Department of Mechanical Engineering

COURSE PLAN 2018-19

VII Semester "A & B" division

INSTITUTE VISION

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

INSTITUTE MISSION

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

DEPARTMENT OF MECHANICAL ENGINEERING

VISION

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

MISSION

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

Program Educational Objectives (PEOs)

The Graduates will be able to

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

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

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

Program Specific Outcomes (PSOs)

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

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

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

Program Outcomes (POs)

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

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

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

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

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

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

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

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

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

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

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

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

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Laboratory – Course Plan and Viva Questions		
6	15MEL76- Design Laboratory	40
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8	15MEP78 – Project Phase – I	--

Student Help Desk

S. N	Purpose	Contact Person	
		Faculty	Instructor
Department Level			
1	Attestations	Dr. B. M. Shrigiri	
2	Online submission of exam form/revaluation form to VTU	Prof. S. B. Awade / Prof. N. M. Ukkali / Prof. M. R. Ingalagi	--
3	Students' Counseling & Discussion with parents (Class Teachers from 3rd A to 7th B)	Prof. Jagadeesh A. Prof. Kushal Ambli Prof. B. M. Doddamani Prof. N. M. Ukkali Prof. R. V. Nyamagoud Prof. M. R. Ingalagi	
4	Department Association Coordinator	Prof. M. M. Shivashimpi/ Prof. M. R. Ingalagi	
5	Students Activities Coordinator	Prof. Jagadeesh A.	
6	Extra-Curricular Activities/ Induction/ Robo Vidya	Prof. T. S. Vandali	
7	Dept.TP Cell Coordinator	Prof. R. V. Nyamagoud	Shri S. R. Nakade
8	I I I coordinator, (INTERNSHIP)	Prof. Chitagopkar Ravi	Shri R. B. Kumbar
9	I I I coordinator (INDUSTRY)	Prof. G. A. Naik	
10	Time Table Coordinator	Prof. G. V. Chiniwalar	
11	I. A. Test Coordinator	Prof. A. M. Biradar	Shri S. C. Jotawar
12	Choice of Electives	Prof. S. N. Toppannavar Prof. D. N. Inamdar Prof. T. S. Vandali	---
13	Department Library Coordinator	Prof. Mahantesh I Tanodi	Shri R. M. Hunachyali
14	Department News Letter Coordinator	Prof. M. M. Shivashimpi/ Prof. S. R. Kulkarni/ Prof. M. R. Ingalagi	
15	Department Technical Magazine Coordinator	Prof. M. S. Futane/ Prof. D. N. Inamdar/ Prof. S. R. Kulkarni	
16	Dept. Alumni / Robo Vidya	Prof. Mahesh Hipparagi	
17	Project Coordinators	Prof. Mahantesh I. Tanodi	Shri R. B. Kumbar
18	Dispensary	Dr. Arun G. Bullannavar	Cell No. 9449141549
Institute Level			
01	Student Welfare Convener	Prof. S. B. Akkoli (9480422508)	
02	TP Cell Coordinator	Prof. S. N. Topannavar (9480849332)	
03	Anti Ragging Convener	Prof. M. S. Futane (9480849334)	
04	Anti Squad Convener	Prof. K. M. Akkoli (9739114856)	
05	Anti Sexual Harassment Convener	Smt. Y. S. Patil (9620945478)	
06	Grievance Redressal Convener	Prof. G. A. Naik (9480539283)	
07	Institute News & publicity	Prof. Mahesh Hipparagi (7411507405)	
08	First Year Coordinator	Dr. R. M. Galagali (9945082054)	

Departmental Resources

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

Faculty Position

Sl. No.	Category	No. in position	Average experience
1	Teaching faculty	25	16
2	Technical staff	12	13
3	Helper / Peons	05	08

Major Laboratories

S.N.	Name of the laboratory	Area in Sq. Meters	Amount Invested (Rs.)
1	Basic Workshop Laboratory	170	3,91,550=00
2	Fluid Mechanics Machinery Laboratory	172	7,71,941=00
3	Energy Conversion Engg. Laboratory	173	12,37,586=00
4	Machine shop Laboratory	170	13,25,837=00
5	Foundry & Forging Laboratory	179	2,92,984=00
6	Design Laboratory	73	3,64,818=00
7	Heat & Mass Transfer Laboratory	148	5,24,576=00
8	Metallography & Material Testing Laboratory	149	10,73,461=00
9	Mechanical Measurements & Metrology Laboratory	95	5,48,011=00
10	CIM & Automation/CAMA Laboratory	66	36,98,180=00
11	Computer Aided Machine Drawing Laboratory	66	10,04,195=00
12	Computer Aided Engg Drawing Laboratory	66	12,89,363=00
13	Department/Other	--	13,60,486=00
	Total	**1527**	**1,38,82,696=00**

Teaching Faculty Details

S.N.	Faculty Name	Designation	Qualification	Area of specialization	Professional membership	Industry Experience (in years)	Teaching Experience (in years)	Contact Nos.
1	Dr. S. C. Kamate	Principal	Ph. D	Thermal(Cogeneration)	LMISTE	03	25	9480849331
2	Dr. S. A. Alur	Professor	Ph. D	Thermal Power Engg.	LMISTE	---	23	9686856029
3	Dr. B M Shrigiri	HOD/Professor	Ph. D	Thermal Power Engg.	LMISTE	01	19	9741483339
4	Dr. R. M. Galagali	Assoc.Professor	M Tech., Ph.D	PDM, Tribology	-----	02	17	9945082054
5	Prof.S.N.Topannavar	Assoc.Professor	M Tech.(Ph.D)	Thermal Power Engg.	LMISTE	01	17	9482440235
6	Prof. D. N. Inamdar	Asso.Professor	M Tech.(Ph.D)	Tool Engg	LMISTE	08	13	9591208980
7	Prof. K. M. Akkoli	Asso.Professor	M Tech.(Ph.D)	Thermal Power Engg.	LMISTE	1.5	13	9739114856
8	Prof.R.K.Chitgopkar	Asst. Professor	M Tech.	Thermal Power Engg.	LMISTE	1.5	25	9886070475
9	Prof.G. A. Naik	Asst. Professor	M Tech.	Production Management	LMISTE	02	20	9480539283
10	Prof. G. V. Chiniwalar	Asst. Professor	M Tech.	Machine Design	LMISTE	04	13	8762336434
11	Prof.M.S.Futane	Asst. Professor	M Tech.	Computer Integrated Manufacturing	LMISTE	01	11	9164105035
12	Prof. T. S. Vandali	Asst. Professor	M Tech.	Machine Design	LMISTE	8.5	07	9686235904
13	Prof.S. A. Goudadi	Asst. Professor	M Tech.	Design Engineering	LMISTE	--	09	9448876682
14	Sri. S.R. Kulkarni	Asst. Professor	M Tech.	Design Engineering	LMISTE	--	09	8123661692
15	Prof.M.M.Shivashimpi	Asst. Professor	M Tech.(Ph.D)	Thermal Power Engg.	LMISTE	01	07	9742197173
16	Prof.M.A.Hipparagi	Asst. Professor	M Tech.(Ph.D)	Production Technology	LMISTE	02	06	7411507405
17	Prof. A. M. Biradar	Asst. Professor	M Tech.	Machine Design	LMISTE	02	06	9986127703
18	Prof. K. G. Ambli	Asst. Professor	M Tech.(Ph.D)	Product Design and Manufacturing	LMISTE	0.8	05	9164534514
19	Prof. S. B. Awade	Asst. Professor	M Tech.	Machine design	LMISTE		04	9632606108
20	Prof.Mahantesh Tanodi	Asst. Professor	M Tech.	Machine design	LMISTE	--	05	9611998812
21	Prof. N. M. Ukkali	Asst. Professor	M Tech.	Machine Design	LMISTE	--	04	9620152199
22	Prof. M. R. Inagalagi	Asst. Professor	M Tech.	Thermal Power Engg	LMISTE	--	03	9743868503
23	Prof. Jagadeesh A.	Asst. Professor	M Tech.	Thermal Power Engg	LMISTE	--	04	9902847774
24	Prof. R. V. Nyamagoud	Lecturer	M Tech.	Thermal Power Engg	LMISTE	--	03	9964822494
25	Prof. B. M. Dodamani	Asst. Professor	M Tech.	Energy System Engg	LMISTE	02	03	9535447575

CALENDAR OF EVENTS FOR THE ACADEMIC YEAR 2018-19

Date	Events
01-08-2018	Commencement of III/V Sem Classes
06-08-2018	Commencement of VII Sem Classes
13-08-2018 to 01-09-2018	Commencement of Induction Program for I Semester students
14-08-2018	Fresher's Day (I Sem)
15-08-2018	Independence Day
26-08-2018	Women's Equality Day
05-09-2018	Teachers Day
08-09-2018 & 09-09-2018	Indoor Games
10-09-2018 to 12-09-2018	First Internal Assessment of III/V/VII Sem
14-09-2018 & 15-09-2018	Feed Back-1
15-09-2018	Engineers Day
17-09-2018	Display of First Internal Assessment Marks & Submission of Feedback-1 report to office
22-09-2018	EDP Activities
02-10-2018	Gandhi Jayanti & Swachh Bharat Abhiyan
15-10-2018 to 17-10-2018	First Internal Assessment of I Sem Second Internal Assessment of III/V/VII Sem
22-10-2018 & 23-10-2018	Feed Back-2
25-10-2018	Submission of Feedback-2 Report to Office
25-10-2018	Display of Second Internal Assessment Marks
28-10-2018	Compensatory Working Day of Connecting Holiday 20-10-2018 (Half Day)
01-11-2018	Kannada Rajyotsava
18-11-2018	Compensatory Working Day of Connecting Holiday 07-11-2018
16-11-2018 to 18-11-2018	Second Internal Assessment of I Sem Third Internal Assessment of III/V/VII Sem
22-11-2018 to 24-11-2018	Lab Internal Assessment of III/V/VII Sem
28-11-2018	Display of Third & Final Internal Assessment Marks(III/V/VII Sem)
30-11-2018	Last Working Day of III/V Sem
04-12-2018	Last Working Day of VII Sem
03-12-2018 to 14-12-2018	Practical Exams of III/V Sem
17-12-2018 to 18-01-2019	Theory Exams of III/V Sem
06-12-2018 to 14-12-2018	Practical Exams of VII Sem
17-12-2018 to 18-01-2019	Theory Exams of VII Sem
03-01-2019 to 05-01-2019	Third Internal Assessment of I Sem
09-01-2019 to 11-01-2019	Lab Internal Assessment of I Sem
17-01-2019	Display of Third & Final Internal Assessment Marks (I Sem)
17-01-2019	Last Working Day of I Sem
21-01-2019 to 30-01-2019	Practical Exams of I Sem
04-02-2019 to 18-02-2019	Theory Exams of I Sem

August-2018

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	

15- Independance day, 22-Bakrid

September-2018

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						

13- Ganesh Chaturthi , 21-Moharam

October-2018

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 Jayanti, 8- Mahalaya Amavasya, 18- Ayudha Pooja, 19- Vijayadashami, 24- Valmiki Jayanti

November-2018

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, 6- Naraka Chaturdashi, 8- Balipadyami, 21- Id-e-Milad, 26- Kanakadasa Jayanthi

December-2018

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- Chrismas

January -2019

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

14-Sankranti, 26-Republic Day

Dr. Shilpa Shrigiri
IQAC Co-ordinator

Hirasugar Institute of Technology Nidasoshi Pin-591236 Dt. Belgaum

8/5/18
Dr. S C Kamate
Principal
PRINCIPAL
Hirasugar Institute of Technology
NIDASOSHI-591 236

FOR THE ACADEMIC YEAR 2018-19

Date	Events
01-08-2018	Commencement of III/V Sem Classes
06-08-2018	Commencement of VII Sem Classes
24-08-2018	Welcome function and AIMSS inauguration
31-08-2018	Group Discussion Competition
05-09-2018	Teachers Day
07-09-2018	Industrial Institute Interaction Activity
08-09-2018 To 09-09-2018	Indoor Games
10-09-2018 To 12-09-2018	First Internal Assessment of III/V/VII Sem
15-09-2018	Engineers Day
22-09-2018	EDP Activities
29-09-2018	Industrial Visit (III semester)
02-10-2018	Gandhi Jayanti & Swachh Bharat Abhiyan
06-10-2018	Industrial Visit (V semester)
13-10-2018	Expert talk by Academician
15-10-2018 To 17-10-2018	Second Internal Assessment of III/V/VII Sem
26-10-2018	Hobby Project Competition
27-10-2018	Industrial Visit (V semester)
28-10-2018	Compensatory Working Day of Connecting Holiday 20-10-2018 (Half Day)
01-11-2018	Kannada Rajyotsava
03-11-2018	Industrial Visit (VII semester)
10-11-2018	One Day work shop
16-11-2018 To 18-11-2018	Third Internal Assessment of III/V/VII Sem
22-11-2018 To 24-11-2018	Lab Internal Assessment of III/V/VII Sem
28-11-2018	Display of Third & Final Internal Assessment Marks(III/V/VII Sem)
30-11-2018	Last Working Day of III/V Sem
04-12-2018	Last Working Day of VII Sem
03-12-2018 To 14-12-2018	Practical Exams of III/V Sem
17-12-2018 To 18-01-2019	Theory Exams of III/V Sem
06-12-2018 To 14-12-2018	Practical Exams of VII Sem
17-12-2018 To 18-01-2019	Theory Exams of VII Sem

August-2018

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	

15- Independance day, 22-Bakrid

September-2018

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						

13- Ganesh Chaturthi , 21-Moharam

October-2018

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 Jayanti, 8- Mahalaya Amavasya, 18- Ayudha Pooja, 19- Vijayadashami, 24- Valmiki Jayanti

November-2018

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, 6- Naraka Chaturdashi, 8-Balipadyami, 21- Id-e-Milad, 26- Kanakadasa Jayanthi

December-2018

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- Chrismas

Prof. M.M. Shivashimpi
AIMSS Co-ordinator

Dr. B.M. Shrigiri
HOD

Scheme of Teaching and Examination

7th Semester

Sl. No.	Subject Code	Title	Teaching Hours per week			Examination				Credits
			Lecture	Tutorial	Practical	Duration (hours)	Theory/ Practical marks	I A marks	Total marks	
1	15ME71	Energy Engineering	3	2	0	3	80	20	100	4
2	15ME72	Fluid Power Systems	4	0	0	3	80	20	100	4
3	15ME73	Control Engineering	3	2	0	3	80	20	100	4
4	15ME742	Tribology	3	0	0	3	80	20	100	3
5	15ME753	Mechatronics	3	0	0	3	80	20	100	3
6	15MEL77	Design Laboratory	1	0	2	3	80	20	100	2
7	15MEL78	CIM Laboratory	1	0	2	3	80	20	100	2
8	15MEP78	Project Phase - I	-	-	-	-	-	100	100	2
		Total	**18**	**04**	**04**		**560**	**240**	**800**	**24**

VTU Scheme

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

B.E. Mechanical Engineering

VII SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week			Examination				Credits
			Lecture	Tutorial	Practical	Duration (Hours)	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15ME71	Energy Engineering	3	2	0	03	80	20	100	4
2	15ME72	Fluid Power Systems	4	0	0	03	80	20	100	4
3	15ME73	Control Engineering	3	2	0	03	80	20	100	4
4	15ME74X	Professional Elective - III	3	0	0	03	80	20	100	3
5	15ME75X	Professional Elective-IV	3	0	0	03	80	20	100	3
6	15MEL76	Design Lab	1	0	2	03	80	20	100	2
7	15MEL77	CIM Lab	1	0	2	03	80	20	100	2
8	15MEP78	Project Phase – I	-	-	-	-	-	100	100	2
		TOTAL	**18**	**4**	**04**		**560**	**240**	**800**	**24**

Professional Elective-III		Professional Elective-IV	
15ME741	Design of Thermal Equipments	15ME751	Automotive Electronics
15ME742	Tribology	15ME752	Fracture Mechanics
15ME743	Financial Management	15ME753	Mechatronics
15ME744	Design for Manufacturing	15ME754	Advanced Vibrations
15ME745	Smart Materials & MEMS		

1. Core subject: This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.

2. Professional Elective: Elective relevant to chosen specialization/ branch

15ME71- Energy Engineering

Subject Title	**Energy Engineering**		
Subject Code	15ME71	**IA Marks**	20
Number of Lecture Hrs / Week	03L+2T	**Exam Marks**	80
Total Number of Lecture Hrs	40	**Exam Hours**	03
CREDITS – 04			

FACULTY DETAILS:		
Name: Dr, Basavaraj M Shrigiri	**Designation:** Professor	**Experience:19**
No. of times course taught:03	**Specialization:** Thermal Power Engineering	
Name: Prof. S N Topannawar	**Designation:** Asst. Professor	**Experience:18**
No. of times course taught:03	**Specialization:** Thermal Power Engineering	

1.0 Prerequisite Subjects:

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

2.0 Course Objectives

1. 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
CO1	Summarize the basic concepts of thermal energy systems.	L1	PO1,PO6
CO2	Identify renewable energy sources and their utilization	L1,L2	PO1,PO2,PO6
CO3	Understand the basic concepts of solar radiation and analyze the working of solar PV and thermal systems.	L1,L2,L3	PO1,PO2,PO4 PO11
CO4	Understand principles of energy conversion from alternate sources including wind, biomass, biogas	L1,L2,L3	PO1,PO2,PO4, PO11
CO5	Understand the concepts and applications of fuel cells, thermoelectric convertor and MHD generator	L1,L2	PO1,PO2,PO6 PO11
CO6	Identify methods of energy storage for specific applications	L1,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, Oilburners, Advantages and Disadvantages of using pulverized fuel, Equipmentfor preparation and burning of pulverized coal, unit system and bin system.Pulverized fuel furnaces, cyclone furnace, Coal and ash handling, Generationof steam using forced circulation, high and supercritical pressures.Chimneys: Natural, forced, induced and balanced draft, Calculations andnumerical involving height of chimney to produce a given draft. Coolingtowers and Ponds. Accessories for the Steam generators such asSuperheaters, De-superheater, control of superheaters, Economizers, Air preheatersand re-heaters. 9 **hours**

Module 2

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

7 **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.

8 **hours**

Module 4

Wind Energy: Properties of wind, availability of wind energy in India, windvelocity and power from wind; major problems associated with wind power,wind machines; Types of wind machines and their characteristics, horizontaland 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.

8 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.

8 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

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
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

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:

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

12.0 Course Delivery Plan

Module	Lecture No.	Content of Lecture	% of Portion
I	1	**Thermal Energy conversion system:** Review of energy scenario in India, General Philosophy and need of Energy	22.5
	2	Different Types of Fuels used for steam generation, Equipment for burning coal in lump form, strokers, different types	
	3	Oil burners, 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. Chimneys: Natural, forced, induced and balanced draft	
	6	Accessories for the Steam generators such as Superheaters, Desuperheater	
	7	control of superheaters, Economizers, Air preheaters and re-heaters	
	8	Calculations and numerical involving height of chimney to produce a given draft. Cooling towers and Ponds	
	9	Calculations and numerical involving height of chimney to produce a given draft. Cooling towers and Ponds	
II	10	**Diesel Engine Power System**: Applications of Diesel Engines in Power field.	40
	11	Method of starting Diesel engines. Auxiliaries like cooling and lubrication system	
	12	Filters, centrifuges, Oil heaters, Intake and exhaust system, Layout of diesel power plant	
	13	**Hydro-Electric Energy**: Hydrographs, flow duration and mass curves, unit hydrograph	
	14	Numericals on Hydrographs	
	15	Storage and pondage, pumped storage plants, low, medium and high head plants	
	16	Penstock, water hammer, surge tanks, gates and valves. General layout of hydel power plants.	
III	17	**Solar Energy**: Fundamentals; Solar Radiation	60
	18	Estimation of solar radiation on horizontal and inclined surfaces; Measurement of solar radiation data	
	19	Solar Thermal systems: Introduction; Basics of thermodynamics and heat transfer	
	20	Flat plate collector; Evacuated Tubular Collector; Solar air collector; Solar concentrator; Solar distillation; Solar cooker	
	21	Solar refrigeration and air conditioning; Thermal energy storage systems	
	22	Solar Photovoltaic systems: Introduction; Solar cell Fundamentals; Characteristics and classification	
	23	Solar cell: Module, panel and Array construction	
	24	Photovoltaic thermal systems	
IV	25	**Wind Energy**: Properties of wind, availability of wind energy in India	80
	26	Wind velocity and power from wind; major problems associated with wind power,	

		wind machines	
	27	Types of wind machines and their characteristics	
	28	horizontal and vertical axis wind mills, coefficient of performance of a wind mill rotor	
	29	Numericals on Wind mills	
	30	**Tidal Power**: Tides and waves as energy suppliers and their mechanics	
	31	Fundamental characteristics of tidal power	
	32	Harnessing tidal energy, limitations	
V	33	**Biomass Energy**: Introduction, Photosynthesis Process	100
	34	Biofuels; Biomass Resources; Biomass conversion technologies	
	35	Urban waste to energy conversion; Biomass gasification	
	36	**Green Energy**: Introduction: Fuel cells: Overview	
	37	Classification of fuel cells	
	38	Operating principles; Fuel cell thermodynamics Nuclear,	
	39	Ocean MHD, thermoelectric and geothermal energy applications	
	40	Origin and their types; Working principles, 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	Assignment 5: 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	Module 5	8	Individual Activity.	Refer all Text Books, Reference books and e-materials

		Identify methods of energy storage for specific applications				

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 plaint.
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 ($28^o28'$N, 77^o 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^o 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 ($22^o13'$N,73^o 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 biodigestion 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

Prepared by	Checked by		
Dr. Basavaraj M Shrigiri	Prof. S N Topannawar	HOD	Principal

15ME72- Fluid Power Systems

Subject Title	**Fluid Power Systems**		
Subject Code	15ME72	**IA Marks**	20
No of Lecture Hrs + Practical Hrs / Week	04	**Exam Marks**	80
Total No of Lecture + Practical Hrs	50	**Exam Hours**	03
			CREDITS – 04

FACULTY DETAILS:		
Name: Prof. R V Nyamagoud	**Designation:** Asst. Professor	**Experience:** 4.6 Years
No. of times course taught: 03	**Specialization:** Thermal Power Engg	
Name: Prof. K M Akkoli	**Designation:** Asst. Professor	**Experience: 15** Years
No. of times course taught: 06	**Specialization:** Thermal Power Engg	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
1	Mechanical Engineering	I/II/III/IV	Engg. 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 systems.
- 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 analyse the functional requirements of a fluid power transmission system for a given application.	1	1,12
CO2	Visualize how a hydraulic/pneumatic circuit will work to accomplish the function.	1	1,2,3,12
CO3	Design an appropriate hydraulic or pneumatic circuit or combination circuit like electro-hydraulics, electro-pneumatics for a given application.	3	1,2,3,12
CO4	Select and size the different components of the circuit.	3	1,2,3,12
CO5	Develop a comprehensive circuit diagram by integrating the components selected for the given application.	1	1,2,3,12
Total Hours of instruction		**50**	

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. **10 hours**

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, selection/ design procedure, 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). **10 hours**

Module3: 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, double pump hydraulic system, counter balance valve application, hydraulic cylinder sequencing circuits, cylinder synchronizing circuit using different methods, hydraulic circuit for force multiplication; speed control of hydraulic cylindermetering in, metering out and bleed off circuits. Pilot pressure operated circuits. Hydraulic circuit examples with accumulator. **10hours**

Module4: 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. **10hours**

Module5: 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. **10 hours**

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
1) 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: 20Marks

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: 80 Marks

11.0 Course Delivery Plan

Module No.	Lecture No.	Content of Lecture	% of Portion
1		**Introduction to fluid power systems**	**15.38**
	1	Pascal's law and problems on Pascal's Law	
	2	continuity equations,	
	3	introduction to conversion of units	
	4	Structure of Hydraulic Control System	
	5	The Source of Hydraulic Power: Pumps Pumping theory, pump classification	
	6	gear pumps, vane pumps, piston pumps	
	7	pump performance, pump selection	
	8	Variable displacement pumps.	
2		**Pumps and actuators**	**26.92**
	9	Linear Hydraulic Actuators [cylinders]	
	10	Mechanics of Hydraulic Cylinder loading	
	11	Hydraulic motor theoretical torque	
	12	Hydraulic motor theoretical power	
	13	Hydraulic motor theoretical flow rate	
	14	hydraulic motor performance	
3		**CONTROL COMPONENTS IN HYDRAULIC SYSTEMS**	**36.53**
	15	Directional Control Valves – Symbolic representation	
	16	Constructional features,	
	17	pressure control valves	
	18	direct and pilot operated types	
	19	Flow control valves.	
		Components and hydraulic circuit design	**50**
	20	Control of single and double – acting Hydraulic Cylinder	
	21	regenerative circuit, pump unloading circuit	
	22	Double pump Hydraulic system	
	23	Counter Balance Valve application, Hydraulic cylinder sequencing circuits	
	24	Locked cylinder using pilot check valve, cylinder synchronizing circuits	
	25	speed control of hydraulic cylinder, speed control of hydraulic motors	

	26	Accumulators and accumulator circuits.	
4		**Pneumatic power systems**	**73.08**
	33	Choice of working medium, characteristics of compressed air.	
	34	Structure of Pneumatic control system	
	35	Pneumatic Actuators: Linear cylinders	
	36	Types, conventional type of cylinder working	
	37	End position cushioning, seals, mounting arrangements applications.	
	38	Rod–less cylinders, types, working advantages. Rotary cylinder types construction and application Design parameters, selection	
5		**Pneumatic control circuits**	
	39	Symbolic representation as per ISO 1219 and ISO 5599.	**86.54**
	40	Design and constructional aspects, poppet valves, slide valves spool valve, suspended seat type slide valve.	
	41	Simple Pneumatic Control: Direct and indirect actuation pneumatic cylinders, use of memory valve	
	42	Flow control valves and speed control of cylinders supply air throttling and exhaust air throttling use of quick exhaust valve.	
	43	Signal processing elements: Use of Logic gates – OR and AND gates pneumatic applications.	
	44	Practical examples involving the use of logic gates. Pressure dependent controls type's construction–practical applications.	
	45	Time dependent controls–Principle, construction, practical applications	
		MULTI-CYLINDER APPLICATIONS	**100**
	46	Coordinated and sequential motion control. Motion and control diagrams – Signal elimination methods	
	47	Cascading method – principle	
	48	Practical application examples (up to two cylinders) using cascading method (using reversing valves). Electro- Pneumatic control	
	49	Principles-signal input and output pilot assisted solenoid control of directional control valves	
	50	Use of relay and contactors. Control circuitry for simple single cylinder applications. Compressed air	
	51	Production of compressed air – compressors, preparation of compressed air- Driers, Filters, Regulators, Lubricators	
	52	Distribution of compressed air- Piping layout.	

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
I	**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.
II	**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.
III	**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?
IV	**Module-4** 1. What is fire resistant fluid? Name any four and list out advantages and disadvantages 2. Identify eight recommendations that should be followed for properly maintaining and disposing of hydraulic fluid. 3. Differentiate between a) Internal and external leaks b) Positive and non positive seal c) Static and dynamic seal

	4. Explain various types of filtering? 5. Write an explanatory note on preventive maintenance of valves, pumps and filters. 6. What are the advantages of pneumatic system? Distinguish between hydraulic and pneumatic system. What are the characteristics of compressed air? Explain. 7. Give complete classification of pneumatic actuators. 8. Sketch and explain a cushion assembly for a pneumatic cylinder. Explain the typical air cylinder with a neat sketch? What are the factors affecting piston speed. 9. Explain the typical air cylinder applications 10. Explain different types of seals used in Pneumatic systems. **11. Explain the design and constructional details of rotary cylinder.**
V	**Module-5** 1. With the aid of suitable sketches, explain briefly the following: Open center, closed center & Tandem center configurations as applied to 3 positions – 4-way valve. 2. Explain the working of two way valve and shuttle valve 3. With a neat sketch explain working principles of Poppet Valves. 4. With *a neat sketch* explain working principles of Spool valve. 5. Explain Non return type flow control valve with neat sketch 6. Explain Memory valve with neat sketch mention its uses 7. Explain Quick exhaust valve with neat sketch. 8. Explain the following i) AND function ii) OR function iii) NOR function iv) NAND function
	1. With a sketch explain any one practical application of multi-cylinder pneumatic system. 2. Explain advantages of cascading method of design of a pneumatic system 3. 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	FCD	FC	SC	% Passing
2017/18	14	35	63	99.07
2016/17	20	67	50	99.07

Prepared by	Checked by		
Prof. R V Nyamagoud	Prof. K M Akkoli	HOD	Principal

15ME73- Control Engineering

Subject Title	CONTROL ENGINEERING		
Subject Code	15ME73	IA Marks	20
Number of Lecture Hrs / Week	04	Exam Marks	80
Total Number of Lecture Hrs	54	Exam Hours	03
CREDITS – 04			

FACULTY DETAILS:		
Name: Prof. N M Ukkali	**Designation:** Asst. Professor	**Experience:**5
No. of times course taught:03	**Specialization:** Machine Design	
Name: Prof. M R Ingalagi	**Designation:** Asst. Professor	**Experience:**05
No. of times course taught:04	**Specialization:** Thermal Power Engineering	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Mechanical Engineering	I & II	Mathematics

2.0 Course Objectives

1. Modeling of mechanical, hydraulic, pneumatic and electrical systems.
2. Representation of system elements by blocks and its reduction
3. Transient and steady state response analysis of a system.
4. Frequency using polar plot.
5. Frequency response analysis using bode plot.
6. Analysis of system using root locus plots.
7. Different system compensators and variable characteristics of linear systems

3.0 Course Outcomes

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

	Course Outcome	Cognitive Level	POs
CO1	Recognize control system and its types , control action	U	1,5,12
CO2	Determine the system governing equations for physical models(Electrical, Thermal, Mechanical, Electro Mechanical) experiencing relative motion.	U	1,5,12
CO3	Calculate the gain of the system using block diagram and signal flow graph for a given application.	U	1,5,12
CO4	Illustrate the response of 1st and 2nd order systems.	U	1,5,12
CO5	Determine the stability of transfer functions in complex domain and frequency domain.	U	1,5,12
CO6	Employ state equations to study the controllability and observability	U	1,5,12
Total Hours of instruction		**54**	

4.0 Course Content

Module 1

Introduction: Concept of automatic controls, Open loop and closed loop systems, Concepts of feedback, requirements of an ideal control system, Types of controllers-Proportional, Integral, Differential, Proportional & Integral, Proportional Differential and Proportional Integral Differential controllers**. 7 hours**

Module 2

Modeling of Physical Systems : Mathematical Models of Mechanical, Electrical, Thermal, Hydraulic and Pneumatic Systems. **3 hours**

Analogous Systems: Direct and inverse analogs for mechanical, thermal and fluid systems**. 4 hours**

Block diagram Algebra: General representation of a feedback control system, transfer functions, rules of block diagram algebra, . to obtain closed loop transfer function. Signal flow graphs : Mason's gain formula **6 hours**

Module 3

Steady state operation: Steady state analysis for general block dia. for a control system, steady state characteristics, equilibrium in a system**. 3 hours**

Transient Response: Transient response and steady state analysis of unit, step input, general operational representation for a differential equation of control system, distinct, repeated and complex conjugate zeros, general form of transient response, Routh's stability criterion for a control system**. 4 hours**

Root Locus Plots : Root locus method: Significance of Root locus, angle and magnitude conditions, breakaway points, ,construction of Root locus using general rules and steps, Lead and Lag compensation **6 Hours**

Module 4

Frequency Domain Analysis: Relationship between time and frequency response, Polar plot, Bode's Plot, Nyquist plot and Nyquist stability criterion, Relative Stability, Phase and Gain Margins **14hours**

Module 5

System Compensation and State Variable Characteristics of Linear Systems : Series and feedback compensation, Introduction to state concepts, state equation of linear continuous data system. Matrix representation of state equations, controllability and observability, Kalmanand Gilberts test **7hours**

5.0 Relevance to Real World

SL.No	Real World Mapping
01	Industrial use for producing various components
02	Model creation for analysis
03	Development of a software applications

6.0 Books Used and Recommended to Students

Text Books
1. Modern Control Engineering, Katsuhiko Ogatta, Pearson Education, 2004. 2. Control Systems Principles and Design,M.Gopal, TMH,2000.
Reference Books
1.Modern Control Systems, Richard. C. Dorf and Robert.H.Bishop, Addison Wesley, 1999 2.System dynamics &control,Eronini-Umez, Thomson Asia pvt Ltd. Singapore, 20026.
Additional Study material & e-Books
1.Feedback Control System,Schaum's series. 2001

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

Website and Internet Contents References
https://www.control engineering.com

8.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	Control engineering	http://www.controleng.com/magazine.html
2	Control engineering digital	http://www.controleng.com/magazine/digital-edition.html
3	Control engineering	https://en.wikipedia.org/wiki/Control_Engineering_(magazine)

9.0 Examination Note

Scheme of Evaluation for Internal Assessment

Internal Assessment test in the same pattern as that of the main examination (Better of the two Tests):20marks.

SCHEME OF EXAMINATION:

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

Max. Marks: 80Marks

10.0 Course Delivery Plan

Module No.	Lecture No.	Content of Lecture	% of Portion
1	1	**Introduction:** Concept of automatic controls	12%
	2	Open loop and closed loop systems, Concepts of feedback, requirements of an ideal control system	
	3	Types of controllers-Proportional	
	4	Integral, Differential, Proportional & Integral,	
	5	Proportional Differential and Proportional Integral	
	6	Requirements of an ideal control system	
	7	Concepts of feedback	
2	8	**T**ransfer function models.	24%
	9	Models of mechanical systems.	
	10	Models of electrical circuits.	
	11	DC and AC motors in control systems. Models of thermal systems.	
	12	Models of hydraulic systems, pneumatic system.	
	13	**Block Diagrams and Signal Flow Graphs:** Transfer Functions definition	
	14	Function	
	15	Blocks representation of systems elements.	
	16	Reduction of block diagrams.	
	17	Signal flow graphs	
	18	Mason's gain formula	
	19	Blocks representation of systems elements.	
	20	Reduction of block diagrams.	
3	21	**Transient and Steady State Response Analysis:**Introduction	24%
	22	First order and second order system response to step.	

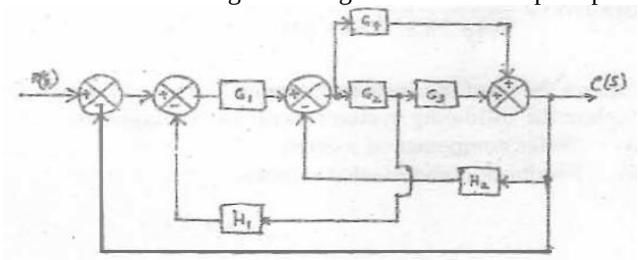
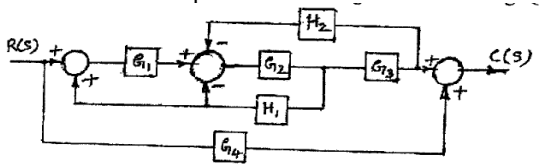
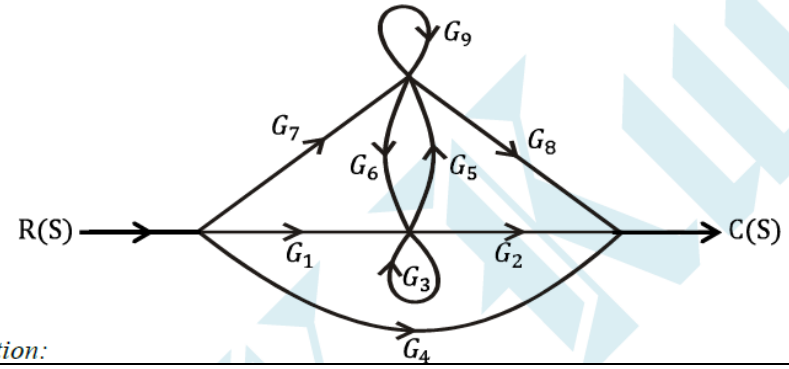
	23	Ramp and impulse inputs.	
	24	Concepts of time constant and its importance in speed of response.	
	25	System stability: Routh's-Hurwitz Criterion.	
	26	**Frequency Response Analysis:** Polar plots	
	27	Nyquist stability criterion	
	28	Stability analysis.	
	29	Relative stability concepts,	
	30	Gain margin and phase margin.	
	31	M&N circles	
	32	Nyquist stability criterion	
	33	Stability analysis.	
4	34	Relationship between time and frequency response	25%
	35	Relationship between time and frequency response	
	36	Relationship between time and frequency response	
	37	Relationship between time and frequency response	
	38	Relationship between time and frequency response	
	39	Polar plot, Bode's Plot, Nyquist plot and Nyquist stability criterion,	
	40	Polar plot, Bode's Plot, Nyquist plot and Nyquist stability criterion,	
	41	Polar plot, Bode's Plot, Nyquist plot and Nyquist stability criterion,	
	42	Polar plot, Bode's Plot, Nyquist plot and Nyquist stability criterion,	
	43	Phase and Gain Margins	
	44	Phase and Gain Margins	
	45	Phase and Gain Margins	
	46	Phase and Gain Margins	
	47	Phase and Gain Margins	
5	48	**System Compensation & State Variable Characteristics of Linear Systems:** Series and feedback compensation.	15%
	49	Introduction to state concepts.	
	50	State equation of linear continuous data system.	
	51	Matrix representation of state equations.	
	52	Controllability and observability.	
	53	Kalman and Gilberts test.	
	54	Matrix representation of state equations	

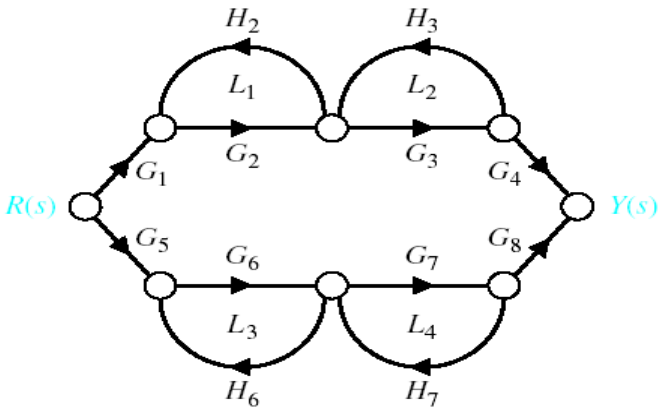
11.0 Assignments, Pop Quiz, Mini Project, Seminars

Sl.No.	Title	Outcome expected: students able to	Allied study	Week No.	Individual / Group activity	Reference: book/website /Paper
1	Assignment 1: University Questions on basics of control engineering	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 1	2	Individual Activity.	Refer all Text Books and Reference books
2	Assignment 2: University Questions on block reduction	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 2	4	Individual Activity.	Refer all Text Books and Reference books
3	Assignment 3: University Questions on Transient and Steady State Response Analysis	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 3	6	Individual Activity.	Refer all Text Books and Reference books
4	Assignment 4:	Students study the	Module 4	8	Individual	Refer all Text Books

	University Questions on Frequency Response Analysis Using Bode Plots	Topics and write the Answers. Get practice to solve university questions.			Activity.	and Reference books
5	Assignment 5: University Questions on System Compensation and State Variable Characteristics of Linear Systems	Students study variable characteristics of linear systems and series and feedback compensation system.	Module 5	8	Individual Activity.	Refer all Text Books and Reference books

12.0 QUESTION BANK

Module 1	
1	What is control system, Explain?
2	Distinguish between open loop and closed loop systems, with examples.
3	What are the requirements of a control system? Briefly explain.
4	Draw the block diagram of PID type controller and explain.
Module 2	
1	Reduce the block diagram in Fig. below to its simplest possible form and find its closed loop transfer function 
2	Obtain the closed loop transfer function of the block diagram shown in  Fig. Q3 (a)
3	For the signal flow graph shown in Fig. 3 (b), determine C/R using mason's gain formula  *ution:*
4	For the signal flow graph shown in below Fig., determine C/R using mason's gain formula.

	
Module 3	
1	Derive petroff's equation for lightly loaded bearings .State assumptions
2	Determine load carrying capacity,frictional force and power loss due to friction for an ideal full journal bearing having following specifications. Diameter of journal =5 cm length of bearing =6.5 cm, Speed of journal =1200 rpm radial clearance = 0.0025 cm Attitude = 0.8 viscosity= 1.6 $x10^{-6}$
3	Derive Reynold's equation in 2D
4	Explain mechanism of pressure development in an oil film
5	Define Sommerfeld's numbers and its significance.
6	Derive an expression of load carrying capacity of idealized journal bearing.
Module 4	
1	Aunity feedback system is characterized by an open loop transfer function GS=10/(S2+5S+6) Determine the following. When the system is subjected to a unit step input. i)undamped natural frequency,ii) Damping ratio, iii)Peak overshoot, iv)Peak time, v)Setting time.
2	Ascertain the stability of the system given by the characteristic equation,S6 + 3S5 + 5S4 + 9S3 + 8S2 + 6S + 4 = 0, by RouthHumritzcriterion.
3	A second order control system is represented by the differential equation; Obtain its total response for unit step input.
Module 5	
1	Explain the need for system compensation. List the types of compensator's used
2	Write notes on: i) Lag Compensator. ii) Lead Compensator.
3	Explain the following systems, with block diagrams. i)Series compensated system ii)Feedback compensated system.

13.0 University Result

Examination	FCD	FC	SC	% Passing
2017-18	44	48	28	100
2016-17	83	40	22	99.30

Prepared by	Checked by		
Prof. M. R. Ingalagi	Prof. N. M. Ukkali	HOD	Principal

15ME742- Tribology

	TRIBOLOGY		
Subject Code	15ME742	**IA Marks**	20
Number of Lecture Hrs / Week	03	**Exam Marks**	80
Total Number of Lecture Hrs	42	**Exam Hours**	03
CREDITS – 03			

FACULTY DETAILS:		
Name: Prof. N M Ukkali	**Designation:** Asst. Professor	**Experience:**5
No. of times course taught:01	**Specialization:** Machine Design	
Name: Prof. S B AWADE	**Designation:** Asst. Professor	**Experience:**05
No. of times course taught:01	**Specialization:** Machine Design	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Applied Science	I to IV	Engineering Mathematics
02	Mechanical Engineering	III	Mechanics Of Materials
03	Mechanical Engineering	V/VI	Design of machine elements

2.0 Course Objectives

1. To educate the students on the importance of friction, the related theories/laws of sliding and rolling friction and the effect of viscosity of lubricants.
2. To expose the students to the consequences of wear, wear mechanisms, wear theories and analysis of wear problems.
3. To make the students understand the principles of lubrication, lubrication regimes, theories of hydrodynamic and the advanced lubrication techniques.
4. To expose the students to the factors influencing the selection of bearing materials for different sliding applications.
5. To introduce the concepts of surface engineering and its importance in tribology
6.

3.0 Course Outcomes

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

	Course Outcome	Cognitive Level	POs
CO1	Understand the fundamentals of tribology and associated parameters.	U	1,2,4,6,8,11,12
CO2	Apply concepts of tribology for the performance analysis and design of components	U	1,2,4,6,8,11,12
CO3	Analyse the requirements and design hydrodynamic journal and plane slider bearings	U	1,2,4,6,8,11,12
CO4	Select proper bearing materials and lubricants for a given tribological application.	U	1,2,4,6,8,11,12
CO5	Apply the principles of surface engineering for different applications of tribology.	U	1,2,4,6,8,11,12
Total Hours of instruction		**42**	

4.0 Course Content

Module 1

Introduction to tribology: Historical background, practical importance, and subsequent use in the field.
Lubricants: Types and specific field of applications. Properties of lubricants, viscosity, its measurement, effect of temperature and pressure on viscosity, lubrication types, standard grades of lubricants, and selection of lubricants. **8hours**

Module 2

Friction: Origin, friction theories, measurement methods, friction of metals and non-metals.
Wear: Classification and mechanisms of wear, delamination theory, debris analysis, testing methods and standards. Related case studies. **8hours**

Module 3

Hydrodynamic journal bearings: Friction forces and power loss in a lightly loaded journal bearing, Petroff's equation, mechanism of pressure development in an oil film, and Reynold's equation in 2D.
Introduction to idealized journal bearing, load carrying capacity, condition for equilibrium, Sommerfeld's number and it's significance; partial bearings, end leakages in journal bearing, numerical examples on full journal bearings only.
10hours

Module 4

Plane slider bearings with fixed/pivoted shoe: Pressure distribution, Load carrying capacity, coefficient of friction, frictional resistance in a fixed/pivoted shoe bearing, center of pressure, numerical examples.
Hydrostatic Lubrication: Introduction to hydrostatic lubrication, hydrostatic step bearings, load carrying capacity and oil flow through the hydrostatic step bearing, numerical examples. **8hours**

Module 5

Bearing Materials: Commonly used bearings materials, and properties of typical bearingmaterials. Advantages and disadvantages of bearing materials.
Introduction to Surface engineering: Concept and scope of surface engineering. Surface modification – transformation hardening, surface melting, thermo chemical processes. Surface Coating – plating, fusion processes, vapor phase processes. Selection of coating for wear and corrosion resistance. **8hours**

5.0 Relevance to future subjects

Sl No	Semester	Subject	Topics
01	VII	Design Lab	Lubrication Experiment
02	VIII	Project work	Determining tribological Parameters

6.0 Relevance to Real World

Sl. No.	Real World Mapping
01	Design of Automobile, Boilers, Heat exchangers and other industrial components

7.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details

8.0 Books Used and Recommended to Students

Text Books
1."Introduction to Tribology", B. Bhushan, John Wiley & Sons, Inc., New York, 2002 2. "Engineering Tribology", Prasanta Sahoo, PHI Learning Private Ltd, New Delhi, 2011. 3. "Engineering Tribology", J. A. Williams, Oxford Univ. Press, 2005
Reference Books
1. "Introduction to Tribology in bearings", B. C. Majumdar, Wheeler Publishing. 2. "Tribology, Friction and Wear of Engineering Material", I. M.Hutchings, Edward Arnold, London, 1992. 3. "Engineering Tribology", G. W. Stachowiak and A. W. Batchelor, Butterworth-Heinemann, 1992. 4. "Friction and Wear of Materials", Ernest Rabinowicz, John Wiley & sons, 1995. 5. "Basic Lubrication Theory", A. Cameron, Ellis Hardwoods Ltd., UK. 6. "Handbook of tribology: materials, coatings and surface treatments", B.Bhushan, B.K. Gupta, McGraw- Hill, 1997.
Additional Study material & e-Books

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

Website and Internet Contents References
www.nptel.ac.in www.vtu.ac.in

10.0 Magazines/Journals Used and Recommended to Students

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

11.0 Examination Note

Scheme of Evaluation for Internal Assessment

Internal Assessment test in the same pattern as that of the main examination (Better of the two Tests):20marks.

SCHEME OF EXAMINATION:

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

Max. Marks: 80Marks

12.0 Course Delivery Plan

Module No.	Lecture No.	Content of Lecture	% of Portion
1	1	**Introduction to tribology:** Historical background, practical importance	19%
	2	Subsequent use in the field.	
	3	**Lubricants:** Types and specific field of applications.	
	4	Properties of lubricants, viscosity, its measurement	
	5	Effect of temperature and pressure on viscosity	
	6	Lubrication types	
	7	Standard grades of lubricants	
	8	Selection of lubricants.	
2	9	**Friction:** Origin, friction theories	20%
	10	Measurement methods	
	11	Friction of metals and non-metals	
	12	**Wear:** Classification and mechanisms of wear	
	13	Delamination theory, debris analysis,	
	14	Testing methods and standards.	
	15	Related case studies.	
	16	Problems	
3	17	**Hydrodynamic journal bearings:** Friction forces and power loss in a lightly loaded journal bearing,	23%
	18	Petroff's equation	
	19	Mechanism of pressure development in an oil film	
	20	Reynold's equation in 2D.	
	21	Introduction to idealized journal bearing, load carrying capacity,	
	22	Condition for equilibrium,	
	23	Sommerfeld's number and it's significance	
	24	Partial bearings	
	25	End leakages in journal bearing	
	26	Numerical examples on full journal bearings only.	
4	27	**Plane slider bearings with fixed/pivoted shoe:** Pressure distribution	19%
	28	Load carrying capacity, coefficient of friction	
	29	Frictional resistance in a fixed/pivoted shoe bearing	
	30	Center of pressure , numerical examples.	
	31	**Hydrostatic Lubrication:** Introduction to hydrostatic lubrication,	
	32	Hydrostatic step bearings, load carrying capacity	
	33	Oil flow through the hydrostatic step bearing	
	34	Numerical examples.	
5	35	**Bearing Materials:** Commonly used bearings materials	19%
	36	Properties of typical bearing materials.	
	37	Advantages and disadvantages of bearing materials	
	38	**Introduction to Surface engineering:** Concept and scope of surface engineering.	
	39	Surface modification – transformation hardening, surface melting,	
	40	Thermo chemical processes	
	41	Surface Coating – plating, fusion processes, vapor phase processes.	
	42	Selection of coating for wear and corrosion resistance.	

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 Introduction to tribology & Lubricants:	Basic definitions and Properties of lubricants	Module 1	2	Individual Activity.	Refer all Text Books and Reference books
2	Assignment 2: Questions on Friction and Wear	Apply concepts of tribology 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: Questions on Hydrodynamic journal bearings and Introduction to idealized journal bearing,	Analyse the requirements and design hydrodynamic journal and plane slider bearings for a given application.	Module 3	6	Individual Activity.	Refer all Text Books and Reference books
4	Assignment 4: Questions on Plane slider bearings with fixed/pivoted shoe and Hydrostatic Lubrication:	Select proper bearing materials and lubricants for a given tribological application.	Module 4	8	Individual Activity.	Refer all Text Books and Reference books
5	Assignment 5: Bearing Materials and Introduction to Surface engineering	Apply the principles of surface engineering for different applications of tribology.	Module 5	8	Individual Activity.	Refer all Text Books and Reference books

14.0 QUESTION BANK

Module 1	
1	Define viscosity fluidity Newtonian fluid.
2	Explain types of viscosity measuring instruments
3	Derive expression for flow of oil between two parallel stationary plates
4	Derive expression for Hagen –Poisuelle law.
Module 2	

1	Brifely explain friction theories.
2	Explain friction measurement methods.
3	Brifely explain Classification and mechanisms of wear.
4	Explain delamination theory.
Module 3	
1	Derive petroff's equation for lightly loaded bearings .State assumptions
2	Determine load carrying capacity,frictional force and power loss due to friction for an ideal full journal bearing having following specifications. Diameter of journal =5 cm length of bearing =6.5 cm, Speed of journal =1200 rpm radial clearance = 0.0025 cm Attitude = 0.8 viscosity= 1.6 $x10^{-6}$
3	Derive Reynold's equation in 2D
4	Explain mechanism of pressure development in an oil film
5 6	Define Sommerfeld's numbers and its significance. Derive an expression of load carrying capacity of idealized journal bearing.
Module 4	
1	Derive an expression for pressure distribution for a plane slider bearing with a fixed shoe.
2	A rectangular plane slider bearing with a fixed shoe has following data Length of bearing =80 mm width of bearing = 60 mm Slider velocity = 2 m/s Viscosity of lubricant = 0.1 Pa-sec Minimum film thickness = 0.02 mm Max film thickness =0.06 mm Draw the graph of variation of pressure along the length of bearing .
3	Derive an expression of load carrying capacity of a plane slider bearing with fixed shoe.
4	Derive expression for a load carrying capacity of hydrostatic step bearing
5	A hydrostatic thrust bearing has following data. Vertical thrust = 60 KN shaft diameter = 500 mm Pocket diameter = 300 mm, Viscosity = 35 cp film thickness = 0.01 mm. Determine rate of oil flow through bearing
Module 5	
1	List any ten desirable properties of bearing material
2	List advantages and disadvantages of bearing materials.
3	Explain Concept and scope of surface engineering.
4	Explain Surface modification and Surface Coating.

16.0 University Result

Examination	FCD	FC	SC	% Passing
Jul-2014	06	07	05	100
Jul- 2013	26	32	17	98.89

Prepared by	Checked by		
Prof. S B AWADE	Prof. N M Ukkali	HOD	Principal

15ME753- Mechatronics

Subject Title	**MECHATRONICS**		
Subject Code	15ME754	**IA Marks**	20
Number of Lecture Hrs / Week	03	**Exam Marks**	80
Total Number of Lecture Hrs	50	**Exam Hours**	03
CREDITS – 03			

FACULTY DETAILS:		
Name: Prof. M S Futane	**Designation:** Asst.Professor	**Experience:**14
No. of times course taught:03	**Specialization:** CIM	
Name: Prof. M A Hipparagi	**Designation:** Asst.Professor	**Experience:**10
No. of times course taught:01	**Specialization:** Prod. Tech	

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 .

3.0 Course Outcomes

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

	Course Outcome	Cognitive Level	POs	RBT level
CO 311.1	Explain the basics of theory, operation, design and application of sensors and actuators.	U	PO1, PO7, PO10,	L2
CO 311.2	Explain the basics of architecture, programming and application of microcontrollers and microprocessors.	U	PO1, PO7, PO10,	L2
CO 311.3	Explain the PLC,basic structure, principle of operations and integration of different elements	U	PO1, PO7, PO10,	L2
CO 311.4	Apply knowledge of mechanical & electrical actuation systems.	U	PO1, PO7, PO10,	L1
CO 311.5	Explain the pneumatic and hydraulic actuation system	U	PO1, PO7, PO10,	L2
Total Hours of instruction		**50**		

4.0 Course Content

MODULE -1

Introduction:
Definition, Multidisciplinary Scenario, Evolution of Mechatronics, Design of Mechatronics system, Objectives, advantages and disadvantages of Mechatronics.
Transducers and sensors:
Definition and classification of transducers, Difference between transducer and sensor,
Definition and classification of sensors, Principleof working and applications of light sensors, proximity switches and Hall Effect sensors. **10 Hours**

MODULE -2

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. **10 Hours**

MODULE -3

Programmable logic controller:
Introduction to PLC's, basic structure, Principle of operation, Programming and concept of ladder diagram, concept of latching & selection of a PLC.
Integration:
Introduction & background, Advanced actuators, Pneumatic actuators, Industrial Robot, different parts of a Robot-Controller, Drive, Arm, End Effectors, Sensor & Functional requirements of robot. **10 Hours**

MODULE -4

Mechanical actuation systems:
Mechanical systems, types of motion, Cams, Gear trains, Ratchet & Pawl, belt and chain drives, mechanical aspects of motor selection.
Electrical actuation systems: Electrical systems, Mechanical switches, Solenoids,Relays, DC/AC Motors, Principle of Stepper Motors & servomotors. **10 Hours**

MODULE -5

Pneumatic and hydraulic actuation systems:
Actuating systems, Pneumatic and hydraulic systems, Classifications of Valves, Pressure relief valves, Pressure regulating/reducing valves, Cylinders and rotary actuators.
DCV & FCV:
Principle & construction details, types of sliding spool valve, solenoid operated, Symbols of hydraulic elements, components of hydraulic system, functions of various units of
hydraulic system. Design of simple hydraulic circuits for various applications. **10 Hours**

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. Anthony Esposito, Fluid Power , Pearson Education, 6th Edition, 2011, ISBN No.9789332518544.
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
2) http://www.vtuupdates.com/2016/09/download-vtu-mech-mam-notes-question-papers.html
3) http://www.mechatronics2u.in/2014/05/microprocessor-overall-notes-for-all-5.html
4) 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: 25 Marks
Theoretical aspects as well as relevant sketches should be drawn neatly.

Scheme of Evaluation for Internal Assessment (20 Marks)
(a) Internal Assessment test in the same pattern as that of the main examination (Better of the two Tests):25marks.

SCHEME OF EXAMINATION:
Four questions to be set from each Part A, part B.
Student has to answer any five question choosing at least one questions from each module .
5 modules , 5 questions= 16*5= Total 80 Marks

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.

12.0 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 of Microprocessor systems, Basic elements of control systems, Microcontrollers	40%
	12	Difference between Microprocessor and Microcontrollers.	
	13	Microprocessor architecture and terminology	
	14	About CPU, memory and address, I/O and Peripheral devices	
	15	Explanation of ALU, Instruction and Program	
	16	Assembler, Registers	
	17	Explanation of Program Counter, Flags	
	18	Fetch cycle, write cycle	
	19	Explanation of bus interrupts.	
	20	Intel's 8085A Microprocessor.	
3	21	Introduction to PLC's	60%
	22	Basic structure of PLC's	
	23	Programming and concept of ladder diagram	
	24	Concept of latching & selection of a PLC.	
	25	Integration of Advanced actuators	
	26	Pneumatic actuators	
	27	Industrial Robot	
	28	Different parts of a Robot-Controller, Drive, Arm	
	29	End Effectors	
	30	Sensor & Functional requirements of robot.	
4	31	Mechanical systems, types of motion	80 %
	32	Cams, Gear trains,	
	33	Ratchet & Pawl mechanism	
	34	Belt and chain drives	
	35	Mechanical aspects of motor selection.	
	36	Electrical systems	
	37	Mechanical switches	
	38	Solenoids, Relays	
	39	DC/AC Motors	
	40	Principle of Stepper Motors & servomotors.	
5	41	Actuating systems, Pneumatic and hydraulic systems.	100%

	42	Classifications of Valves, Pressure relief valves	
	43	Pressure regulating/reducing valves	
	44	Cylinders and rotary actuators	
	45	Principle & construction details	
	46	Types of sliding spool valve	
	47	Symbols of hydraulic elements	
	48	Components of hydraulic system	
	49	Functions of various units of hydraulic system.	
	50	Design of simple hydraulic circuits for various applications	

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: Microprocessor & Microcontrollers	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: Programmable logic controller	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: Mechanical and Electrical actuation systems	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 1	15	Individual Activity.	Book 1,2 of the reference list. Website of the Reference list
5	Assignment 5: Pneumatic and hydraulic actuation systems	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 1	18	Individual Activity.	Book 1,2, of the reference list. Website of the Reference list

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

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

MODULE – 3

4. What is PLC?
5. Explain the PLC structure..
6. Explain briefly the ladder diagram..
7. Discuss about the advanced actuators.
8. Write a note on (a) Industrial robot (b) End effectors
9. Explain briefly the functional requirement of robot.

MODULE – 4

1. How are d.c. motors classified? Illustrate how field windings and armature windings are connected in each case.
2. Write a note on “disadvantages of mechanical switches”
3. With a neat sketch explain solenoid and state its uses.
4. List the solid state switches and explain the two forms of bipolar transistor.
5. Explain multiplexer &demultiplexer with applications.
6. How are ac. Motors classified? Briefly explain each.
7. Explain with neat sketch the ratchet and pawl mechanism

MODULE – 5

1. Explain with neat sketch the pneumatic and hydraulic system
2. Explain briefly the different types of valves.
3. Write a short note on cylinders and rotary actuators.
4. Explain briefly the different types of sliding spool valves.
5. Draw symbols of hydraulic elements
6. Write functions of various units of hydraulic system.

16.0 University Result

Examination	FCD	FC	SC	% Passing
July-2016	00	02	119	95.5
July-2015	25	61	62	99.33

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

15MEL76- Design Laboratory

Subject Title	**Design Laboratory**		
Subject Code	15MEL76	**CIE Marks**	20
Practical Hrs/ Week	04	**SEE Marks**	80
Practical Hrs	42	**Exam Hours**	03
			Credits: 02

FACULTY DETAILS:		
Name: Prof. S.B.Awade	**Designation:** Asst. Professor	**Experience:06**Years
No. of times course taught: First Times	**Specialization:** Design Engg.	
Name: Prof. G.V.Chiniwalar	**Designation:** Asst. Professor	**Experience:16**Years
No. of times course taught:05 Times	**Specialization:** Machine Design	

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 Objectives

1. To understand the natural frequency, logarithmic decrement, damping ratio and damping.
2. To understand the balancing of rotating masses.
3. To understand the concept of the critical speed of a rotating shaft.
4. To understand the concept of stress concentration using Photo elasticity.
5. To understand the equilibrium speed, sensitiveness, power and effort of Governor.

3.0 Course Outcomes

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

CO	Course Outcome	Cognitive Level	POs
C407.1	To understand the working principles of machine elements such as Governors, Gyroscopes etc.	A	2,3,4,5,10,11
C407.2	To identify forces and couples in rotating mechanical system components.	A	2,3,4,5,10,11
C407.3	To identify vibrations in machine elements and design appropriate damping methods and to	A	2,3,4,5,10,11
C407.4	To measure strain in various machine elements using strain gauges.	A	2,3,4,5,10,11
C407.5	To determine the minimum film thickness, load carrying capacity, frictional torque.	A	2,3,4,5,10,11
C407.6	To determine strain induced in a structural member using the principle of photo-elasticity.	A	2,3,4,5,10,11
Total Hours of instruction		42	

4.0 Course Content

PART - A

1. Determination of natural frequency, logarithmic decrement, damping ratio and damping coefficient in a single 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 Fringe constant of Photoelastic material using.
   a) Circular disc subjected to diametral compression.

b) Pure bending specimen (four point bending)

5. Determination of stress concentration using Photoelasticity for simple components like plate with a hole under tension or bending, circular disk with circular hole under compression, 2D Crane hook.

PART - B

6. Determination of equilibrium speed, sensitiveness, power and effort of Porter/Proell /Hartnel Governor. (at least one)
7. Determination of Pressure distribution in Journal bearing.
8. Determination of Principal Stresses and strains in a member subjected to combined loading using Strain rosettes.
9. Determination of stresses in Curved beam using strain gauge.
10. Experiments on Gyroscope (Demonstration only)

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
http://nptel.ac.in
www.vturesource.com
http://www.sapnaonline.com
Anmited video on Governer: https://www.youtube.com/watch?v=HS_YGZXP2xY
Video on proell governer: https://www.youtube.com/watch?v=qD8R-NtC8bo
Video on Gyroscope: https://www.youtube.com/watch?v=NeXIV-wMVUk
Video on Journal bearing:https://www.youtube.com/watch?v=xhtq8xqBXwE
Video on Critical speed of shaft: https://www.youtube.com/watch?v=ZEawe4jCbFw
Balancing of Rotating Masses: https://www.youtube.com/watch?v=0MeAZFFqmek&list=PLdLe0dTcWW-u_dCcNGoAK8fx2PiS5gkVu
Static and dynamic balancing by Tecquipment : https://www.youtube.com/watch?v=p1JDMvWGdsk
Forced vibrations by Tecquipment : https://www.youtube.com/watch?v=r_ouYEYhR5U
Video on Free Vibration: https://www.youtube.com/watch?v=RYKJo2iAz74
Video on free damped vibration of rigid body: https://www.youtube.com/watch?v=AakYHCdMsXI
Video on types of vibration: https://www.youtube.com/watch?v=nsEVfB_CPsE
Theory of Vibration: https://www.youtube.com/watch?v=DMlLEZMXOmc

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

CONTINUOUS INTERNAL EVOLUTION:
Internal Assessment test in the same pattern as that of the main examination: **20marks**.
END SEMESTER EXAMINATION:
One question is to be set from

Part-A	32
Part-B	32
Viva–Voce	16
Total	**80 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)	23.07
2	2	Balancing of rotating masses	7.69
3	3	Determination of critical speed of a rotating shaft.	7.69
4	4	Determination of Fringe constant of Photo elastic material using. a) Circular disc subjected to diametric compression. b) Pure bending specimen (four point bending)	7.69
5	5	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.	7.69
6	6	Determination of equilibrium speed, sensitiveness, power and effort of Porter/Proel /Hartnel Governor. (only one or more)	15.38
7	7	Determination of Pressure distribution in Journal bearing.	7.69
8	8	Determination of Principal Stresses and strains in a member subjected to combined loading using Strain rosettes	7.69
9	9	Determination of stresses in Curved beam using strain gauge.	7.69
10	10	Experiments on Gyroscope (Demonstration only)	7.69

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?

13.0 University Result

Examination	FCD	FC	SC	% Passing
July 2018	48	5	2	100
July 2017	126	5	8	100

Prepared by	Checked by		
Prof. G V Chiniwalar	Prof. S A Goudadi	HOD	Principal

15MEL77- CIM Laboratory

Subject Title	**CIM Lab**		
Subject Code	15MEL77	**IA Marks**	20
No of Lecture Hrs + Practical Hrs/ Week	01+02	**Exam Marks**	80
Total No of Lecture+Practical Hrs	42	**Exam Hours**	03
CREDITS – 02			

FACULTY DETAILS:		
Name: Prof. M A Hipparagi	**Designation:** Asst.Professor	**Experience:**10Years
No. of times course taught:03 Times	**Specialization:** Prod. Tech	
Name: N M Ukkali	**Designation:** Asst.Professor	**Experience:**5 Years
No. of times course taught:02Times	**Specialization:** Machine Design	

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,	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

CNC part programming using CAM packages. Simulation of Turning, Drilling, Milling operations. 3 typical simulations to be carried out using simulation packages like Master- CAM, or any equivalent software.

PART – B

(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. 2. Robot programming: Using Teach Pendent & Offline Programming to perform pick and place, stacking of objects, 2 programs.

PART – C

(Only for Demo/Viva voce)

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

9.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	International Journal of 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
PART B	6	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
	7	Introduction to write a NC part program for turning.	7.14
	8	Introduction to write a NC part program for drilling.	7.14
	9	Introduction to write a NC part program for milling.	7.14
	10	Demonstration-Introduction to Robot Programming Language Using Teach Pendent and Offline Programming to perform pick and place, stacking of objects.	7.14
PART C	11	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	FC	SC	% Passing
July 2017	63	00	00	100
July 2016	67	00	00	100

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