesel engines. Auxiliaries like cooling	
	13	Auxiliaries like lubrication system, filters, centrifuges	
	14	Auxiliaries like Oil heaters, intake and exhaust system	
	15	Layout of diesel power plant	
	16	**Hydro-Electric Energy**: Hydrographs, flow duration and mass curves, unithydrograph	
	17	Solving related numericals	
	18	Storage and pondage, pumped storage plants, low, medium and high head plants	
	19	Penstock, water hammer, surge tanks,gates and valves	
	20	General layout of hydel power plants	
III	21	**Solar Energy**: Fundamentals; Solar Radiation	60
	22	Estimation of solar radiation on horizontal and inclined surfaces	
	23	Measurement of solar radiation data	
	24	Solar Thermal systems: Introduction; Basics of thermodynamics and heat transfer	
	25	Flat plate collector; Evacuated Tubular Collector; Solar air collector; Solar concentrator	
	26	Solar distillation; Solar cooker; Solar refrigeration and air conditioning	
	27	Thermal energy storage systems, Solar Photovoltaic systems: Introduction	
	28	Solar cell Fundamentals; Characteristics and classification;	
	29	Solar cell: Module, panel and Array construction; Photovoltaic thermal systems	
	30	Solving related numericals	
IV	31	**Wind Energy**: Properties of wind, availability of wind energy in India	80
	32	wind velocity and power from wind; major problems associated with wind power, wind machines	
	33	Types of wind machines and their characteristics, horizontal and vertical axis wind mills	
	34	coefficient of performance of a wind mill rotor	
	35	Solving related numericals	
	36	Solving related numericals	
	37	**Tidal Power**: Tides and waves as energy suppliers	
	38	Tides and wave mechanics;	
	39	Fundamental characteristics of tidal power	
	40	Harnessing tidal energy and limitations	
V	41	**Biomass Energy**: Introduction	100
	42	Photosynthesis Process; Biofuels	
	43	Biomass Resources; Biomass conversion technologies	
	44	Urban waste to energy conversion;	

45	Biomass gasification.
46	**Green Energy**: Introduction: Fuel cells: Overview; Classification of fuel cells
47	Operating principles; Fuel cell thermodynamics Nuclear
48	Ocean, MHD, thermoelectric
49	Geothermal energy applications; Origin and their types; Working principles
50	Zero energy Concepts

13.0 Assignments, Pop Quiz, Mini Project, Seminars

Sl.No.	Title	Outcome expected: students able to	Allied study	Week No.	Individual / Group activity	Reference: book/website /Paper
1	Assignment 1: Questions on **Thermal Energy conversion system**	Summarize the basic concepts of thermal energy systems and Identify renewable energy sources and their utilization	Module 1	2	Individual Activity.	Refer all Text Books, Reference books and e-materials
2	Assignment 2: Questions on **Diesel Engine Power System and Hydro- Electric Energy**	Understand principles of energy conversion from alternate sources including Hydel, Diesel etc.	Module 2	4	Individual Activity.	Refer all Text Books, Reference books and e-materials
3	Assignment 3: Questions on **Solar Energy**	Understand the basic concepts of solar radiation and analyze the working of solar PV and thermal systems.	Module 3	6	Individual Activity.	Refer all Text Books, Reference books and e-materials
4	Assignment 4: Questions on **Wind Energy and Tidal Power**	Understand principles of energy conversion from alternate sources including wind, Tidal etc.	Module 4	8	Individual Activity.	Refer all Text Books, Reference books and e-materials

5	Assignment5: Questions on **Biomass Energy and Green Energy**	Understand principles of energy conversion from alternate sources including wind, biomass, biogas Understand the concepts and applications of fuel cells, thermoelectric convertor and MHD generator and to Identify methods of energy storage for specific applications	Module 5	8	Individual Activity.	Refer all Text Books, Reference books and e-materials

14.0 QUESTION BANK

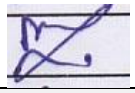
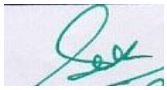
Module 1	
1	Draw a general layout of a modern steam power plaint showing the different circuits and systems and explain the operation of the plant.
2	Explain the different types of fuels used for steam power generation.
3	Write the important points considered for selection of site for steam power plant.
4	Describe in brief various stages of coal handling.
5	What are the difficulties encountered with ash handling? Sketch and explain the following ash handling system, i) Mechanical ii) Hydraulic pneumatic and steam jet. Also write there merits and demerits if any.
6	Sketch and explain the following methods of coal firing: Stoker firing and its advantages. a. Principle of over feed and under feed stokers. b. Chain grate stoker and its advantages & disadvantages c. Spreader stoker, advantages & Disadvantages. d. Single and Multi report underfeed stokers their merits & demerits. e. Pulverized fuel firing advantages & disadvantages. f. Unit system advantages & Disadvantages. g. Central or bin system their advantage & disadvantage.
7	Sketch and explain the following pulveriser i) Bowl mills ii) Ball and race mills iii) Ball mills, (iv) Impact or Hammer mills.
8	Sketch and explain the following pulverised fuel burners i) Long flame burner ii) Turbulent burner & its advantages. iii) Tangential burners and its advantages. iv) Cyclones burners and its advantages.
9	Write the importance of the following boiler accessories: i) Economizer, ii) Air preheater, iii) Reheater, iv) Super heater. Also explain their working with neat sketches. Describe in brief various methods of super heater temperature control.
10	Write advantages and disadvantages of i) Induced draft cooling tower ii) Forced draft cooling tower iii) Natural cooling tower.
11	Describe with sketch natural draught. Derive an expression for the height of chimney.
Module 2	
1	Draw a neat layout of diesel power plant and label all the components and explain.
2	List the advantages and disadvantages of diesel power plant over thermal power plant.
3	What are the different fields where use of diesel power plant is essential?
4	Explain with sketch i) The cooling system ii) Lubrication system, iii) Fuel storage and fuel supply system iv) Air

	supply system v) Exhaust system, vi) starting system of diesel power plant.
5	What is Hydro electric power plant? Write is merits and demerits. How it is classified.
6	Explain the various elements of general Layout for a hydro electric power plant.
7	What are the different factors to be considered while selecting the site for hydroelectric power plant?
8	Define hydrology. What is the importance of rainfall and run off data in the design of hydro electric power plant?
9	Explain with sketches i) Hydrograph, ii) Unit Hydrograph. Flow direction curve, Mass curve etc.
10	Write in brief important Hydro electric power plants in India.
11	Numerical Ref. Class notes.
Module 3	
1	i) Define solar constant ii) What are the reasons for variation in solar radiation reaching the earth than received at the outside of the atmosphere?
2	Write notes on beam and diffuse radiation
3	Define the terms i) altitude angle ii) incident angle iii)zenith angle iv) solar azimuth angle v) latitude angle vi) Declination angle vii) hour angle
4	Calculate the angle made by the beam radiation with the normal flat plate collector, pointing Due south located in New Delhi (28°28'N, 77 ° 17'E) at 9:00 hour, solar time on Dec 1. the collector is tilted at angle of 36 deg with the horizontal?
5	Calculate the sunset hour angle and day length at location latitude of 35 ° N, on Feb 14?
6	What is the difference between a pyrheliometer and pyranometer. Describe the principle of Aungstrom type pyrheliometer?
7	Estimate the daily global radiation in a horizontal surface at Baroda (22°13'N,73 ° 13'E) during the month of march. If constants A and B are given equal to 0.28 and 0.48 respectively and average sunshine hours for days are 9.5?
Module 4	
1	What is the basic principle of wind energy conversion.
2	Prove that in case of horizontal axis wind turbines maximum power can be obtained when Exit velocity=1/3(wind velocity)P_{max}= (8/27) ρ A V^3.
3	Describe the main considerations in selecting a site for wind generators.
4	Describe with neat sketch the working of a wind energy system(WECS) with main components.
5	How are WEC systems classified? Discuss briefly.
6	Discuss advantages and disadvantages of wind energy conversion system.
7	Describe horizontal axis type aero generators.
8	Discuss the advantages and disadvantages of horizontal and vertical axis wind mill. What methods are used to overcome the fluctuating power generation of wind mill?
9	Describe the different schemes for wind electric generation or describe the generating system. Also describe the generator control schemes.
10	Describe the main applications of wind energy giving neat sketches.
11	Explain with sketches the various methods of tidal power generation. What are the limitations of each method?
12	What are difficulties in tidal power development?
13	What are the advantages and disadvantages of tidal energy conversion?
14	What are the applications of tidal energy?
Module 5	
1	How biomass conversion takes place.
2	What is difference between biomass and Biogas.
3	What is meant by anaerobic digestion? What are the factors, which affect bio digestion explain briefly.
4	How are biogas plants classified. Explain them briefly.

5	What are the advantages and disadvantages of floating drum plants?
6	Name the various models of biogas plants.
7	What is meant by wet fermentation and dry fermentation?
8	Give list of materials used for biogas generation.
9	What are the factors which affect the size of the biogas plant?
10	write the main allocation of biogas.

16.0 University Result

Year	S+,S,A (FCD)	B (FC)	C,D,E (SC)	%age of passing
January /February 2021	33	25	02	96.77

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

Subject Title	Fluid Power Systems		
Subject Code	15/17ME72	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
1. http://www.nptel.ac.in 4) 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/

10.0 Examination Note

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**	
	25	Introduction to Pneumatic systems**:** Pneumatic power system, advantages, limitations, applications, Choice of working medium	

	26	Characteristics of compressed air and air compressors	80
	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

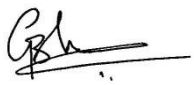
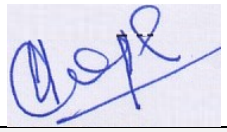
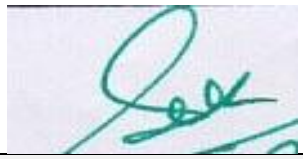
VI	**Module 1** 1. State Pascal's law. Explain briefly its applications. 2. List the merits and demerits of hydraulic system. 3. State the application of hydraulics and pneumatics in a hydraulic press a force of 100N is exerted on the smaller piston (area is 50 cm^2) Determine the Upward force on the 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.
VII	**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
VIII	**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?

IX	**Module-4** 26. What is fire resistant fluid? Name any four and list out advantages and disadvantages 27. Identify eight recommendations that should be followed for properly maintaining and disposing of hydraulic fluid. 28. Differentiate between a) Internal and external leaks b) Positive and non positive seal c) Static and dynamic seal 29. Explain various types of filtering? 30. 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
	8. With a sketch explain any one practical application of multi-cylinder pneumatic system. 9. Explain advantages of cascading method of design of a pneumatic system 10. Explain steps involved in cascading method of design of a pneumatic system. 4. Explain clearly the following as applied to electro-pneumatic controls: i) Normally closed Relay switch ii) Normally open Relay switch 5. What is an electrical relay? How does it work? 6. With a neat sketch explain Control circuitry for simple single cylinder application. 7. Mention the advantages of compressed air as a signal transmission agent. 8. Sketch and explain briefly the following: i) Pneumatic pressure regulator. ii) Air-Filter for pneumatic systems. 9. Describe the elements of FRL unit. 10. 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**		
Course coordinator	**Module coordinator**	**HOD**	**Principal**

SubjectTitle	**TRIBOLOGY**		
SubjectCode	17ME742	**IAMarks**	40
NumberofLecture Hrs/	03	**ExamMarks**	60
TotalNumberofLecture	40	**ExamHours**	03
CREDITS – 03			

FACULTY DETAILS:		
Name: Mr.D.N.Inamdar	**Designation:** Asst. Professor	**Experience:** 19 Years
No. of times course taught:01 Times	**Specialization:** Tool Design.	

1.0 PrerequisiteSubjects:

Sl.No	Branch	Semester	Subject
01	AppliedScience	ItoIV	EngineeringMathematics
02	MechanicalEngineering	III	MechanicsOfMaterials
03	MechanicalEngineering	V/VI	DesignofMachine Elements

2.0 Course Objectives

5. Toeducatethestudentsontheimportanceoffriction,therelatedtheories/lawsofslidingandrollingfrictionandtheeffectofviscosityoflubricants.
6. Toexposethestudentstotheconsequencesofwear,wearmechanisms,weartheoriesandanalysisofwearproblems.
7. Tomakethestudentsunderstandtheprinciplesoflubrication,lubricationregimes,theoriesofhydrodynamic andthe advancedlubricationtechniques.
8. Toexposethestudentstothefactors influencingtheselectionofbearingmaterialsfordifferentslidingapplications.
9. Tointroducetheconceptsofsurfaceengineeringanditsimportanceintribology.

3.0 CourseOutcomes

Afterstudyingthiscourse,studentswillbeable to:

co	CourseOutcome	Cognitive Level	POs
C426.1	Understandthefundamentalsoftribologyandassociated parameters	U	1,2,4,6,8,11,12
C426.2	Applyconceptsoftribologyfortheperformanceanalysisanddesignof componentsexperiencingrelativemotion.	U	1,2,4,6,8,11,12
C426.3	Analysetherequirementsanddesignhydrodynamicjournaland planesliderbearingsforagivenapplication.	U	1,2,4,6,8,11,12
C426.4	Selectproperbearingmaterialsandlubricantsforagiven tribologicalapplication.	U	1,2,4,6,8,11,12
C426.5	Applytheprinciplesofsurfaceengineeringfordifferent applicationsoftribology.	U	1,2,4,6,8,11,12

4.0 CourseContent

Module 1

Introduction to tribology: Historical background, practical importance, and subsequent use in thefield.

Lubricants: Typesandspecificfieldofapplications.Propertiesoflubricants,viscosity,itsmeasurement, effect of temperature and pressure on viscosity, lubrication types, standard grades oflubricants,andselectionoflubricants. **8hours**

Module 2

Friction: Origin,frictiontheories,measurementmethods,frictionofmetalsandnon-metals.

Wear: Classificationandmechanismsof wear,delaminationtheory,debrisanalysis,testingmethodsandstandards.Relatedcasestudies.

8hours

Module 3

Hydrodynamicjournalbearings: Frictionforcesandpowerlossinalightlyloadedjournalbearing,Petroff's equation, mechanism of pressure development in an oil film, and Reynold's equation in 2D.

Introductiontoidealizedjournalbearing,loadcarryingcapacity,conditionforequilibrium,Sommerfeld'snumberandit'ssignificance;partialbearings,endleakagesinjournalbearing,numericalexamples onfulljournalbearings only.**8 hours**

Module 4

Planesliderbearingswithfixed/pivotedshoe: Pressuredistribution,Loadcarryingcapacity,coefficientoffriction,frictionalresistanceinafixed/pivotedshoebearing,centerofpressure,numericalexamples.

Hydrostatic Lubrication: Introduction tohydrostaticlubrication,hydrostatic step bearings,loadcarrying capacityand oilflowthroughthehydrostatic step bearing,numericalexamples.

8 hours

Module 5

BearingMaterials: Commonlyusedbearingsmaterials, andpropertiesoftypicalbearingmaterials.Advantagesanddisadvantagesofbearing materials.

IntroductiontoSurfaceengineering: Conceptandscopeofsurfaceengineering.Surfacemodification– transformationhardening,surfacemelting,thermochemicalprocesses.SurfaceCoating – plating,fusionprocesses,vaporphaseprocesses.Selectionofcoatingforwearandcorrosion resistance. **8hours**

5.0 Relevance to futuresubjects

SlNo	Semester	Subject	Topics
01	VIII	Project work	Determining tribological Parameters

6.0 Relevance to RealWorld

SL.No	Real World Mapping

01	DesignofBearingfor industrial applications

7.0 BooksUsedandRecommendedtoStudents

Text Books

1. "IntroductiontoTribology",B.Bhushan, JohnWiley&Sons,Inc.,NewYork,2002
2. "EngineeringTribology",PrasantaSahoo,PHILearningPrivateLtd,NewDelhi,2011.
3. "EngineeringTribology",J.A.Williams,OxfordUniv.Press,2005

ReferenceBooks

1. "Introductionto Tribologyinbearings",B.C.Majumdar,WheelerPublishing.
2. "Tribology,FrictionandWearofEngineeringMaterial",I.M.Hutchings,EdwardArnold,London,1992.
3. "EngineeringTribology",G.W.StachowiakandA.W.Batchelor,Butterworth-Heinemann,1992.
4. "FrictionandWearofMaterials", ErnestRabinowicz,JohnWiley&sons,1995.
5. "BasicLubricationTheory",A.Cameron,EllisHardwoodsLtd.,UK.
6. "Handbookoftribology: materials,coatingsandsurfacetreatments",B.Bhushan,B.K.Gupta,McGraw- Hill,1997.

8.0 RelevantWebsites(ReputedUniversitiesandOthers)forNotes/Animation/VideosRecommended

WebsiteandInternetContentsReferences

1. www.nptel.ac.in
2. www.vtu.ac.in

9.0 Magazines/JournalsUsedandRecommendedtoStudents

Sl.No	Magazines/Journals	website
1	JournalofTribology	tribology.asmedigitalcollection.asme.org/journal.aspx
2	TribologyInternational-Journal-Elsevier	https://www.journals.elsevier.com/tribology-international

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 CourseDeliveryPlan

Module No.	Lecture No.	Content ofLecture	%of Portion
1	1	**Introductiontotribology:**Historicalbackground,practical importance	20%
	2	Subsequentuseinthefield.	
	3	**Lubricants:**Typesandspecificfieldofapplications.	
	4	Propertiesoflubricants,viscosity,itsmeasurement	
	5	Effectoftemperatureand pressureonviscosity	
	6	Lubricationtypes	
	7	Standard gradesoflubricants	
	8	Selectionoflubricants.	
2	9	**Friction:**Origin,frictiontheories	20%
	10	Measurementmethods	
	11	Frictionofmetalsandnon-metals	
	12	**Wear:**Classificationandmechanismsofwear	
	13	Delaminationtheory,debrisanalysis,	
	14	Testing methodsandstandards.	
	15	Relatedcasestudies.	
	16	Problems	
3	17	**Hydrodynamicjournalbearings:**Frictionforcesandpowerlossinalightlyloadedjournalbearing,	20%
	18	Petroff'sequation	
	19	Mechanismofpressuredevelopmentinanoilfilm	
	20	Reynold'sequationin2D.	
	21	Introductiontoidealizedjournalbearing,loadcarryingcapacity,	
	22	Conditionforequilibrium,	
	23	Sommerfeld'snumberandit'ssignificance	
	24	Partialbearings	
	25	End leakagesinjournalbearing	
	26	Numericalexamplesonfulljournalbearingsonly.	
4	27	**Planesliderbearingswithfixed/pivotedshoe:**Pressuredistribution	20%
	28	Loadcarryingcapacity,coefficientoffriction	
	29	Frictionalresistanceinafixed/pivotedshoebearing	
	30	Centerofpressure, numericalexamples.	
	31	**HydrostaticLubrication:**Introductiontohydrostaticlubrication,	
	32	Hydrostaticstepbearings,loadcarryingcapacity	
	33	Oilflowthroughthehydrostaticstep bearing	
	34	Numericalexamples.	
	35	**BearingMaterials:** Commonlyusedbearingsmaterials	20%
	36	Propertiesoftypicalbearing materials.	
	37	Advantagesanddisadvantagesofbearingmaterials	
	38	**IntroductiontoSurfaceengineering:**Conceptandscopeofsurfaceengg.	

5	39	Surfacemodification–transformationhardening,surface melting,
	40	Thermo chemicalprocesses
	41	SurfaceCoating–plating,fusionprocesses,vaporphaseprocesses.
	42	Selectionofcoatingforwearandcorrosionresistance.

12.0 Assignments,PopQuiz,MiniProject,Seminars

Sl.No.	Title	Outcomeexpected: studentsableto	Allied study	Week No.	Individual/Groupactivity	Reference: book/website /Paper
1	Assignment1:Questionson Introductionto tribology&Lubricants:	BasicdefinitionsandPropertiesoflubricants	Module 1	2	Individual Activity.	Refer all Text Books and Reference books
2	Assignment2:Questionson FrictionandWear	Apply concepts oftribology for the performance analysis and design of components experiencing relative motion.	Module 2	4	Individual Activity.	Refer all Text Books and Reference books
3	Assignment 3:QuestionsonHydrodynamicjournalbearings and introduction to idealized journal bearing,	Analyse therequirements anddesignhydrodynamicjournalandplanesliderbearings for a given application	Module 3	6	Individual Activity.	Refer all Text Books and Reference books
4	Assignment 4: Questionson Planeslider Bearings with fixed /pivotedShoeand Hydrostatic Lubrication:	Select proper bearing materials andlubricantsfora given tribologicalapplication.	Module 4	8	Individual Activity.	Refer all Text Books and Reference books
5	Assignment 5: Bearing Materials and Introduction to Surface engineering	Apply thePrinciples of Surface engineering For different applications of tribology.	Module 5	8	Individual Activity.	Refer all Text Books and Reference books

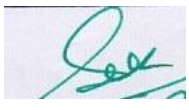
13.0 QUESTIONBANK

Module 1
Define viscosityfluidityNewtonianfluid.
Explaintypesofviscositymeasuringinstruments
Deriveexpression forflowofoilbetweentwoparallelstationaryplates

	DeriveexpressionforHagen–Poisuellelaw.
Module 2	
	Brifelyexplainfrictiontheories.
	Explainfrictionmeasurementmethods.
	BrifelyexplainClassificationandmechanismsofwear.
	Explaindelaminationtheory.
Module 3	
	Derivepetroff'sequationforlightlyloadedbearings.Stateassumptions
	Determineloadcarryingcapacity,frictionalforceandpowerlossduetofrictionforanidealfulljournalbearinghavingfollowingspecifications. Diameterofjournal =5cmlengthof bearing=6.5cm,Speedofjournal=1200rpm radialclearance =0.0025cmAttitude =0.8viscosity= $1.6x10^{-6}$
	DeriveReynold'sequationin2D
	Explainmechanismofpressuredevelopmentinanoil film
	DefineSommerfeld'snumbersand itssignificance. Deriveanexpressionofloadcarryingcapacityofidealizedjournalbearing.
Module4	
	Deriveanexpressionforpressuredistributionforaplaneslider bearingwithafixedshoe.
	Arectangularplaneslider bearingwithafixedshoehasfollowingdata Lengthofbearing=80mmwidthofbearing=60mmSlidervelocity=2m/sViscosityoflubricant=0.1Pa-secMinimumfilmthickness= 0.02 mmMax filmthickness=0.06mm Drawthe graphofvariationofpressure along thelengthofbearing.
	Deriveanexpressionofloadcarrying capacityofaplanesliderbearingwith fixed shoe.
	Deriveexpressionforaloadcarryingcapacityofhydrostaticstepbearing
	Ahydrostaticthrustbearinghasfollowingdata.Verticalthrust=60KNshaftdiameter=500mmPocketdiameter=300mm,Viscosity=35cpfilmthickness=0.01mm.Determinerateofoilflowthroughbearing
Module 5	
	Listanytendesirablepropertiesofbearingmaterial
	List advantagesanddisadvantagesofbearing materials.
	ExplainConceptandscopeofsurfaceengineering.
	ExplainSurfacemodificationandSurfaceCoating.

14.0 UniversityResult

Examination	AB	S	A	B	C	D	E	F	% Passing
Dec/Jan-2019-20	0	8	16	18	12	6	0	1	97
Jan/Feb-2020-21	0	20	19	16	05	0	0	02	96.77

Prepared& Checked by		
Sd/-		
Prof.D. N.Inamdar	**HOD**	**Principal**

Subject Title	**CIM Lab**		
Subject Code	18MEL76	**IA Marks**	40
No of Practical Hrs/ Week	01+02	**Exam Marks**	60
Total No of Practical Hrs	42	**Exam Hours**	03
		CREDITS – 02	

FACULTY DETAILS:		
Name: Prof. M S Futane	**Designation:** Asst.Professor	**Experience:**17Years
No. of times course taught:06 Times	**Specialization:** CIM	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Mechanical Engineering	I/II	CAED
02	Mechanical Engineering	III/IV	CAMD
03	Mechanical Engineering	V/VI	CAMA

2.0 Course Objectives

- To explain the functions and operations of CNC Machines.
- Construct numerical control(NC) part program.
- Construct computer numerical control (CNC) part program.
- Describe the preparatory commands such as G Codes, M Codes, T Codes etc.
- To write manual part program for turning drilling, milling machines and simulate the same.
- Explain robot programming language for simple operations such as pick and place, stacking objects using teach pendent and off line programming.
- Use the knowledge of pneumatics and hydraulics to demonstrate the related experiments.

3.0 Course Outcomes

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

CO	Course Outcome	Cognitive Level	POs
CO408. 1	Appreciate NC & CNC machines & its practical use in industry.	A	1,2,3,4,5,6,8,9,10,12
CO408. 2	Distinguish between absolute & incremental coordinate system.	A	1,2,3,4,5,6,8,9,10,12
CO408. 3	Make use of computer assisted part programming software to perform milling, drilling and turning operations in design, simulation and manufacturing.	A	1,2,3,4,5,6,8,9,10,12
CO408. 4	Write manual part programs for milling, turning operations.	A	1,2,3,4,5,6,8,9,10,12
CO408. 5	Explain what is FMS & ASRS	A	1,2,3,4,5,6,8,9,10,12
CO408. 6	Develop the robot program by using basic commands.	A	1,2,3,4,5,6,8,9,10,12
CO408. 7	Read and explain Electro Hydraulics & Pneumatic circuits.	U	1,2,3,4,5,6,8,9,10,12
Total Hours of instruction		**42**	

4.0 Course Content

PART – A

Manual CNC part programming

using ISO Format G/M codes for 2 turning and 2 milling parts. Selection and assignment of tools, correction of syntax and logical errors, and verification of tool path using CNC program verification software.

PART – B

CNC part programming using CAM packages.

Simulation of Turning, Drilling, Milling operations. 3 typical simulations to be carried out using simulation packages like: Cadem CAM Lab-Pro, MasterCAM. Program generation using software. Optimize spindle power, torque utilization, and cycle time. Generation and printing of shop documents like process and cycle time sheets, tool list, and tool layouts. Cut the part in single block and auto mode and measure the virtual part on screen. Post processing of CNC programs for standard CNC control systems like FANUC, SINUMERIC and MISTUBISHI.

PART – C

(Only for Demo/Viva voce)

FMS (Flexible Manufacturing System): Programming of Automatic storage and Retrieval system (ASRS) and linear shuttle conveyor Interfacing CNC lathe, milling with loading unloading arm and ASRS to be carried out on simple components. Robot programming: Using Teach Pendent & Offline programming to perform pick and place, stacking of objects (2 programs). Pneumatics and Hydraulics, Electro-Pneumatics: 3 typical experiments on Basics of these topics to be conducted.

5.0 Relevance to future subjects

SL. No	Semester	Subject	Topics / Relevance
01	VI	Computer Integrated Manufacturing	Provides basics of machine tools & Programming
02	VIII	Project work	Generation of components for project

6.0 Relevance to Real World

SL.No	Real World Mapping
01	Automobile Industries
02	Designing & simulation purpose

7.0 Books Used and Recommended to Students

Text Books
1. Computer Integrated Manufacturing, J A Rehj and Henry W Krauber
Reference Books
2. Fundamental Concepts and Analysus, Ghosal A. Robotics Oxford 2006.
3. Computer Integrated Manufacturing, J A Rehj and Henry W Krauber
4. CAD/CAM by Zeid TMH.
Additional Study material & e-Books
A Textbook of CIM & automation eBook By M P Grover PDF.

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

Website and Internet Contents References

2. https://en.wikipedia.org/wiki/Machine_shop
3. http://www.nptel.ac.in

9.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	International Journal of Computer Integrated Manufacturing	www.tandfonline.com/toc/tcim20/current
2	Robotics and Computer-Integrated Manufacturing - Journal	https://www.journals.elsevier.com/robotics-and-computer-integrated-manufacturing
3	Robotics and Computer-Integrated Manufacturing - ScienceDirect.com	www.sciencedirect.com/science/journal/07365845

10.0 Examination Note

Internal Assessment:
Theoretical aspects as well as relevant sketches should be drawn neatly for questions asked in Internal Assessments
Scheme of Evaluation for Internal Assessment (20 Marks)
(b) Internal Assessment test in the same pattern as that of the main examination 20marks.
SCHEME OF EXAMINATION: (80 Marks)
One question is to be set from Part-A 40Marks, One question is to be set from either Part-B 20Marks
Viva–Voce 20Marks

11.0 Course Delivery Plan

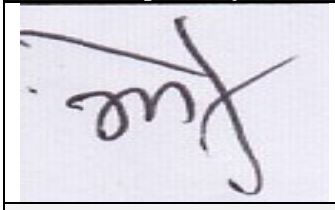
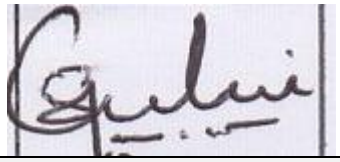
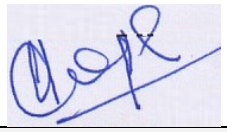
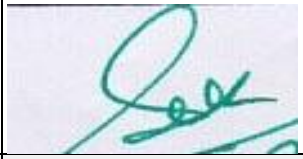
Unit No.	Experiment No.	Content of Lecturer	% of Portion
PART A	1	Introduction to CIM using Edge Cam Software	7.14
	2	Introduction to different preparatory commands ie. G Codes, M Codes etc.	7.14
	3	Preparation of the turning job on computer and its simulation.	7.14
	4	Preparation of drilling job on computer and its simulation.	7.14
	5	Preparation of Milling Job on a Computer and its simulation.	7.14
	6	Selection and assignment of tools	7.14
	7	correction of syntax and logical errors	7.14
PART B	8	Introduction to write a NC part program for turning.	7.14
	9	Introduction to write a NC part program for drilling.	7.14
	10	Introduction to write a NC part program for milling.	7.14
PART C	11	Demonstration of Flexible Manufacturing System(FMS) of Automatic Storage and Retrieval System(ASRS) and Linear Shuttle Conveyor Interfacing CNC Lathe, Milling, Loading, Unloading Arm and ASRS to be carried out on simple components.	7.14
	12	Demonstration-Introduction to Robot Programming Language Using Teach Pendent and Offline Programming to perform pick and place, stacking of objects.	7.14
	13	Demonstration on pneumatics and hydraulics, electro pneumatics at least 3 circuit diagrams.	7.14

12.0 QUESTION BANK

1. Define computer integrated manufacturing and what are its applications.
2. Define automation and types of automation.
3. What is flexible manufacturing system (FMS)?
4. What is ASRS in FMS?
5. Define numerical control and what are the basic components of numerical control.
6. What is the NC coordinate system for drilling and milling?
7. What is the NC coordinate system for turning.
8. What are three basic types of motion control systems in numerical control?
9. Define CNC and need for CNC.
10. What are the advantages and disadvantages of CNC System?
11. What are the different CNC machining centers?
12. What is machine control unit and list the sub systems of MCU.
13. What is CNC part programming? And explain manual part programming and computer assisted part programming briefly.
14. What are the important involved in the development of a part program.
15. List the different NC words to prepare a block in NC programming.
16. What are the different NC data formats?
17. List different preparatory codes and their meaning.
18. What are the standard formats to write a manual part program.
19. What are the different steps in computer assisted part programming?
20. List the different NC part programming languages.
21. What is an industrial robot and what are basic components of it.
22. What are the basic robots motions?
23. List the technical features of robots.
24. What is meant by grippers and effectors in robot?
25. List the robot censors.
26. What are the steps involved in robot programming.
27. What are the different robot applications?
28. What is hydraulics and pneumatics and electro pneumatics draw at least one circuit diagram to explain it.

13.0 University Result

Examination	FCD	Pass	% Passing
July 2019-20	63	63	100

Prepared by	Checked by		
			
Mr. M S Futane	Mr. S. A. Goudadi	HOD	Principal

Course Title	**DESIGN LAB**		
Course Code	18MEL77	**CIE Marks**	40
Practical Hrs/ Week	0:2:2	**SEE Marks**	60
Practical Hrs	02	**Exam Hours**	03
			Credits: 02

FACULTY DETAILS:		
Name: Prof. S.A. Goudadi	**Designation:** Asst. Professor	**Experience:14** Years
No. of times course taught: 1Time		**Specialization:** Design Engg

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Mechanical Engineering	III	Mechanics of Materials
02	Mechanical Engineering	V	Dynamics of Machines
03	Mechanical Engineering	VII	Mechanical vibrations

2.0 Course Learning Objectives:

- To understand the concepts of natural frequency, logarithmic decrement, damping and damping ratio.
- To understand the techniques of balancing of rotating masses.
- To verify the concept of the critical speed of a rotating shaft.
- To illustrate the concept of stress concentration using Photo elasticity.
- To appreciate the equilibrium speed, sensitiveness, power and effort of a Governor.
- To illustrate the principles of pressure development in an oil film of a hydrodynamic journal bearing.

3.0 Course Outcomes

After successful completion of the course, the student will be able to;

CO	Course Outcome	Cognitive Level	POs
C418.1	Compute the natural frequency of the free and forced vibration of single degree freedom systems, criticalspeed of shafts.	L3	1,2,6,8,12
C418.2	Carry out balancing of rotating masses.	L3	1,2,6,8,12
C418.3	Analyse the governor characteristics.	L3	1,2,6,8,12
C418.4	Determine stresses in disk, beams, plates and hook using photo elastic bench	L3	1,2,6,8,12
C418.5	Determination of Pressure distribution in Journal bearing	L3	1,2,6,8,12
C418.6	Analyze the stress and strains using strain gauges in compression and bending test and stress distribution in curved beams.	L3	1,2,6,8,12
Total Hours of instruction		42	

4.0 Course Content

Sl.No.	Experiments
	PART - A

1	Determination of natural frequency, logarithmic decrement, damping ratio and damping coefficient in asingle degree of freedom vibrating systems (longitudinal and torsional).
2	Balancing of rotating masses
3	Determination of critical speed of a rotating shaft
4	Determination of equilibrium speed, sensitiveness, power and effort of Porter/Proell /Hartnel Governor.
PART - B	
5	Determination of Fringe constant of Photo-elastic material using. a) Circular disc subjected to diametral compression. b) Pure bending specimen (four-point bending)
6	Determination of stress concentration using Photo-elasticity for simple components like plate with a hole under tension or bending, circular disk with circular hole under compression, 2D Crane hook
7	Determination of Pressure distribution in Journal bearing
8	Determination of Principal Stresses and strains in a member subjected to combined loading using Strain
9	Determination of stresses in Curved beam using strain gauge.

5.0 Relevance to future subjects

SL. No	Semester	Subject	Topics / Relevance
1	VIII	Project work	Analysis of vibration of machine parts, Performance of Journal bearings

6.0 Relevance to Real World

SL.No	Real World Mapping
01	As a field of study it is very important for analyzing systems consisting of single bodies or multiple bodies interacting with each other.
02	A dynamics analysis is what allows one to predict the motion of an object or objects, under the influence of different forces, such as gravity or a spring.

7.0 Books Used and Recommended to Students

Reference Books
1. Theory of machines By S.S.Rattan
2. Mechanical Vibrations By V.P.singh

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

Website and Internet Contents References
4. http://nptel.ac.in
5. www.vturesource.com
6. http://www.sapnaonline.com
7. Anmited video on Governer: https://www.youtube.com/watch?v=HS_YGZXP2xY

8. *Video on proell governer: https://www.youtube.com/watch?v=qD8R-NtC8bo*
9. *Video on Gyroscope: https://www.youtube.com/watch?v=NeXIV-wMVUk*
10. Video on Journal bearing:https://www.youtube.com/watch?v=xhtq8xqBXwE
11. Video on Critical speed of shaft: https://www.youtube.com/watch?v=ZEawe4jCbFw
12. Balancing of Rotating Masses: https://www.youtube.com/watch?v=0MeAZFFqmek&list=PLdLe0dTcWW-u_dCcNGoAK8fx2PiS5gkVu
13. Static and dynamic balancing by Tecquipment : https://www.youtube.com/watch?v=p1JDMvWGdsk
14. Forced vibrations by Tecquipment : https://www.youtube.com/watch?v=r_ouYEYhR5U
15. Video on Free Vibration: https://www.youtube.com/watch?v=RYKJo2iAz74

9.0 Magazines/Journals Used and Recommended to Students

Sl. No	Magazines/Journals	website
1	Mechanism and Machine Theory	https://www.journals.elsevier.com
2	International Journal of Mechanical and Materials Engineering (IJMME)	http://www.springer.com
3	Multi body System Dynamics	http://www.springer.com
4	Journal of Dynamic Systems, Measurement, and Control	http://dynamicsystems.asmedigitalcollection.asme.org/article.aspx?articleid=1403252

10.0 Examination Note

Scheme of Examination:
One question from Part A: 40 marks
One question from Part B: 40 Marks
Viva voce: 20 Marks
Total: 100 Marks

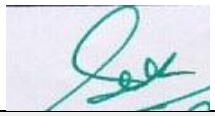
11.0 Course Delivery Plan

Expt No	Lecture/ Practical No	Name of the Experiment	% of Portion
1	1	Determination of natural frequency, logarithmic decrement, damping ratio and damping coefficient in a single degree of freedom vibrating systems (longitudinal and torsional)	16.67
2	2	Balancing of rotating masses	8.33
3	3	Determination of critical speed of a rotating shaft.	8.33
4	4	Determination of equilibrium speed, sensitiveness, power and effort of Porter/Proel /Hartnel Governor.	16.67
5	5	Determination of Fringe constant of Photo elastic material using. a) Circular disc subjected to diametric compression. b) Pure bending specimen (four point bending)	12.5
6	6	Determination of stress concentration using Photo elasticity for simple components like plate with a hole under tension or bending, circular disk with circular hole under compression, 2D Crane hook.	18.75
7	7	Determination of Pressure distribution in Journal bearing.	6.25

8	8	Determination of Principal Stresses and strains in a member subjected to combined loading using Strain rosettes	6.25
9	9	Determination of stresses in Curved beam using strain gauge.	6.25

12.0 QUESTION BANK

1. What are the different types of vibrations?
2. What is natural frequency?
3. What is resonance?
4. What is the critical speed?
5. Why we are balancing the rotating masses?
6. What is the meaning of stress concentration?
7. Define sensitivity, effort, power in governors.
8. What is the difference between journal and bearing?
9. Define the principal stress.
10. What is the difference between strain rosettes and strain gauges?
11. What is the difference between governor and fly wheel?

Prepared by	Checked by		
-Sd-	-Sd-		
Prof. S.A.Goudadi	**Prof.** Mahantesh Tanodi	**HOD**	**Principal**