Department of Mechanical Engineering

COURSE PLAN 2023-24

V Semester

INSTITUTE VISION

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

INSTITUTE MISSION

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

DEPARTMENT OF MECHANICAL ENGINEERING

VISION

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

MISSION

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

Program Educational Objectives (PEOs)

The Graduates will be able to

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

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

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

Program Specific Outcomes (PSOs)

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

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

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

Program Outcomes (POs)

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

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

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

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

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

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

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

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

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

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

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

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

CONTENTS

Departmental Resources

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

Faculty Position

Sl. No.	Category	No. in position	Average experience
1	Teaching faculty	09	20
2	Technical staff	05	18
3	Helper / Peons	03	14

Major Laboratories

S.N.	Name of the laboratory	Area in Sq. Meters	Amount Invested (Rs.)
1	Basic Workshop Laboratory	170	438593
2	Fluid Mechanics Machinery Laboratory	172	775916.75
3	Energy Conversion Engg. Laboratory	173	1278158.2
4	Machine shop Laboratory	170	1372566.5
5	Foundry & Forging Laboratory	179	321057.11
6	Design Laboratory	73	365861
7	Heat & Mass Transfer Laboratory	148	524576
8	Metallography & Material Testing Laboratory	149	1102945.2
9	Mechanical Measurements & Metrology Laboratory	95	557593.75
10	CIM & Automation/CAMA Laboratory	66	5114658
11	Computer Aided Machine Drawing Laboratory	66	2197382
12	Computer Aided Engg Drawing Laboratory	66	2818657
13	Department/Other	--	2107430
14	Research Centre	73	640747
	Total	**1527**	**19616142**

Teaching Faculty Details

S.N.	Faculty Name	Designation	Qualification	Area of specialization	Teaching Exp (in years)	Contact Nos.
1	Dr. S. C. Kamate	Principal	Ph. D	Thermal(Cogeneration)	32	9480849331
2	Dr. S. N. Topannavar	Assoc. Prof.	Ph. D	Thermal Power Engg.	24	9482440235
3	Prof. K. M. Akkoli	Assoc. Prof.	Ph. D	Thermal Power Engg.	19	9739114856
4	Prof. D. N. Inamdar	Asst. Prof	M Tech.(Ph. D)	Tool Engg	20	9591208980
5	Prof.M.S.Futane	Asst. Prof	M Tech.	Computer Integrated Manufacturing	17	9164105035
6	Prof.S. A. Goudadi	Asst. Prof	M Tech.	Design Engineering	15	9448876682
7	Prof.M.M.Shivashimpi	Asst. Prof	M Tech.(Ph.D)	Thermal Power Engg.	16	9742197173
8	Prof.M.A.Hipparagi	Asst. Prof	M Tech.(Ph.D)	Production Technology	14	7411507405
9	Prof. G. M. Zulapi	Asst. Prof	M Tech.	Product Design & Manufacturing	15	9480213587
10	Prof. P.M.Kokitakar	Asst. Prof	M Tech.	Design Engineering	05	8095048022

REVISED ACADEMIC CALENDAR OF EVENTS-02 (CoE-02) OF III & V SEM FOR THE AY: 2023-24

Ref: 1. VTU CoE Notification No.: VTU/BGM/ACA/2023-24/3252, Dated 30th Sept. 2023
2. VTU CoE Notification No.: VTU/BGM/ACA/2023-24/2668, Dated 25th Aug. 2023
3. VTU Revised CoE Notification No.: VTU/BGM/ACA/2023-24/3681, Dated 20th Oct. 2023

Calendar

October -2023

Sun	Mon	Tue	Wed	Thu	Fri	Sat
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				

November -2023

Sun	Mon	Tue	Wed	Thu	Fri	Sat
			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		

December -2023

Sun	Mon	Tue	Wed	Thu	Fri	Sat
					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						

January -2024

Sun	Mon	Tue	Wed	Thu	Fri	Sat
	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			

February -2024

Sun	Mon	Tue	Wed	Thu	Fri	Sat
				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		

March -2024

Sun	Mon	Tue	Wed	Thu	Fri	Sat
31					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

Date	Events & Holidays
28th Sept.2023	GH: Eid-Milad
2nd Oct. 2023	GH: Gandhi Jayanthi
14th Oct.2023	GH: Mahalaya Amavasya
17th Oct. 2023	Fresher's day: A Welcome Function for 1st year students
23rd -24th Oct. 2023	GH: Mahanavami, Ayudhapooja, Vijayadasami
25th Oct to 23rd Nov. 2023	V Sem Innovation/Entrepreneurship/Societal Internship (2021 Scheme)
28th Oct. 2023	Valmiki Jayanti
1st Nov. 2023	GH: Kannada Rajyothsava
14th Nov. 2023	GH: Balipadyami, Deepavali
15th Nov. 2023	Commencement of III Semester Classes
25th Nov. 2023	Commencement of V Semester Classes
30th Nov. 2023	GH: Kanakadasa Jayanti
8th-9th Dec. 2023	International Conference
25th Dec. 2023	GH: Christmas
21st-23rd Dec.2023	1st IA Test for III & V Semesters
23rd Dec. 2023	1st Feedback on Teaching-Learning (III & V Sems.)
27th Dec. 2023	Display of 1st IA Test Marks (III & V Sems.)
12th Jan. 2024	National Youth Day
15th Jan. 2024	GH: Uttarayana Punya Kala Sankrathi (Tentative)
19th -20th Jan. 2024	Lab IA Test-I (III Sem. 2022 Scheme & V Sem. 2021 Scheme)
22nd-24th Jan. 2024	2nd IA Test for III & V Semesters
24th Jan. 2024	2nd Feedback on Teaching-Learning (III & V Sems.)
26th Jan. 2024	Republic Day
29th Jan. 2024	Display of 2nd IA Test Marks (III & V Sems.)
9th -10th Feb. 2024	Lab IA Test-II (III Sem. 2022 Scheme)
15th-17th Feb. 2024	3rd IA Test for III Semester
19th Feb. 2024	Display of 3rd IA Test Marks (III Sem.)
20th Feb. 2024	Last Working Day of the III Semester
21st -29th Feb. 2024	III Semester VTU Practical Examination
04th -23rd March 2024	III Semester VTU Theory Exams (SEE)
1st & 2nd March 2024	Lab IA Test-II (V Sem. 2021 Scheme)
5th -7th March 2024	3rd IA Test for V Sem
9th March 2024	Display of 3rd IA Test Marks
8th March 2024	GH: Mahashivaratri & International Women's Day
9th March 2024	Last Working Day of the V Semester
11th-20th March. 2024	V Semester Practical Examination
1st April 2024	Commencement of IV Semester
22nd March-20th April 24	V Semester VTU Theory Exams (SEE)
22nd April 2024	Commencement of VI Semester
29th March 2024	GH: Good Friday

GH: General Holiday, RH: Local Holiday

Dr.S.N.Topannavar
IQAC Coordinator & Dean (Academics)

Dr.S.C.Kamate
Principal

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VTU Scheme of Teaching and Examination

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
B.E. in MECHANICAL ENGINEERING
Scheme of Teaching and Examinations 2021
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
(Effective from the academic year 2021 - 22)

V SEMESTER

SL No	Course and Course Code	Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching Hours /Week				Examination				Credits
				Theory Lecture	Tutorial	/	Self -Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	T	P	S					
1	BSC 21ME51	Theory of Machines	TD: ME PSB: ME	2	2	0	0	03	50	50	100	3
2	IPCC 21ME52	Thermo-fluids Engineering	TD: ME PSB: ME	3	0	2	0	03	50	50	100	4
3	PCC 21ME53	Finite Element Analysis	TD: ME PSB: ME	2	0	2	0	03	50	50	100	3
4	PCC 21ME54	Modern Mobility and Automotive Mechanics	TD: ME PSB: ME	3	0	0	0	03	50	50	100	3
5	PCC 21MEL55	Design lab	TD: ME PSB: ME	0	0	2	0	03	50	50	100	1
6	AEC 21XX56	Research Methodology & Intellectual Property Rights	TD: Any Department PSB: As identified by University	2	0	0	0	02	50	50	100	2
7	HSMC 21CIV57	Environmental Studies	TD: Civil/ Environmental /Chemistry/ Biotech. PSB: Civil Engg	2	0	0	0	1	50	50	100	1
8	AEC 21ME58X	Ability Enhancement Course-V	Concerned Board	If offered as Theory courses: 0	2	0		01	50	50	100	1
				If offered as lab.Courses: 0	0	2		02				
								Total	400	400	800	18

Ability Enhancement Course – IV

21ME581	Basics of MATLAB(0-0-2-0)	21ME583	VFX – Visual Effects (0-2-0-0)
21ME582	Digital Marketing (0-2-0-0)		

Note: BSC: Basic Science Course, PCC: Professional Core Course, IPCC: Integrated Professional Core Course, AEC –Ability Enhancement Course INT –Internship, HSMC: Humanity and Social Science & Management Courses.
L –Lecture, T – Tutorial, P- Practical/ Drawing, S – Self Study Component, CIE: Continuous Internal Evaluation, SEE: Semester End Examination.

Integrated Professional Core Course (IPCC): refers to Professional Theory Core Course Integrated with Practical of the same course. Credit for IPCC can be 04 and its Teaching – Learning hours (L : T : P) can be considered as (3 : 0 : 2) or (2 : 2 : 2). Theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by CIE only and there shall be no SEE. For more details the regulation governing the Degree of Bachelor of Engineering /Technology (BE/B.Tech.) 2021-22 may be referred.

Subject Title	THEORY OF MACHINES		
Subject Code	18ME44	IA Marks	40
No of Lecture Hrs + Tutorial Hrs / Week	03+01	Exam Marks	60
Total No of Lecture + Practical Hrs	50	Exam Hours	03
		CREDITS – 04	

FACULTY DETAILS:		
Name: Prof. Mahantesh Tanodi	**Designation:** Asst. Professor	**Experience:** 10 Years
No. of times course taught: 09	**Specialization:** Machine Design	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
1	Mechanical Engineering	I/II	Elements of Mechanical Engineering
2	Mechanical Engineering	I/II/III/IV	Engg Mathematics
3	Mechanical Engineering	III	Mechanics of Materials

2.0 Course Objectives

- To understand the concept of machines, mechanisms and to analyze a mechanism for displacement, velocity and acceleration at any point in a moving link.
- To understand the force-motion relationship in components subjected to external forces and analysis of standard mechanisms
- To understand the theory of gears and gear trains.
- To understand the undesirable effects of unbalances resulting from prescribed motions in mechanism.
- To understand the principles in mechanisms used for speed control and stability control.
- To compute the natural and damped frequencies of free 1-DOF mechanical systems and to analyze the vibrational motion of 1-DOF mechanical systems under harmonic excitation conditions

3.0 Course Outcomes

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

CO	Course Outcome	Cognitive Level	POs	PSOs
C301.1	Knowledge of mechanisms and their motion and the inversions of mechanisms	L2	PO1,PO2, PO6, PO8, PO12	PSO1,PSO2
C301.2	Analyse the velocity, acceleration of links and joints of mechanisms..	L1,L2,L3,	PO1,PO2, PO6, PO8, PO12	PSO1,PSO2
C301.3	Analyse the mechanisms for static and dynamic equilibrium.	L1,L2,L3,	PO1,PO2, PO6, PO8, PO12	PSO1,PSO2
C301.4	Carry out the balancing of rotating and reciprocating masses and also analyse different types of governors used in real life situation.	L2,L3	PO1,PO2, PO6, PO8, PO12	PSO1,PSO2
C301.5	Analyze the free and forced vibration phenomenon.	L2,L3,	PO1,PO2, PO6, PO8, PO12	PSO1,PSO2
	Total Hours of instruction	**50**		

4.0 Course Content

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MODULE -1

Introduction: Mechanisms and machines, Kinematic pairs-types, degree of freedom, Kinematic chains and their classification, Kinematic inversions,

Velocity and Acceleration analysis of planar mechanisms Graphical method: Velocity and Acceleration Analysis of Mechanisms Velocity and acceleration analysis of four bar mechanism, slider crank mechanism. Mechanism illustrating Corioli's component of acceleration. Angular velocity and angular acceleration of links, velocity of rubbing. Velocity and Acceleration Analysis of Mechanisms (Analytical Method):Velocity and acceleration analysis of four bar mechanism, slider crank mechanism using complex algebra method.

MODULE -2

Static force analysis: Static equilibrium, analysis of four bar mechanism, slider crank mechanism.

Dynamic force analysis: D'Alembert's principle, analysis of four bar and slider crank mechanism.

Flywheel: Introduction to Flywheel and calculation of its size for simple machines like punching machine, shearing Machine

MODULE -3

Spur Gears: Gear terminology, law of gearing, path of contact, arc of contact, contact ratio of spur gear. Interference in involute gears, methods of avoiding interference, condition and expressions for minimum number of teeth to avoid interference.

Gear Trains: Simple gear trains, compound gear trains. Epicyclic gear trains: Algebraic and tabular methods of finding velocity ratio of epicyclic gear trains, torque calculation in epicyclic gear trains. Discussions on applications of gear trains.

MODULE -4

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

Balancing of Reciprocating Masses: Inertia Effect of crank and connecting rod, Single cylinder Engine, Balancing in multi cylinder-inline engine (primary and secondary forces). Discussions on applications

Governors: Types of Governors; Force Analysis of Porter and Hartnell Governors. Controlling Force, Stability, Sensitiveness, Isochronism, Effort and Power. Discussion on applications.

MODULE -5

Free vibrations: Basic elements of vibrating system, Types of free vibrations, Longitudinal vibrations- Equilibrium method, D'Alembert's principle, Determination of natural frequency of single degree freedom systems,

Damped freevibrations: Under damped, over damped and critically damped systems. Logarithmic decrement.

Forced vibrations: Undamped forced vibration of spring mass system, Damped forced vibrations, Rotating unbalance, Reciprocating unbalance, Vibration isolation, Critical speed. Discussions on applications.

5.0 Relevance to future subjects

SL. No	Semester	Subject	Topics / Relevance
01	VI	Design of machine element II	Gears/clutches/Brakes
02	VII	Project Work	Kinematic analysis and synthesis of Mechanical parts and Dynamic force analysis.

6.0 Relevance to Real World

SL. No	Real World Mapping
01	Kinematic analysis and synthesis of Mechanisms
02	Kinematic analysis and synthesis of Gears
03	Industrial drawings and design of various components
04	Design of Automobile, Boilers, Heat exchangers, other industrial components and vibratory

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	Equipments

7.0 Books Used and Recommended to Students

Text Books
1.Rattan S.S, Theory of Machines, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 4 th Edition, 2014.
2.Mechanism and Machine Theory G. Ambekar PHI 2009
3.Theory of Machines Kinematics and Dynamics Sadhu Singh Pearson Third edition 2019
Reference Books
1 Theory of Machines Rattan S.S Tata McGraw-Hill Publishing Company 2014
2 Mechanisms and Machines- Kinematics, Dynamics and Synthesis Michael M Stanisic Cengage Learning 2016
Additional Study material & e-Books
1.Nptel.ac.in
2.VTU, E- learning

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

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

9.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	Mechanism and Machine Theory - Journal - Elsevier	https://www.journals.elsevier.com/mechanism-and-machine-theory
2	Theory of Mechanisms and Machines: electronic journal	tmm.spbstu.ru/english.html
3	Mechanisms and robotics	http://mechanismsrobotics.asmedigitalcollection.asme.org/journal.aspx

10.0 Examination Note

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of 20 Marks (duration 01 hour)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of 10 Marks

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for 20 Marks (duration 01 hours)

- At the end of the 13th week of the semester

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- The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be scaled down to 50 marks

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (duration 03 hours)

- The question paper will have ten questions. Each question is set for 20 marks.Marks scored shall be reduced proportionally to 50 marks
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), should have a mix of topics under that module

11.0 Course Delivery Plan

Module No.	Lecture No.	Content of Lecture	% of Portion
1		**Mechanisms**	20
	1	Definitions: Link , types of links, joint, types of joints kinematic pairs, Constrained motion, kinematic chain	
	2	Mechanism and types , degrees of freedom of planar mechanisms, Equivalent mechanisms, Groshoff's criteria and types of four bar mechanisms	
	3	Inversions of four bar chain	
	4	Inversions of slider crank chain	
	5	Inversions of double slider crank chain Grashoff's chain	
	6	Mechanisms: Quick return motion mechanisms Drag link mechanism, Whitworth mechanism and Crank and slotted lever Mechanism	
	7	Straight line motion mechanisms,Peaucellier's mechanism and Robert's mechanism	
	8	Intermittent Motion mechanisms: Geneva wheel mechanism, Ratchet and Pawl mechanism	
	9	Toggle mechanism, pantograph,	
	10	Condition for correct steering, Ackerman steering gear mechanism.	
		Velocity and Acceleration Analysis of Mechanisms (Graphical Method)	
	11	Velocity and acceleration analysis of four bar mechanism,	
	12	slider crank mechanism	
	13	Mechanism illustrating Coriolis component of acceleration	
	14	Angular velocity and angular acceleration of links, velocity of rubbing.	
2	1	**Static force Analysis, Dynamic force Analysis:**	20
	2	Introduction: Static Equilibrium. Equilibrium of Two and Three Force Members	
	3	Members with Two Forces and Torque, Free Body Diagrams	
	4	Static Force Analysis of Four Bar Mechanism	
	5	Slider-Crank Mechanism	
	6	Shaper Mechanism	
	7	D'Alembert's Principle,	
	8	Dynamic Force Analysis of Four-Bar Mechanism	
	9	Dynamic Force Analysis of Slider Crank Mechanism	
	10	Shaper Mechanism	
		Fly Wheels	
	11	Introduction to Flywheel and calculation of its size for simple machines like punching machine, shearing Machine	
3	12	**Gears:**	20
	13	Gear terminology, law of gearing	

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	14	Path of contact, arc of contact, contact ratio of spur gear	
	15	Interference in involute gears, methods of avoiding interference,	
	16	Condition and expressions for minimum number of teeth to avoid interference	
	17	Solving of related numerical	
	18	**Gear Trains:** Simple gear trains, compound gear trains. Epicyclic gear trains	
	19	Algebraic methods of finding velocity ratio of epicyclic gear trains,	
	20	Solving of related numerical.	
	21	Tabular methods of finding velocity ratio of epicyclic gear trains,	
	22	Solving of related numerical.	
	23	Solving of related numerical.	
4	24	**Balancing of Rotating Masses, Balancing of Reciprocating Masses:**	
	25	Static and Dynamic Balancing	
	26	Balancing of Single Rotating Mass by Balancing Masses in Same plane	
	27	Balancing of Single Rotating Mass by Balancing Masses in Different planes.	
	28	Balancing several rotating masses by balancing mass in same plane.	
	29	Balancing several rotating masses by balancing masses in different planes.	
	30	**Balancing of Reciprocating Masses:** Inertia Effect of Crank and Connecting rod,	`
	31	Balancing of Single Cylinder Engine,	
	32	Balancing in Multi Cylinder inline engine (Primary & Secondary forces),	
	33	V-type engine,	
	34	Radial engine – direct and reverse crank method.	
	35	**Governors,**	
	36	Types of Governors;	
	37	Force Analysis of Porter Governors.	
	38	Force Analysis of Hartnell Governors.	
	39	Controlling Force, Stability, Sensitiveness, Isochronism, Effort and Power in Governors	
5	40	**Free vibrations:**	
	41	Basic elements of vibrating system, Types of free vibrations,	
	42	Longitudinal vibrations-Equilibrium method,	
	43	D"Alembert"s principle, Energy method,	
	44	Rayleigh"s method.	
	45	Determination of natural frequency of single degree freedom systems,	
	46	Effect of spring mass,	
	47	Damped free vibrations	
	48	Under damped, over damped and	
	49	critically damped systems.	
	50	Logarithmic decrement	
	51	**Forced vibrations:**	
	52	Undamped forced vibration of spring mass system,	
	53	Damped forced vibrations,	
	54	Rotating unbalance,	
	55	Reciprocating unbalance,	
	56	Vibration isolation,	
	57	Support motion(absolute and relative motion),	
	58	Transverse vibration of shaft with single concentrated load,	
	59	several loads,	
	60	uniformly distributed load,	
	61	Critical speed.	

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12.0 Assignments, Pop Quiz, Mini Project, Seminars

Sl. No.	Title	Outcome expected: students able to	Allied study	Week No.	Individual / Group activity	Reference: book/website /Paper
1	*Assignment -1*: **Introduction:** Mechanisms and machines. Velocity and Acceleration Analysis of Mechanisms	Explain Basic definitions and Mechanisms	M1	2	Individual Activity.	Text Book 1&2
2	Assignment 1: Questions on Static force Analysis, Dynamic force Analysis:	Determine the forces and couples for static and dynamic conditions of four bar and slider crank and shaper mechanisms to keep the system in equilibrium.	M2	4	Individual Activity.	Text Book 1&2
3	*Assignment -1*: **Gears & Gear Trains**	Explain Gear terminology & types of gears	M3	6	Individual Activity.	Text Book 1&2
4	Assignment 2: Questions on Balancing of Rotating Masses, Balancing of Reciprocating Masses:	Determine magnitude and angular position of balancing masses under static and dynamic Condition of rotating masses in same and different planes.	M4	8	Individual Activity.	Text Book 1&2
5	Assignment 5: Forced Vibrations (Single Degree of Freedom)	Undamped and Damped Forced Vibrations rotating and reciprocating unbalance systems,Magnification factor and transmissibility of forced vibration (SDOF) systems.	M5	10	Individual Activity.	Text Book 1&2

13.0 QUESTION BANK

MODULE-1:
INTRODUCTION:

1. Define kinematic link, kinematic pair, and kinematic chain.
2. Distinguish between a) mechanism and machine b) completely constrained motion and successful constrained motion.
3. What is an inversion? Explain various inversions of single and double slider crank chains.
4. Discuss various types of constrained motions.
5. What are quick-return mechanisms? Where are they used? Discuss the functioning of any one of them.
6. Explain briefly elliptical trammel and scotch yoke mechanism with neat diagram.
7. Define mobility of a mechanism with example.
8. What is the difference between exact and approximate straight line mechanism. Explain each with suitable example.
9. Explain the working of the following mechanisms with neat sketch a) pantograph b) toggle mechanism c) Ackermann's steering gear mechanism d) Geneva mechanism e) Ratchet and pawl mechanism.
10. Explain the following mechanisms with suitable sketches a) drag link mechanism b) whit worth mechanism c) crank and slotted link mechanism.

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MODULE-2:

VELOCITY AND ACCELERATION ANALYSIS OF MECHANISMS (GRAPHICAL METHODS):

1. In mechanism shown in fig.2.1, crank2 rotates at 3000rpm.Find the acceleration of the point C in magnitude, direction and sense. Find also the angular acceleration of link 3.

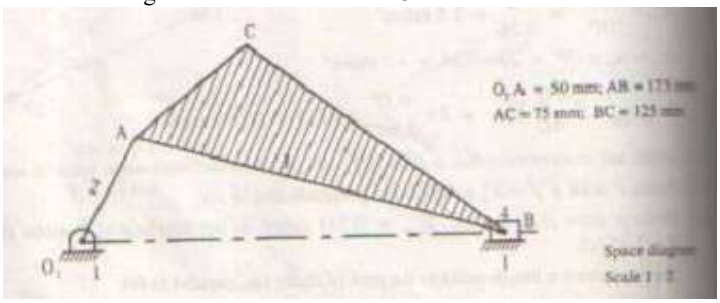

Fig. 2.1

2. The crank of a slider crank mechanism is 480mm long and rotates at 20 rad/sec in the counter clockwise direction. It has a connecting rod of 1600mm long. Determine the following when the crank is 60 degree from the inner dead centre, angular velocity of the connecting rod, the position and the velocity of a point P on the connecting rod having least absolute velocity shown in the fig.2.2

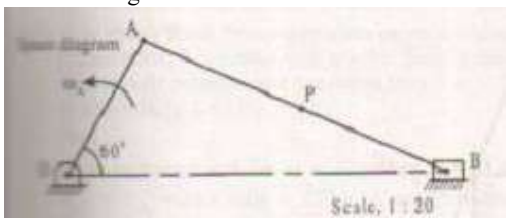

Fig. 2.2

3. The crank O2A of four bar mechanism shown in fig.2.3, is rotating clockwise at a constant speed of 100 rad/sec. Determine(a)The acceleration of the point C (b)The angular acceleration of the links 3&4.

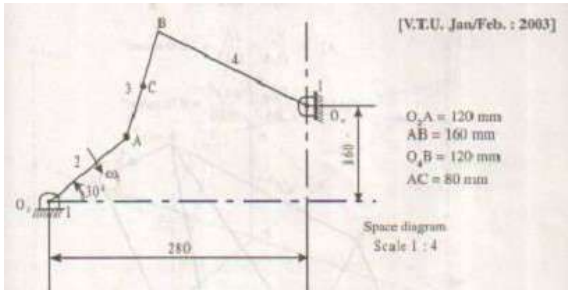

Fig. 2.3

4. A four bar mechanism ABCD is made up of four links, pin jointed at the ends. AD is fixed link which is 180 mm long. The links AB, BC, CD are 90 mm, 120mm and 120mm respectively. At certain instant, the link AB makes an angle of 60 degree with the link AD, if the link AB rotates at uniform speed of 100 rpm clockwise determine angular velocity of links BC and CD and angular acceleration of link CD and CB as shown in fig 2.4

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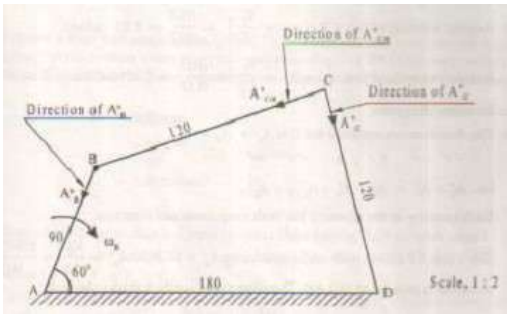

Fig. 2.4

5. In a slider crank mechanism, the crank OB = 30mm and the connecting rod BC=120mm. the crank rotates at uniform speed of 300rpm clockwise. Find the crank position shown in the figure in which the crank is turned 60 degree, find a) velocity of piston C and angular velocity of connecting rod BC b) acceleration of piston C and angular acceleration of connecting rod BC as shown in fig 2.5

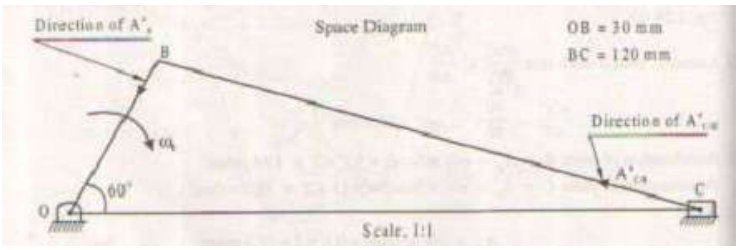

Fig. 2.5

VELOCITY ANALYSIS BY INSTANTANEOUS CENTER METHOD:

1. State and prove Arnold-Kennedy theorem of three centers or three centers inline theorem with a neat diagram.
2. Locate all the instantaneous centers for the four bar mechanism shown in the figure as shown in fig.2.6

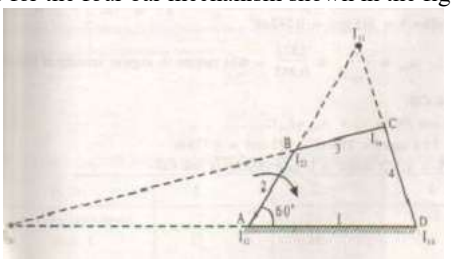

Fig. 2.6

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

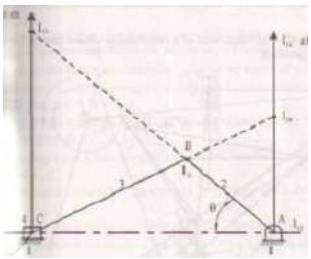

Fig. 2.7

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4. In a four bar mechanism shown in fig 4.4,link 2 is rotating at angular velocity ω2.locate all the instantaneous centers of the mechanism &find a) the angular speeds of link 3 & 4, the linear velocity of links 3 & 4, the linear velocities of points E & F as shown in the figure 2.8

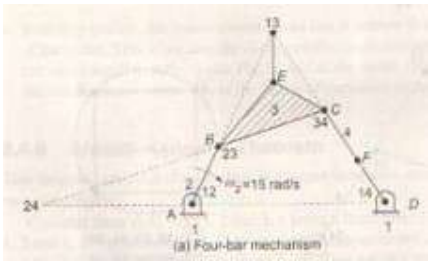

Fig. 2.8

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

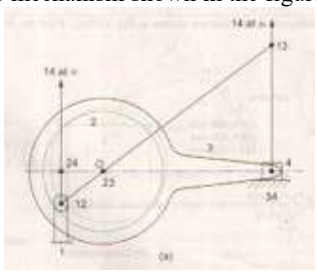

Fig. 2.9

VELOCITY AND ACCELERATION ANALYSIS OF MECHANISMS (ANALYTICAL METHODS):

1. If the crank and connecting rod are 150 mm and 600 mm long respectively and the crank rotates at a constant speed of 100 rpm, determine a) velocity and acceleration of the piston b) angular velocity c) and angular acceleration of the connecting rod. The angle which the crank makes with the inner dead centre is 30 degrees.
2. The length of the connecting rod of a gas engine running at 340 rpm is 600mm and the crank is 120mm long. When the piston has moved one fourth stroke during out stroke determine a) then angular position of the crank b) the angular speed of connecting rod and c) the acceleration of the piston.
3. The length of the crank of a reciprocating engine is 120mm and its connecting rod length is 600mm it rotates at 360 rpm and at a particular instant it makes an angle of 50 degree with the inner dead center. Find a) velocity and acceleration of the piston b) velocity and acceleration of the midpoint of the connecting rod c) angular velocity and angular acceleration of the connecting rod.

MODULE-3:

SPUR GEARS:

1. Two spur gears have 24 and 30 teeth of module =10mm, standard addendum=1 module, pressure angle=20 degrees find a) length of arc of contact b) contact ratio.
2. Two mating gears with module pitch 6mm have 20 and 50 teeth of pressure angle 20 degrees and addendum 6mm. Determine the number of pairs of teeth in contact.
3. A pinion of 24 teeth drives a gear of 60 teeth at a pressure angle of 20 degrees. The pitch radius of pinion is 38mm and outside radius is 41mm. The pitch radius of the gear is 95mm and the outside radius 98.5mm. Calculate the length of path of contact and contact ration.
4. Two 20 degrees involute gears in mesh have a gear ratio of 2 and 20 teeth on the pinion. The module is 5mm and the pitch line speed is 1.5 mtr per second. Assuming addendum to be equal to 1 module find a) angle turned through by pinion when one pair of teeth is in mesh and b) maximum velocity of sliding.
5. Two spur gears have 30 teeth each of involute shape. The circular pitch is 25mm. Pressure angle=20 degrees, determine the addendum of wheels if arc of contact is twice the circular pitch.
6. Two gear wheels mesh externally and are to give velocity ratio of 3. The teeth are of involute form of module 6mm and standard addendum=1module. Pressure angle=18 degrees, pinion rotates at 90 rpm. Find a) number of teeth on each wheel so that interference is just avoided b) length of path of contact c) maximum velocity of sliding between teeth.

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7. Find the minimum number of teeth to avoid under cutting when the addendum for teeth is 0.84 module. Gear ratio is 3:1; find the length of arc of contact in terms of module. Pressure angle=20 degrees.
8. Two gears in mesh have a module of 8mm and a pressure angle of 20 degree. The larger gear has 57 teeth while pinion has 23 teeth. If the addenda on pinion and gear wheel are equal to 1module find a) the number of pairs of teeth in contact the angle of action of the pinion and the gear wheel.

GEAR TRAINS:

1. Two spur gears A & B of an Epicyclic gear train is shown in the figure 4.1 have 24 and 30 teeth respectively. The arm rotates at 100 rpm clockwise. Find the speed of gear B on its own axis when gear A is fixed. If instead of being fixed the wheel A rotates at 200 rpm in ccw direction, what will be the speed of gear B. (solve it by algaebraic method)

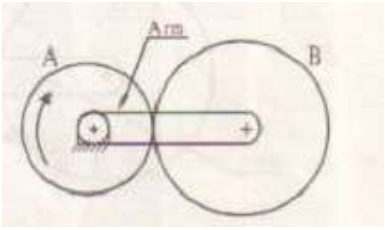

Fig. 4.1

2. In an Epicyclic gear train shown in the figure 4.2, the arm A is fixed to the shaft S the wheel B having 100 teeth rotates freely on the shaft S , wheel F 150 teeth is separately driven. If the arm A runs at 200 rpm, wheel F at 100 rpm in the same direction find a) number of teeth of gear C b) speed of the wheel B. (solve it by algebraic method)

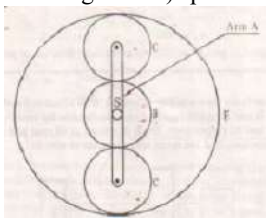

Fig. 4.2

3. A fixed annular wheel B has 92 teeth. Wheel C and D have 25 and 15 teeth respectively. Wheel E has 52 teeth, if the arm A rotates at 130 rpm, what is the speed of wheel E shown in the figure 4.3.(solve it by algaebraic method)

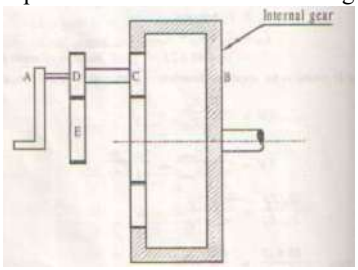

Fig. 4.3

4. The gear train shown in the fig.3.4.Gear A meshes with gear B.In the compound gear B-C, gear C meshes with gear D, Rotating relative to A around the same axis of A. If the gear A is fixed, arm F is used as the driving member, determine the speed ratio n_D/n_F. Number of teeth on wheels A,B,C&D are 61,61,62&60 respectively(solve it by graphical method.)

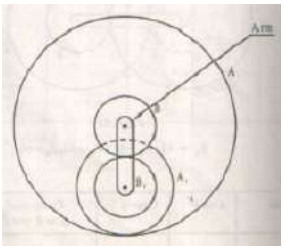

Fig. 4.4

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5. An Epicyclic gear train is constructed as shown in fig 4.5.A fixed annular wheel A & a smaller concentric wheel B are connected by a compound wheel A_1-B_1.A_1 gearing with A. B_1 gearing with B. The compound wheel revolves on a stud which is carried around an arm which revolves about the axis A&B.A has 130 teeth,B1=80 teeth, pitch of A&A_1 being twice that of pitch of B&B_1.How many revolutions B will make for one revolution of the arm. (solve it by algebraic method)

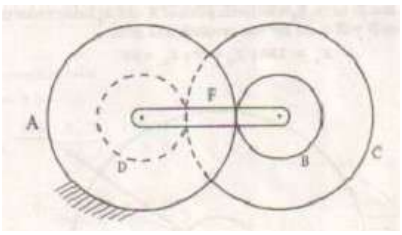

Fig. 4.5

6. An Epicyclic gear train is shown in the fig. 4.6.The wheel A is fixed& the input at the arm R is 3KW at 600rpm.Find the speed of wheel D and the torque required to hold the wheel A. Neglect frictional losses. (solve it by algebraic method)

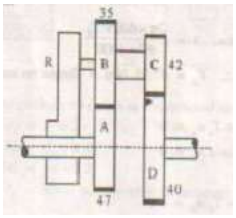

Fig. 4.6

7. In Epicyclic gear train shown in the fug 4.7, wheels A, D, E are free to rotate independently on the spindle O, while the compound wheel B-C rotates on the spindle P on the arm OP .If wheel A is given clockwise revolution of 60rpm, while gear D is given counterclockwise revolution at 300rpm,Determine the magnitude and direction of speeds of arm OP and wheel E.

Wheel	A	B	C	D	E
Teeth	12	30	14	?	?

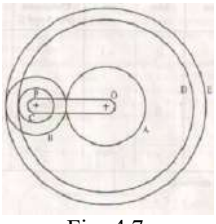

Fig. 4.7

8. Explain the term train value and velocity ratio used in gear trains.
9. Explain different types of gear trains with neat sketches and give examples where each one is used in practice.
10. Explain the sketches (a) Compound gear train (b) Reverted gear train (c) Epicyclic gear train.

MODULE-4:

1. Four masses 150kg, 250kg, 200kg and 300kg are rotating in the same plane at radii of 0.25m, 0.2m, 0.3m and 0.35m respectively. Their angular location is 40, 120 and 250 degrees from the mass 150kg respectively measured in anticlockwise direction. Find the position and magnitude of the balance mass required, if its radius of rotation is 0.25m.
2. A 3.6 m long shaft carries 3 pulleys, two at its two ends and the third at the midpoint. The two end pulleys have masses 79 Kg and 40 Kg with their radii 3 mm and 5 mm from the axis of the shaft respectively. The middle pulley has a mass of 50 Kg with radius 8 mm. The pulleys are so keyed to the shaft that the assembly is in static balance. The shaft rotates at 300 rpm in two bearings 2.4 m apart with equal overhangs on either side. Determine (i) Relative angular positions of the pulleys, (ii) Dynamic reaction on the bearings.

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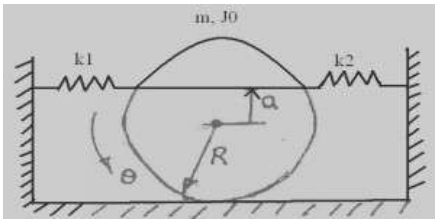
3. Prove that the resultant unbalanced force is minimum when half of the reciprocating masses are balanced by rotating masses i.e., when c = 1/2
4. A four cylinder vertical engine has cranks 150 mm long. The planes of rotation of the first, second and fourth cranks are 400mm, 200 mm and 200 mm respectively from the third crank and their reciprocating masses are 50 kg, 60 kg and 50 kg respectively. Find the mass of the reciprocating parts for the third cylinder and the relative angular positions of the cranks in order that the engine may be in complete primary balance.
5. The firing order in a 6 cylinder vertical 4 stroke in line engine 1-4-2-6-3-5, the piston stroke is 100 mm. length of each C.R = 200 mm. the pitch distance between cylinder centerlines are 100 mm, 100 mm, 150 mm, 100 mm and 100mm. determine the out of balance primary and secondary forces and couples on this engine taking a plane midway between cylinders 3 and 4 as reference plane. The reciprocating mass per cylinder is 2kg and the engine runs at 1500 rpm.

MODULE-5:

1. What are the different types of vibrations?
2. Determine the natural frequency of spring - mass system taking the mass of the spring in to account.
3. Split the Harmonic function X= 5 Sin ($\omega t + \pi/4$) into two Harmonic functions one having phase of zero and the other of 600.
4. A cylinder of mass m and mass moment of inertia Jo rolling without slipping but restrained by two linear springs of stiffness k_1 and k_2 as shown in Figure. Determine:
   i) The natural frequency of vibration of the system.
   ii) The value of "a" for which the natural frequency is maximum.



5. Determine the natural frequency of a spring mass system where the mass of is also to be taken in to account
6. Derive differential equation for undamped free vibrations. (Newton's method).
7. In a single degree damped vibrating system, a suspended mass of 18 kg makes 10 oscillations in 8 seconds. The amplitude decreases to 25% of the initial value after 5 cycles

14.0 University Result

Examination	FCD	FC	SC	% Passing

Prepared by	Checked by		
Prof.D. N. Inamdar	Prof.D. N. Inamdar	HOD	Principal

5.0 Relevance to future subjects

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

6.0 Relevance to Real World

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

7.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
01	Tutorial	Solving the unsolved problems from the reference and text books and demonstration in laboratory
02	Nptel.ac.in	E- Learning
03	VTU, E- learning	E- Learning
04	MOOCS	E- Learning
05	Open courseware	E- Learning

8.0 Books Used and Recommended to Students

Text Books

1. Engineering Thermodynamics P.K. Nag Tata McGraw Hill 6th Edition 2018
2. Applications of Thermodynamics V.Kadambi, T. R.Seetharam, K. B. Subramanya Kumar Wiley Indian Private Ltd.
3. Turbo machines M. S. Govindegowda and A. M. Nagaraj M. M. Publications 7Th Ed, 2012
4. Thermodynamics Yunus A, Cengel, Michael A Boles Tata McGraw Hill 7th Edition
5. An Introduction to Energy Conversion, Volume III, Turbo machinery, V. Kadambi and Manohar Prasad New Age International Publishers reprint 2008
6. Turbo Machines B.U.Pai Wiley India Pvt, Ltd 1st Edition

Reference Books

1. Principles of Engineering Thermodynamics Michael J, Moran, Howard N. Shapiro Wiley 8th Edition
2. An Introduction to Thermodynamics, Y.V.C.Rao Wiley Eastern Ltd 2003.
3. Thermodynamics Radhakrishnan PHI 2nd revised edition
4. I.C.Engines M.L.Mathur& Sharma. Dhanpat Rai& sons- India
5. Turbines, Compressors & Fans S. M. Yahya Tata McGraw Hill Co. Ltd 2nd edition, 2002
6. Principals of Turbo machines D. G. Shepherd The Macmillan Company 1964
7. Fluid Mechanics & Thermodynamics of Turbo machines S. L. Dixon Elsevier 200

Additional Study material & e-Books

1. Fluid Mechanics by R.K. Banasal
2. Thermodynamics Rajput

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

Website and Internet Contents References

1. Nptel.ac.in
2. VTU, E- learning
3. MOOCS
4. Open courseware

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10.0 Magazines/Journals Used and Recommended to Students

Sl. No	Magazines/Journals	website
1	International Turbo machinery	https://www.turbomachinerymag.com/
2	Journal of Engineering for Gas Turbines and Power	https://gasturbinespower.asmedigitalcollection.asme.org/journal.aspx
3	Thermal News	http://www.thermalnews.com/main/
4	Turbine Magazine	http://www.windarphotonics.com/turbine-magazine
5	Future Power Technology Magazine	http://www.power-technology.com/features/featurefuture-power-technology-magazine-turbine-edition/
6	Applied Thermal Engineering	http://www.sciencedirect.com/science/journal/13594311
7	Case Studies in Thermal Engineering	http://www.sciencedirect.com/science/journal/2214157X
8	Auto car India Magazine	http://www.autocarindia.com/Magazine/
9	Low-Tech magazines	http://www.lowtechmagazine.com/

11.0 Examination Note

Assessment Details (both CIE and SEE):

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC:

Two Tests each of 20 Marks (duration 01 hour)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester

Two assignments each of 10 Marks

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Scaled-down marks of two tests and two assignments added will be CIE marks for the theory component of IPCC for 30marks.

CIE for the practical component of IPCC:

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The15 marks are for conducting the experiment and preparation of the laboratory record, the other 05 marks shall be for the test conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' writeups are added and scaled down to 15 marks.
- The laboratory test (duration 03 hours) at the end of the 15th week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 05 marks.

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for 20 marks.

SEE for IPCC:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

- The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be reduced proportionally to 50 marks
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), should have a mix of topics under that module.

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- The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component):

- The minimum marks to be secured in CIE to appear for SEE shall be the 12 (40% of maximum marks-30) in the Theory component and 08 (40% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included. The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

12.0 Course Delivery Plan

Module	Lecture No.	Content of Lecturer	% of Portion
I	1	**Performance Testing of IC Engines:** Two-stroke and Four-stroke I.C. engines - Measurement of speed, air flow, fuel consumption,	20
	2	Measurement of Brake Power and Indicated Power, Performance curves, Heat Balance sheet., Frictional power: various methods – Willan's line, Morse test, motoring etc.	
	3	Solving related Numericals	
	4	Solving related Numericals	
	5	**Reciprocating Air Compressors:** Operation of a single stage reciprocating compressors: work input through p-v diagram, effect of clearance and volumetric efficiency	
	6	, adiabatic, isothermal and mechanical efficiencies. Multi-stage compressor, saving in work, optimum intermediate pressure, inter-cooling, minimum work for compression .Discussion on application	
	7	Solving related Numericals	
	8	Solving related Numericals	
II	9	**Refrigeration:** Vapour compression refrigeration system; description, analysis, refrigerating effect, capacity, power required, units of refrigeration, COP, reversed	40
	10	Carnot cycle, vapour absorption refrigeration system and Air refrigeration system. Use of refrigeration tables and p-h chart. Classification of Refrigerants. Desirable properties of refrigerants.	
	11	Solving related Numericals	
	12	Solving related Numericals	
	13	**Psychrometries:** Atmospheric air and Psychrometric properties: DBT, WBT, DPT, partial pressure, specific and relative humidity and relation between the enthalpy and adiabatic saturation temperatures.	
	14	Construction and use of psychrometric chart. Analysis of various processes: Heating, cooling, dehumidifying and humidifying. Adiabatic mixing of stream of moist air. Analysis of summer and winter air-conditioning systems. Discussion on commercial Air conditioning systems	
	15	Solving related Numericals	
	16	Solving related Numericals	
III	17	**Introduction to Turbo machines:** Classification of Turbomachines, Basic constructional details, Euler's equation for a Turbo machine, Impulse & Reaction machine -	60
	18	Axial flow and radial flow machines, utilization factor, degree of reaction & efficiencies of Turbo machines.	
	19	Solving related Numericals	
	20	Solving related Numericals	
	21	**Introduction to positive displacement machines:** Classification, comparison with turbo machines. Construction and working of reciprocating pump,	

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	22	Construction and working of Gear and vane pumps. Discussion on engineering applications.	
	23	Solving related Numericals	
	24	Solving related Numericals	
IV	25	**Hydraulic Turbines:** Classification of hydraulic turbines, Various heads and efficiencies, working principle, Velocity triangles, work done, efficiencies etc in Pelton wheel.	80
	26	Francis turbine and Kaplan turbine. Draft tubes, Cavitation in reaction turbines, characteristic curves.Significance of Specific speed and Unit quantities.	
	27	Solving related Numericals	
	28	Solving related Numericals	
	29	**Centrifugal Pumps:** Main Parts of centrifugal pump, Various heads and efficiencies, work done, minimum speed for starting centrifugal pump	
	30	Classifications- Performance characteristics of centrifugal pumps, Cavitation in pumps and NPSH. Pumps in series and parallel, casings. Discussion on engineering applications	
	31	Solving related Numericals	
	32	Solving related Numericals	
V	33	**Centrifugal Fans, Blowers & Compressors:** types; velocity triangles, work done and degree of reaction, size & speed;	100
	34	vane shape & efficiency; vane shape & characteristics; actual performances characteristics; Concept of slip and slip coefficient. Discussion on engineering applications.	
	35	Solving related Numericals	
	36	Solving related Numericals	
	37	**Steam and gas Turbines:** Impulse turbines, Staging - expression for work done in a 2-stage velocity compounded turbine effect of blade & nozzle losses-	
	38	Reaction staging- reheat factor- performance characteristics, introduction to gas turbines	
	39	Solving problems using Mollier's chart	
	40	Solving problems using Mollier's chart	

13.0 Assignments, Pop Quiz, Mini Project, Seminars

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

14.0 Practical Component of IPCC

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Expt. No	Lecture / Practical No.	Name of the Experiment	% of Portion
1	1	Determination of calorific value of solid/liquid fuels using Bomb Calorimeter	100
2	2	Determination of calorific value of gaseous fuels using Junker's Gas Calorimeter.	
3	3	Performance test on single cylinder engine four/two stroke and draw Heat balance sheet	
4	4	Performance test on multi cylinder engine, draw Heat balance sheet and perform Morse test	
5	5	Performance test on Vapour compression refrigeration -test rig.	
6	6	Performance test on Air conditioning-test rig.	
7	7	Performance test on single/multi stage Reciprocating compressor.	
8	8	Performance test on single / multi-stage centrifugal pump.	
9	9	Performance test on Pelton turbine and draw main and operating characteristics.	
10	10	Performance test on Franci's turbine and draw main and operating characteristics.	
11	11	Performance test on Kaplan turbine and draw main and operating characteristics.	
12	12	Performance test on centrifugal blower and draw performance characteristics for different vane shapes.	
13	13	Demonstration on Computerised IC Engine test rig for its performance and analysis.	

15.0 QUESTION BANK

Module I:

1. List the methods used for finding out indicated power of internal combustion engine. Explain the method applicable to multi cylinder engine.
2. Briefly classify the IC engines.
3. Explain Morse test.
4. Explain with neat working of swinging field dynamomter.
5. Derive an expression for work done in a reciprocating air compressor i) without clearance ii) with clearance.
6. What is the purpose of multi staging in reciprocating compressor?
7. Derive an expression for work done for single stage, single acting reciprocating compressor with clearance volume
8. Derive an expression for the condition for the minimum work input, required for a two stage compressor, with perfect inter cooling.
9. What are the draw backs of a single stage compressor for producing high pressure? How are these overcome by multistage compression?
10. Show that for a multistage compressor $Z = (Px+1P1)^{1/x}$ where Z=stage pressure ratio, x = number of stages, $(Px+1/P1)$ overall pressure ratio.

Numericals

1. The following observations have been made from the test of a four cylinder, two stroke petrol engine. Diameter of the cylinder = 10 cm; stroke = 15 cm; speed = 1600 rpm; Area of indicator diagram = 5.5 cm2; Length of the indicator diagram = 55 mm; spring constant = 3.5 bar/cm; Determine the indicated power of the engine.
2. An eight cylinder, four stroke engine of 9 cm bore, 8 cm stroke and with a compression ratio of 7 is tested at 4500 rpm on a dynamometer which has 54 cm arm. During a 10 minute test, the dynamometer scale beam reading was 42 kg and the engine consumed 4.4 kg of gasoline having a calorific value of 44,000 kJ/kg. Air at 27o C and 1bar was supplied to the carburetor at a rate of 6 kg/min. Find (i) the brake power, (ii) the brake mean effective pressure, (iii) the brake specific fuel consumption (iv) the brake specific air consumption (v) volumetric efficiency (vi) the brake thermal efficiency and(vii) the air fuel ratio.
3. During a trial of 60 minutes on a single, cylinder on engine having cylinder dia. 300 mm 5toke 450 mm and working on two stroke cycle, the following observation were made. Total fuel used = 9.6litres, Calorific value of fuel = 45000 kJ/kg, Total number of revolutions = 12624, Gross mean effective pressure = 7.24 bar, Pumping mean effective pressure = 0.34 bar, Net load on brake = 3150 Newton, Diameter of brake drum = 1.78 m, Diameter of rope = 40 mm, Cooling water circulated = 545 liters, Cooling water temperature rise = 25°C, Specific gravity of oil = 0.8, Heat carried away by the exhaust gases = 15% total heat supplied. Determine IP, BP and

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mechanical efficiency. Draw up the heat balance sheet on minute basis.

4. The following data were obtained from a Morse test on a 4-cylinder, 4-stroke cycle SI engine coupled to a hydraulic dynamometer, operating a constant speed of 1500rpm. Brake load with all four cylinders firing = 296 N Brake load with cylinder No.1 not firing = 201 N Brake load with cylinder No.2 not firing = 206 N Brake load with cylinder No.3 not firing = 192 N Brake load with cylinder No.4 not firing = 200 N The brake power in kW is calculated using the equation BP = WN/42300, where W is the brake load in Newton's and N is the speed of the engine in rpm. Calculate i) Brake power ii) Indicated power Hi) Friction power iv) Mechanical efficiency.
5. During a test on a single cylinder 4 stroke oil engine the following observations were made Bore = 30cm, stroke = 45cm, duration of trail = 1hr, total fuel consumption = 7.6kg calorific value of fuel = 45,000 kJ/kg, total revolutions made = 12000, mean effective pressure 6 bar, net brake load = 1.47 kN. Brake drum diameter 1.8m rope diameter 3cm. Mass of jacket cooling water circulated = 550kg water enters at 150°C water leaves at 600°C. Total air consumption 360kg room temperature 200°C, exhaust gas temperature = 300°C. Calculate: i) Indicated and brake power; ii) Indicated thermal efficiency; iii) Mechanical efficiency; iv) Draw the heat balance sheet on minute basis
6. A double acting compressor, with a piston displacement of 0.05 m 3 per stroke, operates at 500 rpm. The clearance is 5 percent and it receives air at 100 KPa and discharges at 600 KPa. The compression is polytrophic according to the law PV 1.35 =constant. Determine the power required to drive the compressor and the mass of air delivered in kg/s if the suction temperature is 27o C.
7. A single acting air compressor has a cylinder of bore 15 cm and the piston stroke is 25 cm. The crank speed is 600 rpm. Air is taken from atmosphere (1 bar and 27° C) and is delivered at 11 bars. Assuming polytrophic compression of the type PV1.25 = C, find the power required to drive the compressor if its mechanical efficiency is 80%. The compressor has a clearance which is 1/20th of the stroke volume. How long will it take to deliver 1 m 3 of air at the compressor inlet conditions? Also find the volumetric efficiency of the compressor.
8. A reciprocating compressor has a 5 % clearance with a bore and stroke of 25 x 30 cm. The compressor operates at 500 rpm. Air enters the cylinder at 27 o C and 95KPa and discharges at 2000 KPa. If the indices for both compression and expansion are equal to 1.3. Determine (i) volumetric efficiency (ii) the volume of air handled at inlet conditions in m3/s (iii) the power required to drive the compressor if the mechanical efficiency is 90 % (iv) the mass of air delivered in kg/s, (v) the mass of air in the clearance space.
9. An air compressor takes air at 1 bar and 20° C and compresses the same according to the law PV 1.2 = C. It then delivered to a receiver at a constant pressure of 10 bar. Determine i) Temperature at the end of compression ii) Work done and Heat Transferred during compression, per kg of air. R = 0.287 KJ/kg K.
10. Two stage, single acting reciprocating air compressor, with complete intercooling atmospheric air at 1 bar and 15°C, compresses it polytropically (n = 1.3) to 30 bar. Both cylinders have the same stroke; calculate the diameter of the HP cylinder. The diameter of the LP cylinder is 300mm.
11. Air at standard atmospheric conditions is compressed and delivered to a receiver of 0.4 m diameter and 1 m long until a final pressure of 10 atm is reached. Assuming ideal conditions with no valve pressure drops, compute the power needed to drive the compressor for (i) isothermal compression, (il) polytropic compression with n = 1.32. Assume that the receiver temperature is maintained atmospheric throughout and filing takes place in 5 min. Atmospheric temperature is 25°C. Also calculate isothermal efficiency of the compressor.

Module II:

1. Draw neat P-V and T-S diagrams for reversed Brayton cycle and derive COP.
2. What is one ton of refrigeration?
3. Distinguish between refrigeration and refrigerator.
4. Write note on properties of refrigerants.
5. With a neat sketch, describe the clearly the working of a Bell – Coleman cycle.
6. Derive an expression for an Air refrigeration system.
7. Explain the effect of superheat and sub cooling on the vapour compression cycle with the help of T-S and p-h diagrams.
8. With a neat sketch, explain the working of vapour absorption refrigeration system.
9. With a schematic diagram, explain the summer air conditioning system for hot and wet weather
10. With a neat schematic diagram, explain the working of winter air conditioning system. Represent the processes on psychometric chart.

Numericals :

1. A reversed Carnot cycle is used for heating and cooling. The work supplied is 10 kW. If the COP is 3.5 for cooling determine (i) the ratio of maximum temperature to minimum temperature in the cycle (ii) refrigeration effect in tons and (iii)COP if the cycle is used as a heat pump.

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2. An ideal air refrigeration cycle has the following specifications: Pressure of air at compressor inlet = 101 kPa; Pressure of air at turbine inlet = 404 kPa; Temperature of air at compressor inlet = −6 ° C; Temperature of air at turbine inlet = 27 ° C; Determine (i) The COP of the cycle, (ii) Power required to produce 1 ton of refrigeration, and (iii) air circulation rate per ton of refrigeration.
3. In an air refrigerating machine, the compressor takes in air at 1 bar and10 ° C. After compression to 5.5 bar, the air is cooled to 30 ° C before expanding it back to 1bar. Assuming ideal conditions, determine (i) refrigeration effect per unit mass of air (ii) heat rejected by air per unit mass in the intercooler and (ii) COP of the cycle, In an actual plant using the above cycle, the air flow rate is 1700 kg / h and the relative COP of the actual plant is 0.65. Determine the power required for the actual plant for the same refrigerant.
4. In a saturated vapour compression refrigeration cycle operating between an evaporator temperature of -10°C and a condenser temperature of 40°C, the sub enthalpy of the refrigerant, Freon-12 at the end of compression is 220 kJ /kg. ease Show the cycle on T-S and p-h planes. Calculate i) COP ii) refrigerating capacity and compressor power assuming a refrigerating flow rate of 1 kg/min.
5. For a hall to be air-conditioned, the following conditions are given: Outdoor conditions: 40° DBT, 20°C WBT, required comfort condition 20°C WBT, 60% RH. Seating capacity of the hall is 1500, amount of outdoor air supplied = 0.3 m^3/min per person. If the required condition is achieved first by adiabatic humidification and then by cooling, estimate i) the capacity of the cooling coil in tones and ii) the capacity of the humidifier in kg/h.
6. Moist air at 35 ° C has dew point of 15 ° C. Calculate its relative humidity, specific humidity and enthalpy. Take Cp_v = 1.88 KJ /kg K. 7. 30 m ^{3} /min. of air at 15 ° C DBT and 13 ° C WBT is mixed 12 m ^{3} /min. of air at 25 ° C DBT and 18 ° C WBT. Calculate DBT, specific humidity of mixture. Take atm. Pressure as 760 mm of Hg. Calculate by calculation method only.
7. A sling psychrometer reads 40°C D.B.T and 28°C W.B.T. calculate the following. i) Specific humidity ii) Relative humidity iii) Vapour density in air iv) Dew point temperature v) Enthalpy of mixture per kg of dry air.

Module III:

1. Define Turbo machine. Briefly classify turbo machines
2. With a neat sketch explain the parts of a turbo machine.
3. Compare the turbo machines with positive displacement machines
4. How a turbo machines are classified?
5. Write in brief importance of Turbo machines
6. Define utilization factor and vane efficiency
7. Derive the relationship between utilization factor and degree of reaction
8. Write combined velocity triangles for different values of degree of reaction
9. What is the condition for maximum utilization factor?
10. Differentiate between i) Impulse turbine ii) Reaction turbine
11. Explain in brief general analysis of an impulse and reaction turbo machine. Write the effect of blade discharge angle on energy transfer. Writer the values of degree of reaction for impulse and reaction type turbo machine.
12. Analyze a radial flow turbo machine. Draw the velocity triangle diagram at inlet and for different discharge angles at outlet. Derive an expression for energy transfer in terms of blade discharge angles. Also derive an equation for Degree of Reaction in terms of blade discharge angles.
13. Draw on a common graph. (1) Energy transfer versus blade discharge angles and Degree of reaction versus blade discharge angles. Then write the effect of blade discharge angle on (i) Energy transfer and (ii) Degree of reaction.
14. Draw the combined velocity triangle diagram for the value of (i) R = 0.5 (ii) 1>R>0.5 and R>1.
15. Derive the relation between Utilization factor and degree of reaction for axial flow turbo machine.
16. Derive the Euler's turbine equation.
17. Derive the modified Euler's turbine equation.
18. Explain Construction and working of reciprocating pump, gear and vane pumps.

Numericals :

1. The following data refers to a hydraulic reaction turbine of radial type. a) Head of the water = 160 m , b) Rotor blade angle at energy = 119 o , c) Diameter at entry = 3.65 m, d) Diameter at exit = 2.45 m , e) Discharge angle at exit = 30 o , radial with a velocity of 15.5 m/s , f) Radial component at inlet = 10.3 m/s . Find the power developed in KW, Degree of reaction and utilization factor for a flow rate of 10 m^3 /s.
2. At a stage in a 50 % reaction axial flow turbine running at 300 rpm. The power output is 265 KW, Utilization factor being 0.615. Find the absolute velocities of V1 and V2. Assume symmetric velocity of triangles at inlet and

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outlet.

3. In De Laval steam nozzle angle at inlet 18 °. Relative velocities is reduced to the extent of 6 % when steam flows over the moving blades. The output of the turbine is 120 KW/kg flow of steam. If blades are equiangular, find the speed ratio, absolute velocity of steam and blade speed for maximum utilization factor
4. Air enters in an axial flow turbine with a tangential component of the absolute velocity equal to 600 m/s in the direction of rotation. At the rotor exit, the tangential component of the absolute velocity is 100 m/s in a direction opposite to that of rotational speed. The tangential blade sped is 250 m/s. Evaluate i) The change in total enthalpy of air between the inlet and outlet of the rotor ii) The power in KW if the mass flow rate is 10 kg/s iii) The change in total temperature across the rotor.
5. A mixed flow turbine handling water operates under a static head of 65 m. In a steady flow, the static pressure at the rotor inlet is 3.5 atmospheric (gauge). The absolute velocity at the rotor inlet has no axial component and is directed at an angle of 25 ° to the tangent of wheel so that Vu1 is positive. The absolute velocity at exit purely axial. If the degree of reaction for the machine is 0.47 and utilization factor is 0.896, compute the tangential blade speed at inlet as well as the inlet blade angle β1. Find also the work output per unit mass flow of water.
1. In mixed flow turbo machine, the fluid enters such that the absolute velocity is axial at inlet and at outlet relative velocity is radial. What is the degree of reaction and energy input to the fluid, if relative velocity at outlet is same as tangential blade speed at inlet? The following data may be used. i) Inlet diameter = 0.16 m ii) Exit diameter = 0.5 m, iii) Speed = 3000 rpm, iv) Blade angle at inlet = 45 °

Module IV:

1. What is hydraulic Turbine? Classify it. Sketch the layout of hydro electric power plant.
2. Define i) hydraulic efficiency, ii) mechanical efficiency iii) overall efficiency and volumetric efficiency.
3. What are the main components of Pelton Turbine? Explain their function.
4. Design the pelton turbine.
5. Draw the velocity triangles diagrams at bucket inlet and outlet and write an expression for Force, work, power and efficiency; maximum hydraulic efficiency with its condition.
6. With the help of neat sketch explain the working of double regulation oil pressure governor.
7. Sketch Francis Turbine, Level its main components and explain its working.
8. Draw the velocity triangle diagrams at radial inward flow Francis turbine and derive an expression for (i) Work done, (ii) Hydraulic efficiency.
9. Sketch Kaplan Turbine, Label its main components and explain its working.
10. What is a draft tube? What is its function? What are its types? Derive an expression for -ve head created at the runner outlet by using a draft tube.
11. What is centrifugal pump? Draw it lay out and explains.
12. How a centrifugal pump is classified.
13. Explain the following heads of a centrifugal pump: (i) Suction heat, (ii) Delivery head, (iii) Static heat, (iv) Manometer of head & (v) Total or gross or effective head.
14. Derive an expression for work done by impeller of a centrifugal pump on water.
15. Define explain, and write an expression for the following efficiencies of centrifugal pump: i) Mechanical efficiency, (ii) Manometric efficiency, (iii) overall efficiency and (iv) Hydraulic efficiency.
16. Derive an expression for pressure rise in pump impeller.
17. Derive an expression for minimum starting speed of a centrifugal pump.
18. What is cavitation? Explain causes of cavitation.
19. What is priming? Explain necessity and phenomenon of priming.
20. Explain with flow diagram the purpose of multistage pump when connected in series and parallel.

Numericals:

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

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through the runner and hydraulic efficiency.

5. The following date refers to Francis turbine speed=1200rpm, Net head=130m, Discharge=0.7m^3/sec, Inner diameter=1.3m. Height of the runner at inlet=0.05m. The angle of the inlet guide vanes is set at 72 degree and absolute velocity at outlet is radial. Calculate Torque, Power and Hydraulic efficiency.
6. A centrifugal pump is running at 100 rpm. The outlet vane angle of the impeller is 30 ^{o} and velocity of flow rate at outlet is 3 m/s. The pump is working against a total head of 30 m and the discharge through the pump is 0.3 m^3 /s. If the man metric efficiency is 75 % determine a) Diameter of the impeller b) width of the impeller at outlet.
7. A centrifugal pump running at 1450 rpm discharges 110 lit/s against a head of 23 m. If the diameter of impeller is 25 cm and its width 5 cm find the vane angle at outer periphery. The man metric efficiency of the pumps is 75 %.
8. A centrifugal pump discharges 0.15 m^3 /s of water against at a head of 12.5 m. The speed of the impeller is 600 rpm. The outer and inner diameter and inner diameter of impeller are 50 cm and 25 cm respectively and vanes are bent back at 35 o to the tangent at the exit. If the area of flow remains 0.07 m2 from inlet to outlet determine a) Man metric efficiency b) Vane angle at inlet.
9. A centrifugal pump with an impeller outlet diameter of 375mm runs at 750 rpm and delivers 35 liters/sec of water. The radial velocity at the impeller exit is 2m/sec. The difference between the water levels at the over head tank and the sump is 14.2 m including frictional losses. The total power input needed to run the pump is 6.1KW, its mechanical and volumetric efficacies being 0.95 and 0.96 respectively. The rotor blades are backward curve with an exit angle of 45 degree. Compute i) The ideal head developed with no slip and no hydraulic losses ii) the actual pump efficiency.

Module V:

1. Explain important parts of centrifugal compressor
2. Derive expression for overall pressure ratio developed in centrifugal compressor
3. Define i) slip factor ii) power input factor
4. Explain with the help of a diagram the surging of centrifugal compressor
5. Classify the axial flow compressor
6. With the help of neat sketch explain the construction and working principle of axial flow compressors.
7. Sketch and explain axial compressor stage velocity triangles and derive an expression for (i) ratio of blade speed 6 velocity of flow (ii) degree of reaction. Also writer conditions for 50% R. 8. Derive an expression for work input to compressor. Also describe work done factor.
8. Describe in brief (i) Compressor stage efficiency (ii) Degree of Reaction (iii) Radial pressure gradient.

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

Numericals:

1. A centrifugal compressor delivers 18.2 kg/s of air with a total pressure ratio of 4:1. Speed is 15000 rpm. Inlet total temperature is 15 ^{o} C. Slip coefficient is 0.9, Power input factor is 1.04. Efficiency is 0.8. Calculate overall diameter of impeller.
2. A single stage axial flow blower with no inlet guide vane but row of stationary vanes after rotor runs at 3600 rpm. The rotor hub and tip diameter are 20 cm and 12.5 cm respectively. Mass flow rate is 0.5 kg/s. The turning angle of rotor is 20 ^{o} towards axial direction during air flow over blade. If atmospheric temperature and pressure are 25 o C and 1 atm. Respectively assuming constant axial velocity through machine find i) Total pressure rise of air if hydraulic efficiency is 0.9 ii) Power required iii) Degree of reaction.

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3. An air compressor has 8 stages of equal pressure ratio 1.35. The flow rate through compressor 50 kg/s and its ŋo = 82%. If the conditions of air at entry are 1 bar and 40° C find the i) stage of air at compressor exit ii) polytrophic efficiency iii) efficiency of each stage iv) power required to drive compressor assuming ŋm = 90%.
2. In a single stage steam turbine saturated at 10 bar is supplied through a convergent- divergent steam nozzle. The nozzle angle is 20 °. Find i) the best blade angle if blades are equiangular ii) The maximum power developed by turbine if number of nozzle used are 5 and area at throat of each nozzle is 0. 6 cm^2. Assume, Cb = 0.87 and ŋn = 0.88, Take U = 400 m/s, steam pressure at exit of nozzle is 1 bar.
3. In two stage velocity compounded axial flow steam turbine, steam enters first row of moving blades with an absolute velocity of 550 m/s. Steam leaves last row of moving blades are axially. The nozzle angle at inlet of moving blades = 16 °. The blade angles at inlet and outlet of both rotors are same and equal to 32 °. Find blade speed to satisfy above conditions by drawing velocity triangles of inlet and outlet of each stage separately.
4. Steam flows through the nozzle with a velocity of 450 m/s at a direction which is inclined at an angle of 16 ° to the plane tangent. Steam comes out of the moving blades with a velocity of 100 m/s in the direction of 110 ° with the direction of blade motion. The blades are equiangular and the steam flow rate is 10 kg/s. Find i) Power developed ii) the power loss due to friction iii) Axial thrust iv) Blade efficiency and v) Blade coefficient
5. In an Impulse turbine (with single row wheel), the mean diameter of the blade is 1.05m and the speed is 3000rpm. The nozzle angle is 20 degree and ratio of blade speed to steam speed is 0.45 and the relative velocity and outlet from the blades to that at inlet is 0.85. Outlet angle is made 3 degree is less than the inlet angle. The steam flow is 10Kg/sec. Draw the velocity diagram for the blade and determine the following. i) tangential thrust on the blade ii) Axial thrust on the blade iii) Resultant thrust on the blade iv) Power developed in the blade v) Blading efficiency.
4. The first stage of an impulse turbine is compounded for velocity and has two rows of moving blades and one ring of fixed blades. The nozzle angle is 18 degree and leaving angles of blades are respectively, first moving 30 degree, fixed 20 degree, and second 30 degree. The velocity of steam leaving the nozzle is 550m/sec. The friction loss in each blade row is 10% of the relative velocity. Steam leaves second row moving blades axially, find i) blade velocity ii) Blade efficiency and specific speed consumption

16.0 University Result

Year	S+,S,A (FCD)	B (FC)	C,D,E (SC)	%age of passing
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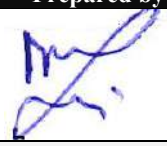
Prepared by	Checked by		
			
Dr. M. M. Shivashimpi	Dr. K. M. Akkoli	HOD	Principal

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Subject Title	FINITE ELEMENT ANALYSIS		
Subject Code	21ME53	CIE Marks	50
Number of Lecture Hrs / Week	5L+2P	SEE Marks	50
Total Number of Lecture Hrs	25 hrs +13 practical sessions	Exam Hours	03
CREDITS – 04			

FACULTY DETAILS:		
Name: Mr. S A Goudadi	Designation: Asst. Professor	Experience:16
No. of times course taught:01	Specialization: Design Engineering	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Mechanical Engineering	I/II/III/IV	Engg. Mathematics
02	Mechanical Engineering	III	Mechanics of Mechanics
03	Mechanical Engineering	VI	Design of Machine Elements-II
04	Mechanical Engineering	VI	Heat and Mass Transfer

2.0 Course Objectives

- To learn basic principles of finite element analysis procedure.
- To learn the basic principles of finite element analysis procedure
- To understand heat transfer problems with application of FEM.
- Solve 1 D, 2 D and dynamic problems using Finite Element Analysis approach.
- To learn and apply finite element solutions to structural, thermal, dynamic problem to develop the knowledge and skills needed to effectively evaluate finite element analyses.

3.0 Course Outcomes

After successfully completion of this course, the student will be able to

CO	Course Outcome	Cognitive Level	POs
C310.1	Understand the concepts behind formulation methods in FEM and Choose interpolation polynomial equation for simplex elements	L1,L2	PO1,PO2,PO3,PO6,PO8,PO11,PO12
C310.2	Develop element characteristic equation and solve the global equation of FEA elements such as bars and trusses.	L2,L3	PO1,PO2,PO3,PO6,PO8,PO11,PO12
C310.3	Develop element characteristic equation and solve the global equation of FEA for beams and circular shafts	L2,L3	PO1,PO2,PO3,PO6,PO8,PO11,PO12
C310.4	Develop element characteristic equation and solve the global equation of FEA for 1D heat transfer and fluid flow	L2,L3	PO1,PO2,PO3,PO6,PO8,PO11,PO12
C310.5	Develop element characteristic equation and solve the global equation of FEA for axi symmetric and dynamic problems	L2,L3	PO1,PO2,PO3,PO6,PO8,PO11,PO12
Total Hours of instruction		**50**	

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4.0 Course Content

Module I

Introduction to Finite Element Method: General steps of the finite element method. Engineering applications of finite element method. Advantages of the Finite Element Method. Potential energy method, Displacement method of finite element formulation. Convergence criteria, Discretization process, ***Rayleigh Ritz method, Galerkin's method (for study purpose only)***

Types of elements: 1D, 2D and 3D, Node numbering, Location of nodes. Strain- displacement relations, Stress-strain relations, Plain stress and Plain strain conditions, temperature effects.

Interpolation models: Simplex, complex and multiplex elements, linear interpolation polynomials in terms of global coordinates 1D, 2D, 3D Simplex Elements.

Module II

Introduction to the stiffness (Displacement) method: Introduction, One-Dimensional Elements-Analysis of Bars and Trusses, Linear interpolation polynomials in terms of local coordinate's for 1D, 2D elements. Higher order interpolation functions for 1D quadratic and cubic elements in natural coordinates, Constant strain triangle, Four-Noded Tetrahedral Element (TET 4), Eight-Noded Hexahedral Element (HEXA 3 8), 2D iso-parametric element,

Numerical Problems: Solution for displacement, stress and strain in 1D straight bars, stepped bars and tapered bars using elimination approach and penalty approach

Module III

Beams and Shafts: Boundary conditions, Load vector, Hermite shape functions , Beam stiffness matrix based on Euler- Bernoulli beam theory, Numerical problems on simply supported, fixed straight and cantilever beams, propped cantilever beams with concentrated and uniformly distributed load.

Torsion of Shafts: Finite element formulation of shafts, determination of stress and twists in circular shafts.

Module IV

Heat Transfer: Basic equations of heat transfer: Energy balance equation, Rate equation: conduction, convection, radiation, 1D finite element formulation using variational method, Problems with temperature gradient and heat fluxes, heat transfer in composite sections, straight fins.

Fluid Flow: Flow through a porous medium, Flow through pipes of uniform and stepped sections, Flow through hydraulic networks.

Module V

Axi-symmetric Solid Elements: Derivation of stiffness matrix of axisymmetric bodies with triangular elements, Numerical solution of axisymmetric triangular element(s) subjected to surface forces, point loads, angular velocity, pressure vessels.

Dynamic Considerations: Formulation for point mass and distributed masses, Consistent

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element mass matrix of one dimensional bar element, truss element, triangular element, beam element. Lumped mass matrix of bar element, truss element, Evaluation of eigen values and eigen vectors, Applications to bars, stepped bars, and beams.

PRACTICAL COMPONENT

S.N.	Experiments
1	**Introduction to FEA software , Pre-processing tools, Solver tools and Post-processing tools.**
2	Analysis of Bars of constant cross section area, tapered cross section area and stepped bar subjected to Point forces, Surface forces and Body forces(Minimum 2 exercises of different types)
3	Analysis of trusses (Minimum 2 exercises of different types)
4	Analysis of Beams – Simply supported, cantilever, Propped cantilever beams with point load , UDL, beams with varying load etc.
5	
6	Stress analysis of a rectangular plate with a circular hole.
7	Thermal Analysis – 1D & 2D problem with conduction and convection boundary conditions (Minimum 2 exercises of different types)
8	
9	Dynamic Analysis to find: Natural frequency of beam with fixed – fixed end condition, Response of beam with fixed – fixed end conditions subjected to forcing function

5.0 Relevance to future subjects

Sl No	Semester	Subject	Topics
01	VII	Mechanical Vibrations	Modal Analysis and Harmonic Analysis
02	VIII	Project work	Part Modeling and Analysis

6.0 Relevance to Real World

SL.No	Real World Mapping
01	Examples of bars, beams and Trusses
02	Examples of 1D bars for heat transfer

7.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
01	NPTEL	Analysis Application

8.0 Books Used and Recommended to Students

Text Books

1. Logan, D. L., A first course in the finite element method,6th Edition, Cengage Learning,2016.
2. Rao, S. S., Finite element method in engineering, 5th Edition, Pergaman Int. Library of Science, 2010.
3. Chandrupatla T. R., Finite Elements in engineering, 2nd Edition, PHI, 2013.

Reference Books

1. J.N.Reddy, "**Finite Element Method"-** McGraw -Hill International Edition.Bathe K. J. Finite Elements Procedures, PHI.
2. Bathe K. J "**Finite Elements Procedures** "PHI

Additional Study material & e-Books

1. VTU, E- learning, **2. NPTEL of FEM and FEA,** 3. FEM by ARK Swamy.

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

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/Videos Recommended

Website and Internet Contents References
1) https://en.wikipedia.org/wiki/Finite_element_method 2) nptel.ac.in/courses/112104116 3) http://autofem.com/en/examples.html

10.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	International Journal of Computational Methods	***www.worldscientific.com***
2	International Journal of Solids and Structures	http://www.sciencedirect.com/science/journal/00207683

11.0 Examination Note

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

Two Tests each of **20 Marks (duration 01 hour)**

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Scaled-down marks of two tests and two assignments added will be CIE marks for the theory component of IPCC for **30 marks**.

CIE for the practical component

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The **15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write- ups are added and scaled down to 15 marks.
- The laboratory test **(duration 03 hours)** at the end of the 15th week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 05 marks**.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

SEE for

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Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

- The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be reduced proportionally to 50 marks
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 12 (40% of maximum marks-30) in the theory component and 08 (40% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE.

Marks secured will be scaled down to 50.

12.0 Course Delivery Plan

Module No.	Lecture No.	Content of Lecture	% of Portion
1	1.	**Introduction to Finite Element Method:** General description of the finite element method.	20
	2.	Engineering applications of finite element method. Advantages of the Finite Element Method.	
	3.	Potential energy method, Displacement method of finite element formulation ***Rayleigh Ritz method, Galerkin's method(for study purpose only)***,	
	4.	Convergence criteria, Discretization process, Types of elements: 1D, 2D and3D, Node numbering,	
	5.	Location of nodes. Strain displacement relations,	
	6.	Stress strain relations, Plane stress and Plane strain conditions, temperature effects	
	7.	**Interpolation models:** Simplex, complex and multiplex elements,	
	8.	Linear interpolation	
	9.	Polynomials in terms of global coordinates	
	10.	1D, 2D, 3D Simplex Elements.	
2	11.	**Introduction to the stiffness (Displacement) method:** Linear interpolation polynomials in terms of local coordinate's for 1D,2D elements,	20
	12.	Higher order interpolation functions for 1D quadratic and	
	13.	cubic elements in natural coordinates, Constant strain triangle	
	14.	Four-Nodded Tetrahedral Element (TET 4) , Eight-Nodded Hexahedral Element (HEXA 8),	

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	15.	2D Iso parametric element, Lagrange interpolation functions,	
	16.	Introduction, One-Dimensional Elements-Analysis of Bars and Trusses	
	17.	**Numerical Problems:** Solution for displacement, stress and strain in 1D straight bars,	
	18.	stepped bars and tapered bars using elimination approach and penalty approach ,	
	19.	Analysis of trusses	
	20.	**Numerical Problems**	
3	21.	**Beams and Shafts:** Boundary conditions, Load vector, Hermite shape functions,	20
	22.	Beam stiffness matrix based on Euler-Bernoulli beam theory,	
	23.	Numerical problems on cantilever beams,	
	24.	propped cantilever beams with concentrated and uniformly distributed load	
	25.	Numerical problems on simply supported, fixed straight and beams	
	26.	cantilever beams using direct stiffness method with concentrated and	
	27.	uniformly distributed	
	28.	**Torsion of Shafts:** Finite element formulation of shafts,	
	29.	Determination of stress and	20
	30.	Twists in circular shafts.	
4	31.	**Heat Transfer:** Basic equations of heat transfer:	
	32.	Energy balance equation,	
	33.	Rate equation: conduction, convection, radiation,	
	34.	1D finite element formulation using variational method	
	35.	Problems with temperature gradient and	
	36.	Heat fluxes	
	37.	Heat transfer in composite sections, Straight fins.	
	38.	Fluid Flow: Flow through a porous medium,	
	39.	Flow through pipes of uniform and stepped sections,	
	40.	Flow through hydraulic networks.	
5	41.	**Axi-symmetric Solid Elements**: Derivation of stiffness matrix of axisymmetric bodies with triangular elements	20
	42.	Numerical solution of axisymmetric triangular element(s) subjected to surface forces, point loads.	
	43.	Angular velocity,	
	44.	Pressure Vessels	
	45.	**Dynamic Considerations:** Formulation for point mass and distributed masses	
	46.	Consistent element mass matrix of one dimensional bar element,	
	47.	truss element, axisymmetric triangular element, beam element	
	48.	Lumped mass matrix of bar element, Truss element, evaluation of eigen values and eigen vectors	
	49.	Application to bars, stepped bars and	
	50.	beams	

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Practical No	Name of the Experiment	% of Portion
01	Introduction to FEM and Analysis software	7.69
02	Analysis of rectangular plate with a hole.	7.69
03	**Stress Analysis:**	7.69
04	Analysis of the tapered bar.	7.69
05	Analysis of the stepped bar	7.69
06	Analysis of two bar truss element for the nodal displacement and stress in each bar	7.69
07	Analysis of three bar truss element for the nodal displacement and stress in each element	7.69
08	Analysis of two bar truss element for the nodal displacement and stress in each element	7.69
09	To find the SFD and BMD for cantilever beam with point load.	7.69
10	To find the SFD and BMD for simply supported beam with UDL and point load	7.69
11	To find the SFD and BMD for simply supported beam with UVL	7.69
12	To determine the temperature at any point in the composite wall	7.69
13	Model analysis**:** Mode shapes & corresponding national frequency for different models.	7.69

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 FEM	Understand the concepts behind formulation methods in FEM and Choose interpolation polynomial equation for simplex elements	Module I	2	Individual Activity.	Text Books
2	Assignment 1: Questions on Analysis of bars, trusses	Develop element characteristic equation and solve the global equation of FEA elements such as bars and trusses.	Module II	4	Individual Activity.	Text Books
3	Assignment 1: Questions on Beams and Shafts	Develop element characteristic equation and solve the global equation of FEA for beams and circular shafts	Module III	6	Individual Activity.	Text Books
4	Assignment 2: Questions on heat transfer and fluid flow	Develop element characteristic equation and solve the global equation of FEA for 1D heat transfer and fluid flow	Module IV	8	Individual Activity.	Text Books
5	Assignment 2: Questions on Axi-symmetric Solid Elements, Dynamic Considerations	Develop element characteristic equation and solve the global equation of FEA for axi symmetric and dynamic problems	Module V	10	Individual Activity.	Text Books

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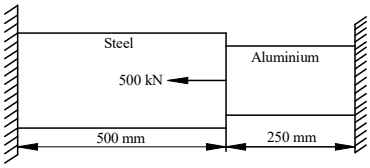
15.0 QUESTION BANK

Module – 1

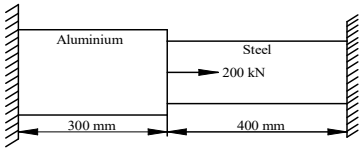
1. Write the equilibrium equations in elasticity subjected to body force
2. Write the equilibrium equations in elasticity subjected to traction force
3. Write the stress strain relations for plane stresses and plane strains
4. Write the General description of Finite Element Method
5. Write the Engineering applications of finite element methods
6. Explain different types of elements
7. Explain size of the elements, location of nodes, node numbering scheme
8. Write the Polynomial form of interpolation functions-of linear, quadratic and cubic, Simplex, Complex, Multiplex elements.
9. Explain the Selection of the order of the interpolation polynomial,
10. What is meant by Convergence requirements,
11. What is 2D Pascal triangle
12. Derive an expression for Principal of a minimum potential energy,
13. What is meant by principle of virtual work?

Module – 2

1. Write the Linear interpolation polynomials in terms of global coordinates of bar. triangular (2D simplex) elements
2. What is CST element?
3. What is Higher Order and Isoparametric Elements.
4. Explain the Lagrangian interpolation, Higher order one dimensional elements- quadratic Cubic element their shape functions.
5. Write the Shape functions of 1D quadratic element in natural coordinates
6. Write the shape functions of 1D cubic element shape
7. Derive an expression for Stiffness matrix of bar element by direct method.
8. Write plane trusses by direct stiffness,
9. Explain Solution for displacements reactions.
10. Find the reactions and stresses by using elimination approach
11. Explain penalty approach
12. Using the penalty approach, determine the nodal displacements, stresses and reaction solutions of the axially loaded bar shown in the following Fig. Take E_{steel} = 200 GPa, E_{Al} = 70 GPa, A_{steel} = 16 mm^2, A_{Al} = 24 mm^2.



13. Determine the nodal displacements, stresses induced in a stepped bar shown in the following Fig. subjected to thermal loads. Take E_{steel} = 200 GPa, E_{Al} = 72 GPa, A_{steel} = 1000 mm^2, A_{Al} = 500 mm^2, α_{steel} = 11.7×10-6 / ^{0}C, α_{Al} = 23×10-6 / ^{0}C, $\Delta T = 60^0$.



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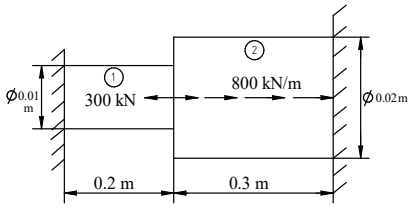
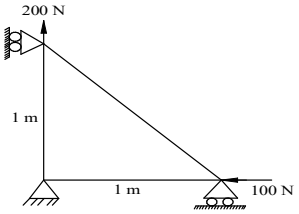
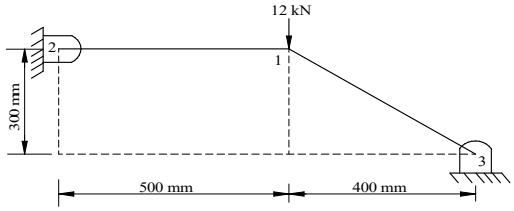
14. Obtain the displacement at node 2 and stresses in the circular solid stepped bar as shown in figure. Take E1 = 70 GPa, E2 = 200 GPa for the element 1 and 2 respectively.



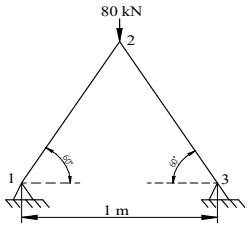
15. Write the properties of shape functions, Truss element.
16. Determine the nodal displacement in the truss segments subjected to concentrated load as shown in Figure. Take E = 70 GPa, A = 0.01 m^2.



17. Obtain the displacement at node 1, and stresses induced in each member of the truss shown in figure. Take E = 70 GPa and A = 200 mm^2.

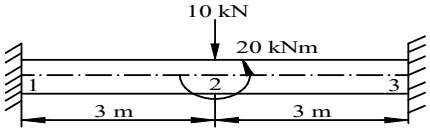


18. For the two member truss shown in figure, determine nodal displacements and stresses in each member. Take E = 70 GPa and A = 100 mm^2.



Module – 3

1. Write the Shape function of beam element.
2. Write the Hermite shape function of beam element
3. For the beam shown in the figure, determine the displacement at the centre node. Take E = 210 GPa, b = 0.2 m and h = 0.4 m.



4. Analyse the beam shown in figure, by finite element method and determine the end reactions. Also determine the deflections at mid span of every element. Take E = 2x10^5 N/mm^2 and I = 5x10^6 mm^4.

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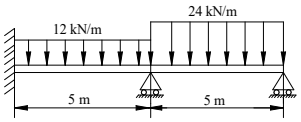
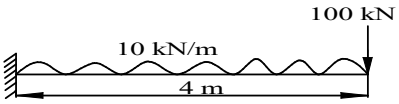
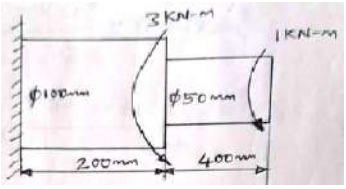


5. Determine the maximum deflection and internal loads in the uniform cross-section of the cantilever beam as shown in the Fig.3. If the beam is treated as a single finite element. Take E = 70 x 10^9 N/m^2, I = 4 x 10^{-4} m^4.



6. Explain Finite element formulation of shafts
7. A solid stepped bar of circular cross section shown in figure is subjected to a torque of 1 kN-m at its free end and a torque of 3 kN-m at its change in cross section. Determine the angle of twist and shear stresses in the bar. Take E=2×10^5 N/mm^2 and G= 7×10^4 N/mm^2.



Module -4

1. Problems related to beam, heat transfer 1D problems, and convection.
2. Discuss the finite element formulation of circular fin with conduction-convection boundary condition.
3. For the brick wall shown in Fig. 2, the inner surface temperature is 28^{0}C and the outer surface is exposed to cold air at -15^{0}C. Determine the temperature distribution in steady state, within the wall, by considering 2 elements. What is the heat flux through the wall?

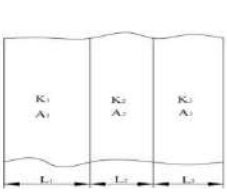


Fig.1

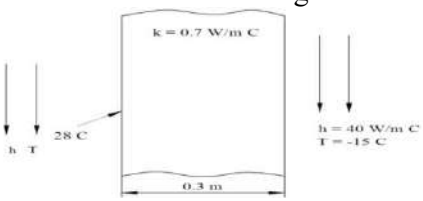
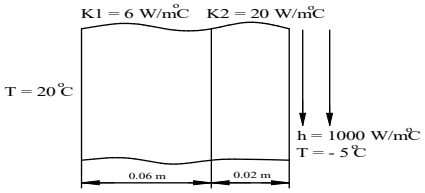
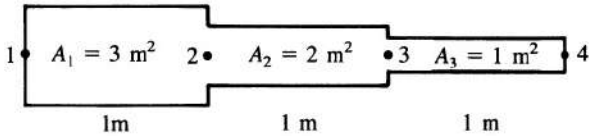


Fig.2

4. Determine the temperature distribution through the composite wall as shown in figure when convection heat loss occurs on the right surface. Assume a unit cross-sectional area.

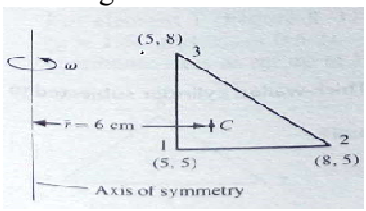


5. For the smooth pipe of variable cross section shown in figure, determine the potential at the junctions, the velocities in each section of pipe and the volumetric flow rate. The potential at the left end is p_1=10 m^2/s and that at the right end is p_4=1 m^2/s.

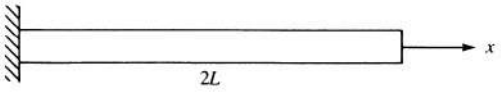


Module -5

1. What is axisymmetric element? Where do you use?
2. Derive stiffness matrix of axisymmetric triangular element.
3. Derive the stiffness matrix, consistent mass matrix and lumped matrix for 1D bar element
4. For the element of an axisymmetric body rotating with a constant with a constant angular velocity ω = 100rev/min as shown in figure evaluate the approximate body force matrix. Include the weight of the material, where the weight density ρ = 7800 kg/m^3. The coordinates of the element(in cm) are shown in figure.



5. For the bar shown in figure with length 2L, modulus of eleasticty E, mass density ρ and cross-sectional area A, determine the first natural frequencies.



Prepared by		
Prof. S. A. Goudadi	HOD	Principal

Subject Title	MODERN MOBILITY & AUTOMOTIVE		
Subject Code	21ME54	IA Marks	50
Number of Lecture Hrs / Week	03	Exam Marks	50
Total Number of Lecture Hrs	40	Exam Hours	03
		CREDITS –3	

FACULTY DETAILS:		
Name: Prof. M S Futane	**Designation:** Asst. Professor	**Experience:**18
No. of times course taught: 01	**Specialization:** CIM	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Mechanical Engineering	IV	KOM
02	Mechanical Engineering	V	DOM

2.0 Course Objectives

To impart the knowledge on:

1. To understand the different chassis design & main components of automobile
2. To understand the working of transmission and control system employed in automobiles
3. To understand the automotive pollution and alternative automotive technologies under trail
4. To understand the upcoming electric vehicle technology

3.0 Course Outcomes

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

	Course Outcome	Cognitive Level	POs
C323.1	To identify the different parts of an automobile and it's working	L1,L2	PO1,PO2 PO7,PO12
C323.2	Understand the working of different systems employed in automobile	L2	PO1,PO2 PO7,PO12
C323.3	Analyse the limitation of present day automobiles	L2	PO1,PO2 PO7,PO12
C323.4	Evaluate the energy sources suitability	L2	PO1,PO2 PO7,PO12
C323.5	Apply the knowledge for selection of automobiles based on their suitability	L2	PO1, PO7,PO12
Total Hours of instruction		**40**	

4.0 Course Content

MODULE 1

CHASSIS & POWER PLANT: History of Automobile, Classification of Automobile w.r.t Usage, Chassis, Body, Power Sources, capacity, main components of Internal Combustion Engines and their Functions, Fuel supply system, Cooling System, Lubrication System & Ignition System, Engine Management System, super charged engines, hybrid engines, modern GT engines

MODULE 2

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TRANSMISSION & SUSPENSION SYSTEMS: Clutches; Plate Clutches, Cone Clutch, Centrifugal Clutch, Fluid Flywheel Gear Box; Gear Shifting mechanism, synchromesh Gear box, Torque converter, Automatic Manual Transmission (AMT), Automatic Transmission (AT), intelligent manual Transmission (IMT) Continuously Variable Transmission (CVT),Infinitely Variable Transmission (IVT)- Working of Differential, Rear Axle types &construction.
Suspension – layout & working of Hydraulic& Air suspension, Independent suspension, Functions& advantages of Leaf Spring, Coil Spring, Telescopic Shock Absorber, Torsion Bar

MODULE 3

CONTROL & SAFETY SYSTEMS: Steering system- mechanisms & Linkages, Steering gear boxes- Rack & pinion, worm & wheel construction & working,, power Steering construction & working, steering geometry, Wheel balancing
Braking System- Mechanism and Linkages; Mechanical Brakes, Hydraulic Brakes, Power Brakes, Parking brakes, ABS,
Safety system – Safety measures in modern vehicle – safety frames – working of - air bags, seat belt, collapsible steering, spoilers, defoggers, fire safety measures in heavy vehicles, bullet proof vehicles

MODULE 4

AUTOMOTIVE EMISSION & ALTERNATE VEHICLES: Exhaust gas pollutants and their effects on environment, Emission norms, IC engine fuels types, extraction& availability, BIO Fuels – Production and impact. Ethanol engines, CNG vehicles- operation, advantages& disadvantages, over view of Hydrogen - fuel cell vehicles, advantages & disadvantages, IC engine/ electric hybrid vehicles over view, layout, transmission & control system, solar powered vehicles- wind powered vehicles, super capacitors, supply rails

MODULE 5

ELECTRIC VEHICLES& STORAGE BATTERIES: Electric vehicles principle and components- layout of two & 4 wheeler, Motors used in Electric vehicles –types- over view of construction and working, power transmission & control system in Electric vehicles. Batteries –construction & working principle of Lead acid, nickel based, sodium based, Lithium & Metal Air batteries. Battery charging types and requirements, battery cooling, fire safety measures in EV vehicles

5.0 Relevance to future subjects

Sl No	Semester	Subject	Topics
01	VIII	Project work	Fuel, engine systems, driving systems

6.0 Relevance to Real World

SL.No	Real World Mapping
01	Industrial applications and design of various components
02	Design of driving systems
03	Maintenance and repair of automobiles

7.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
01	Practical	Topic: Assembly of all automobile components

8.0 Books Used and Recommended to Students

Text Books

1. **Automotive mechanics,** William H Crouse & Donald L Anglin,10th Edition Tata McGraw Hill Publishing Company Ltd., 2007
2. **Automotive Mechanics,** S. Srinivasan, Tata McGraw Hill 2003.

Reference Books

- **Automobile engineering,** Kirpal Singh, Vol I and II (12th Edition) Standard Publishers 2011 2
- **Electric Vehicle Technology** Explained James Larminie Oxford Brookes University, Oxford, UK John Lowry Acenti

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- Designs Ltd., UK
- **Automotive Systems & Modern Mobility** by Dr T Madhusudhan, et al., Cengage publications
- **Modren Electric, Hybrid Electric, and Fuel Cell Vehicles,**MehrdadEhsani, YiminGao, CRC Press, Taylor & Francis Group
- **Automotive mechanics: Principles and Practices**, Joseph Heitner, D Van Nostrand Company, Inc
- . **Fundamentals of Automobile Engineering,** K.K.Ramalingam, Scitech Publications (India) Pvt. Ltd. 4.
- Automobile Engineering, R. B. Gupta, SatyaPrakashan,(4th Edition) 1984.

Additional Study material & e-Books

http://www.vssut.ac.in/lecture_notes/lecture1428910741.pdf

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

Website and Internet Contents References

- http://www.bradford.ac.uk/timetabling/timetables/ei/mechanical-and-automotive-engineering-beng-meng/BEng_MEng-Mechanical-Engineering-2016-17.pdf
- http://www.vssut.ac.in/lecture_notes/lecture1428910741.pdf
- http://www.mechanicalgeek.com/wp-content/uploads/2016/11/ME2354-AE.pdf
- https://archive.nptel.ac.in/courses/107/106/107106088/
- https://onlinecourses.nptel.ac.in/noc20_de06/preview
- https://www.digimat.in/nptel/courses/video/107106088/L01.html
- https://nptel.ac.in/courses/107106088
- https://www.youtube.com/watch?v=LZ82iANWBL0&list=PLbMVogVj5nJTW50jj9_gvJmdwFWHaqR5J

10.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	SAE	http://magazine.sae.org/jnlauto/
2	**IAME**	http://www.iame.com.au/
3	**AD&P BLOG**	http://www.adandp.media/
4	**Automotive Engineering**	http://www.freetrademagazines.com/automotive-engineering-magazine/automotive-magazines/

11.0 Examination Note

Continuous Internal Evaluation:
Three Unit Tests each of 20 Marks (duration 01 hour)
- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of 10 Marks
- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for 20 Marks (duration 01hours)
- At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be scaled down to **50 marks**

Scheme of Evaluation for Internal Assessment
Internal Assessment test in the same pattern as that of the main examination:20marks.

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Semester End Examination:
Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject **(duration 03 hours)**

- The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be reduced proportionally to **50 marks**
- **There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), should have a mix of topics under that module.**

12.0 Course Delivery Plan

Module No.	Lecture No.	Content of Lecture	% of Portion
1	1	History of Automobile, Fuel supply system	23.80
	2	Classification of Automobile w.r.t Usage, Chassis, Body of Internal Combustion Engines and their Functions,	
	3	Classification of Automobile w.r.t Power Sources, capacity, main components of Internal Combustion Engines and their Functions,	
	4	Cooling System	
	5	Lubrication System	
	6	Ignition System	
	7	Engine Management System	
	8	Super charged engines	19.05
	9	Hybrid engines, modern	
	10	GT engines	
2	11	Plate Clutches, Cone Clutch	
	12	Centrifugal Clutch, Fluid Flywheel	
	13	Gear Box; Gear Shifting mechanism, synchromesh Gear box	
	14	Torque converter, Automatic Manual Transmission(AMT)	
	15	Automatic Transmission (AT), intelligent manual Transmission (IMT) Continuously Variable Transmission (CVT), Infinitely Variable Transmission (IVT)	19.05
	16	Working of Differential, Rear Axle types &construction.	
	17	Suspension layout & working of Hydraulic& Air suspension, Independent suspension	
	18	Functions& advantages of Leaf Spring, Coil Spring, Telescopic Shock Absorber, Torsion Bar	
3	19	**Steering system-** mechanisms & Linkages, ,,	
	20	Steering gear boxes- Rack & pinion, worm & wheel construction & working	
	21	Power Steering construction & working, steering geometry, Wheel balancing	19.05
	22	**Braking System-** Mechanism and Linkages	
	23	Mechanical Brakes, Hydraulic Brakes	
	24	Power Brakes, Parking brakes, ABS	
	25	**Safety system** – Safety measures in modern vehicle – safety frames – working of - air bags, seat belt, collapsible steering	
	26	Spoilers, defoggers, fire safety measures in heavy vehicles, bullet proof vehicles	19.05
4	27	Exhaust gas pollutants and their effects on environment, Emission norms	
	28	IC engine fuels types, extraction& availability	
	29	BIO Fuels – Production and impact	
	30	Ethanol engines, CNG vehicles- operation, advantages& disadvantages	
	31	Over view of Hydrogen - fuel cell vehicles, advantages & disadvantages	
	32	IC engine/ electric hybrid vehicles over view, layout	
	33	Solar powered vehicles- wind powered vehicles	
	34	Super capacitors, supply rails	
5	35	Electric vehicles principle and components	19.05
	36	Layout of two & 4 wheeler	

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	37	Motors used in Electric vehicles –types	
	38	Over view of construction and working, power transmission & control system in Ev	
	39	Batteries –construction & working principle of Lead acid, nickel based	
	40	Sodium based, Lithium & Metal Air batteries	
	41	Battery charging types and requirements	
	42	Battery cooling, fire safety measures in EV vehicles	

13.0 Assignments, Pop Quiz, Mini Project, Seminars

Sl.No.	Title	Outcome expected	Allied study	Week No.	Individual / Group activity	Reference: book/website /Paper
1	Assignment 1: Questions on Chassis & Power Plant	Sketch and write the Answers.	Unit 1	2	Individual Activity.	Reference Book-3,4
2	Assignment 2: questions on Transmission & Suspension Systems	With neat sketch and explanation.	Unit 2	6	Individual Activity.	Reference Book-3,4
3	Assignment 3: Questions on Control & Safety Systems	Sketch and write the Answers.	Unit 3	8	Individual Activity.	Reference Book-3,4
4	Assignment 4: Questions on Automotive Emission & Alternate Vehicles	Sketch and write the Answers.	Unit 4	10	Individual Activity.	Reference Book-3,4
5	Assignment 5: Questions on Electric Vehicles& Storage Batteries	Explain the given questions	Unit 5	12	Individual Activity.	Reference Book-3,4

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14.0 QUESTION BANK

MODULE – 1: Chassis & Power Plant

1. With a neat labeled diagram explain Spark Ignition (SI)
2. How does valve actuating mechanism work?
3. Explain with neat diagrams valve and port timing diagrams
4. What are different types of combustion chambers of S. I. Engine?
5. What is compression ratio? Explain briefly.
6. Write a note on engine positioning.
7. Why engines are need to be cooled? And what are different methods of cooling.
8. With line diagram explain different lubrication arrangements.
9. Explain the following ignition systems
   -Battery Ignition system
   -Magneto Ignition system
10. What are different types of superchargers?
11. With a neat labeled diagram explain turbocharger construction and operation.

MODULE – 2: Transmission & Suspension Systems

1. Draw a neat diagram for general arrangement of clutch
2. What is the principle behind friction clutches?
3. With a neat diagram explain Fluid flywheel
4. Explain with neat sketch Single plate, multi-plate and centrifugal clutches.
5. What is necessity for gear ratios in transmission?
6. Explain planetary gears systems.
7. Write a note on torque converters
8. What are principles of automatic transmission?
9. List all the formulae which are involved in calculation of gear ratios and torque transmission by clutches.
10. What are requirements of Torsion bar suspension systems?
11. What is Air suspension system?.

MODULE – 3: Control & Safety Systems

1. Explain steering geometry.
2. Explain the followings camber, king pin inclination, included angle, castor, toe in & toe out.
3. What are the condition for exact steering
4. Write a note on power steering
5. What is over steer, under steer and neutral steer? numerical
6. What are different types of brakes?
7. With a neat sketch Explain briefly hydraulic braking system.
8. Explain with a neat sketch construction and working of master and wheel cylinder.
9. With a neat sketch explain working of drum brakes
10. What is the purpose and operation of antilock-braking system?
11. Explain Hotchkiss and torque tube drives
12. What are different arrangements of fixing the wheels to rear axle?

MODULE – 4: Automotive Emission & Alternate Vehicles

1. What alternative fuels can be used for IC engines?
2. What is normal and abnormal combustion?

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3. Explain cetane and octane numbers.
4. What is Forced Induction?
5. Why inter cooling is necessary?
6. Explain Emission standards- Euro I, II, III and IV norms, Bharat Stage II, III norms.
7. What are Catalytic converters?
8. How the air-fuel mixture is controlled?
9. With a neat sketch explain Exhaust gas recirculation.
10. Write a note on Air-injection system
11. How do you control evaporative emissions?
12. How do you control crankcase emissions?

MODULE – 5: Electric Vehicles& Storage Batteries

1. How do you control crankcase emissions?
2. Briefly explain different motors used in EVs.
3. Write a short note on power transmission & control system in Electric vehicles.
4. Explain with sketch Lead Acid Battery.
5. Explain with sketch Nickel based Battery.
6. Explain with sketch sodium based Battery.
7. Explain with sketch Lithium & Metal Air Battery.
8. Write a short note on battery cooling ^ fire safety measures.

		
Course Coordinator	**HOD**	**Principal**

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Course Title	**DESIGN LAB**		
Course Code	21MEL55	**CIE Marks**	50
Practical Hrs/ Week (L:T:P: S)	0:0:2:0	**SEE Marks**	50
Practical Hrs	03	**Exam Hours**	03
			Credits: 01

FACULTY DETAILS:		
Name: Prof. S.A. Goudadi	**Designation:** Asst. Professor	**Experience:16** Years
No. of times course taught: 1 Time		**Specialization:** Design Engg

1.0 Prerequisite Subjects:

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

2.0 Course Learning Objectives:

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

3.0 Course Outcomes

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

CO	Course Outcome	Cognitive Level	POs
C418.1	Compute the natural frequency of the free and forced vibration of single degree freedom systems, criticalspeed of shafts.	L3	1,2,6,8,12
C418.2	Carry out balancing of rotating masses.	L3	1,2,6,8,12
C418.3	Analyse the governor characteristics.	L3	1,2,6,8,12
C418.4	Study the effect of gyroscopic couple on plane disc	L3	1,2,6,8,12
C418.5	Determine stresses in disk, beams, plates and hook using photo elastic bench	L3	1,2,6,8,12
C418.6	Determination of Pressure distribution in Journal bearing	L3	1,2,6,8,12
C418.7	Analyze the stress and strains using strain gauges in compression and bending test and stress distribution in curved beams.	L3	1,2,6,8,12
C418.8	To realize different mechanisms and cam motions	L3	1,2,6,8,12

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4.0 Course Content

S.N.	Experiments
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 equilibrium speed, sensitiveness, power and effort of Porter/Proell /Hartnel Governor.
5	Determination of Pressure distribution in Journal bearing
6	Study the principle of working of a Gyroscope and demonstrate the Effect of gyroscopic Couple on plane disc
7	Study of different types of cams, types of followers and typical follower motions. Obtain
8	cam profile for any two types of follower motions and types of follower
9	Determination of Fringe constant of Photo-elastic material using. a)Circular disc subjected to diametral compression. b)Pure bending specimen (four-point bending).
	Demonstration Experiments (For CIE)
10	**Demonstration and study of operation of different Mechanisms and their Inversions:**
11	Slider crank chain, Double slider crank chain and its inversions, Quick return motion mechanisms- Peaucellier's mechanism. Geneva wheel mechanism, Ratchet and Pawl mechanism, toggle mechanism, pantograph, Ackerman steering gear mechanism.
12	Demonstration 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,

5.0 Relevance to future subjects

S.N.	Semester	Subject	Topics / Relevance
1	VI	Mini Project	Analysis of vibration of machine parts, Performance of Journal bearings, Study of photo elasticity
2	VIII	Project work	

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

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

Website and Internet Contents References
2. *http://nptel.ac.in*
3. *www.vturesource.com*
4. *http://www.sapnaonline.com*
5. *Anmited video on Governer: https://www.youtube.com/watch?v=HS_YGZXP2xY*
6. *Video on proell governer: https://www.youtube.com/watch?v=qD8R-NtC8bo*
7. *Video on Gyroscope: https://www.youtube.com/watch?v=NeXIV-wMVUk*
8. Video on Journal bearing:https://www.youtube.com/watch?v=xhtq8xqBXwE
9. Video on Critical speed of shaft: https://www.youtube.com/watch?v=ZEawe4jCbFw
10. Balancing of Rotating Masses: https://www.youtube.com/watch?v=0MeAZFFqmek&list=PLdLe0dTcWW-u_dCcNGoAK8fx2PiS5gkVu
11. Static and dynamic balancing by Tecquipment : https://www.youtube.com/watch?v=p1JDMvWGdsk
12. Forced vibrations by Tecquipment : https://www.youtube.com/watch?v=r_ouYEYhR5U
13. Video on Free Vibration: https://www.youtube.com/watch?v=RYKJo2iAz74

9.0 Magazines/Journals Used and Recommended to Students

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

10.0 Examination Note

Scheme of Examination:

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination(SEE).

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to

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students at the beginning of the practical session.

- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8th week of the semester and the second test shall be conducted after the 14th week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and average marks of two tests is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly. Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva- voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero. The duration of SEE is 03 hours

11.0 Course Delivery Plan

Expt No	Lecture/Practical No	Name of the Experiment	% of Portion
1	14	Determination of natural frequency, logarithmic decrement, damping ratio and damping coefficient in a single degree of freedom vibrating systems (longitudinal and torsional)	18.18
2	15	Balancing of rotating masses	9.09
3	16	Determination of critical speed of a rotating shaft	9.09
4	17	Determination of equilibrium speed, sensitiveness, power and effort of Porter/Proell /Hartnel Governor.	9.09
5	18	Determination of Pressure distribution in Journal bearing	9.09
6	19	Study the principle of working of a Gyroscope and demonstrate the Effect of gyroscopic Couple on plane disc	9.09
7	20 21	Study of different types of cams, types of followers and typical follower motions. Obtain cam profile for any two types of follower motions and types of follower	9.09
8	22	Determination of Fringe constant of Photo-elastic material using. a)Circular disc subjected to diametral compression. b)Pure bending specimen (four-point bending).	9.09
Demonstration Experiments (For CIE)			
9	23 24	**Demonstration and study of operation of different Mechanisms and their Inversions:** Slider crank chain, Double slider crank chain and its inversions, Quick return motion mechanisms- Peaucellier's mechanism. Geneva wheel mechanism, Ratchet and Pawl mechanism, toggle mechanism, pantograph, Ackerman steering gear mechanism.	9.09
10	25	Demonstration 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,	9.09

12.0 QUESTION BANK

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

Prepared by		
Prof. S. A. Goudadi	HOD	Principal

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Subject Title	**Research Methodology & Intellectual Property Rights**		
Subject Code	21RMI56	**CIE Marks**	50
Number of Lecture Hrs / Week(L:T:P:S)	1:2:0:0	**SEE Marks**	50
Total Hours of Pedagogy	25 hours Theory	**Exam Hours**	03
			CREDITS – 02

FACULTY DETAILS:

Name: Dr. K. M. Akkoli	**Designation:** Associate Professor	**Experience:** 20Years
No. of times course taught: 11	**Specialization:** Thermal Power Engineering	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Students should have the knowledge of basic subjects	I-IV Sem	Research and IPR

2.0 Course Objectives

- To understand the knowledge on basics of research and its types.
- To learn the concept of Literature Review, Technical Reading, Attributions and Citations.
- To learn Ethics in Engineering Research.
- To discuss the concepts of Intellectual Property Rights in engineering.

3.0 Course Outcomes

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

	Course Outcome	RBT Level	POs
C506.1	To know the meaning of engineering research.	L2	1,2,3,8,9,10,12
C506.2	To know the procedure of Literature Review and Technical Reading.	L3	1,2,3,8,12
C506.3	To know the fundamentals of patent laws and drafting procedure.	L3	1,2,3,5,8,9,10,12
C506.4	Understanding the copyright laws and subject matters of copyrights and designs.	L3	1,2,3,5,8,9,10,12
C506.5	Understanding the basic principles of design rights.	L3	1,2,3,5,8,9,10,12

4.0 Course Content

Module-1

Introduction: Meaning of Research, Objectives of Engineering Research, and Motivation in Engineering Research, Types of Engineering Research, Finding and Solving a Worthwhile Problem.

Ethics in Engineering Research, Ethics in Engineering Research Practice, Types of Research Misconduct, Ethical Issues Related to Authorship.

Module-2

Literature Review and Technical Reading, New and Existing Knowledge, Analysis and Synthesis of Prior Art Bibliographic Databases, Web of Science, Google and Google Scholar, Effective Search: The Way Forward

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Introduction to Technical Reading Conceptualizing Research, Critical and Creative Reading, Taking Notes While Reading, Reading Mathematics and Algorithms, Reading a Datasheet.

Attributions and Citations: Giving Credit Wherever Due, Citations: Functions and Attributes, Impact of Title and Keywords on Citations, Knowledge Flow through Citation, Citing Datasets, Styles for Citations, Acknowledgments and Attributions, What Should Be Acknowledged, Acknowledgments in, Books Dissertations, Dedication or Acknowledgments.

Module-3

Introduction to Intellectual Property: Role of IP in the Economic and Cultural Development of the Society, IP Governance, IP as a Global Indicator of Innovation, Origin of IP History of IP in India. Major Amendments in IP Laws and Acts in India.

Patents: Conditions for Obtaining a Patent Protection, To Patent or Not to Patent an Invention. Rights Associated with Patents. Enforcement of Patent Rights. Inventions Eligible for Patenting. Non-Patentable Matters. Patent Infringements. Avoid Public Disclosure of an Invention before Patenting. Process of Patenting. Prior Art Search. Choice of Application to be Filed. Patent Application Forms. Jurisdiction of Filing Patent Application. Publication. Pre-grant Opposition. Examination. Grant of a Patent. Validity of Patent Protection. Post-grant Opposition. Commercialization of a Patent. Need for a Patent Attorney/Agent. Can a Worldwide Patent be Obtained. Do I Need First to File a Patent in India. Patent Related Forms. Fee Structure. Types of Patent Applications. Commonly Used Terms in Patenting. National Bodies Dealing with Patent Affairs. Utility Models.

Process of Patenting. Prior Art Search. Choice of Application to be Filed. Patent Application Forms. Jurisdiction of Filing Patent Application. Publication. Pre-grant Opposition. Examination. Grant of a Patent. Validity of Patent Protection. Post-grant Opposition. Commercialization of a Patent. Need for a Patent Attorney/Agent. Can a Worldwide Patent be Obtained. Do I Need First to File a Patent in India. Patent Related Forms. Fee Structure. Types of Patent Applications. Commonly Used Terms in Patenting. National Bodies Dealing with Patent Affairs. Utility Models.

Module-4

Copyrights and Related Rights: Classes of Copyrights. Criteria for Copyright. Ownership of Copyright. Copyrights of the Author. Copyright Infringements. Copyright Infringement is a Criminal Offence. Copyright Infringement is a Cognizable Offence. Fair Use Doctrine. Copyrights and Internet. Non-Copyright Work. Copyright Registration. Judicial Powers of the Registrar of Copyrights. Fee Structure. Copyright Symbol. Validity of Copyright. Copyright Profile of India. Copyright and the word 'Publish'. Transfer of Copyrights to a Publisher. Copyrights and the Word 'Adaptation'. Copyrights and the Word 'Indian Work'. Joint Authorship. Copyright Society. Copyright Board. Copyright Enforcement Advisory Council (CEAC). International Copyright Agreements, Conventions and Treaties. Interesting Copyrights Cases.

Trademarks: Eligibility Criteria. Who Can Apply for a Trademark. Acts and Laws. Designation of Trademark Symbols. Classification of Trademarks. Registration of a Trademark is Not Compulsory. Validity of Trademark. Types of Trademark Registered in India. Trademark Registry. Process for Trademarks Registration. Prior Art Search. Famous Case Law: Coca-Cola Company vs. Bisleri International Pvt. Ltd.

Module-5

Industrial Designs: Eligibility Criteria. Acts and Laws to Govern Industrial Designs. Design Rights. Enforcement of Design Rights. Non-Protectable Industrial Designs India. Protection Term. Procedure for Registration of Industrial Designs. Prior Art Search. Application for Registration. Duration of the Registration of a Design. Importance of Design Registration. Cancellation of the Registered Design. Application Forms. Classification of Industrial Designs. Designs Registration Trend in India. International Treaties. Famous Case Law: Apple Inc. vs. Samsung Electronics Co.

Geographical Indications: Acts, Laws and Rules Pertaining to GI. Ownership of GI. Rights Granted to the Holders. Registered GI in India. Identification of Registered GI. Classes of GI. Non-Registerable GI. Protection of GI. Collective or Certification Marks. Enforcement of GI Rights. Procedure for GI Registration Documents Required for GI Registration. GI Ecosystem in India.

Case Studies on Patents. Case study of Curcuma (Turmeric) Patent, Case study of Neem Patent, Case study of Basmati patent. **IP Organizations in India. Schemes and Programmes**

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5.0 Relevance to future subjects

Sl No	Semester	Subject	Topics
01	VI, VII & VIII	Project	Research projects

6.0 Relevance to Real World

Sl. No	Real World Mapping
01	To develop a system for paper publication, patenting and product development

7.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
01	Practical	Seminar and case studies

8.0 Books Used and Recommended to Students

Text Books

1. Dipankar Deb • Rajeeb Dey, Valentina E. Balas "Engineering Research Methodology", ISSN 1868-4394 ISSN 1868-4408 (electronic), Intelligent Systems Reference Library, ISBN 978-981-13-2946-3 ISBN 978-981-13-2947-0 (eBook), https://doi.org/10.1007/978-981-13-2947-0
2. Intellectual Property A Primer for Academia by Prof. Rupinder Tewari Ms. Mamta Bhardwa

Reference Books

1. David V. Thiel "Research Methods for Engineers" Cambridge University Press, 978-1-107-03488- 4
2. Intellectual Property Rights by N.K.Acharya Asia Law House 6th Edition. ISBN: 978-93-81849-30-9

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

Website and Internet Contents References

https://onlinecourses.nptel.ac.in
https://www.tutorialspoint.com/fundamentals-of-research-methodology

10.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	Journal of Mixed Methods Research	https://journals.sagepub.com/
2	International Journal of Social Research Methodology	https://www.tandfonline.com/

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11.0 Examination Note

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

Three Unit Tests each of 20 Marks (duration 01 hour)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of 10 Marks

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for 20 Marks (duration 01 hours)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will **be scaled down to 50 marks** (to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course). CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the Outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (duration 03 hours)

1. The question paper will be set for 100 marks. Marks scored shall be proportionally reduced to 50 marks
2. The question paper will have ten questions. Each question is set for 20 marks.
3. There will be 2 questions from each module. Each of the two questions is under a module (with a maximum of 2 sub-questions).
4. The students have to answer 5 full questions, selecting one full question from each module.

Marks scored by the students will be proportionally scaled down to 50 marks

12.0 Course Delivery Plan

Module	Lecture No.	Content of Lecturer	% of Portion
1	1	Introduction: Meaning of Research, Objectives of Engineering Research,	20
	2	Types of Engineering Research, Motivation in Engineering Research	
	3	Finding and Solving a Worthwhile Problem	
	4	Ethics in Engineering Research, Ethics in Engineering Research Practice	
	5	Types of Research Misconduct, Ethical Issues Related to Authorship.	
2	6	**Literature Review and Technical Reading**, New and Existing Knowledge, Analysis and Synthesis of Prior Art Bibliographic Databases, Web of Science, Google and Google Scholar	20
	7	Effective Search: The Way Forward Introduction to Technical Reading Conceptualizing Research, Critical and Creative Reading, Taking Notes While Reading, Reading Mathematics and Algorithms, Reading a Datasheet.	

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	8	**Attributions and Citations**: Giving Credit Wherever Due, Citations: Functions and Attributes	
	9	Impact of Title and Keywords on Citations, Knowledge Flow through Citation, Citing Datasets	
	10	Styles for Citations, Acknowledgments and Attributions, What Should Be Acknowledged, Acknowledgments in, Books Dissertations, Dedication or Acknowledgments	
3	11	**Introduction To Intellectual Property:** Role of IP in the Economic and Cultural Development of the Society, Major Amendments in IP Laws and Acts in India, IP Governance, IP as a Global Indicator of Innovation, Origin of IP History of IP in India.	
	12	**Patents:** Conditions for Obtaining a Patent Protection, To Patent or Not to Patent an Invention. Rights Associated with Patents. Enforcement of Patent Rights.	
	13	Inventions Eligible for Patenting. Non-Patentable Matters. Patent Infringements. Avoid Public Disclosure of an Invention before Patenting. Process of Patenting. Prior Art Search.	
	14	Choice of Application to be Filed. Patent Application Forms. Jurisdiction of Filing Patent Application. Types of National Bodies Dealing with Patent Affairs.	20
	15	Commercialization of a Patent. Need for a Patent Attorney/Agent. Can a Worldwide Patent be obtained, Patent Applications, Commonly Used Terms in Patenting.	
4	16	**Copyrights and Related Rights:** Classes of Copyrights. Criteria for Copyright. Ownership of Copyright. Copyrights of the Author. Copyright Infringements.	
	17	Copyright Infringement is a Criminal Offence. Copyright Infringement is a Cognizable Offence. Fair Use Doctrine. Copyrights and Internet. Non-Copyright Work. Copyright Registration. Judicial Powers of the Registrar of Copyrights.	
	18	Copyright Profile of India. Copyright and the word 'Publish'. Transfer of Copyrights to a Publisher. Copyrights and the Word 'Adaptation'. Copyrights and the Word 'Indian Work'. Joint Authorship. Copyright Society.	
	19	**Trademarks:** Eligibility Criteria. Who Can Apply for a Trademark. Acts and Laws. Designation of Trademark Symbols. Classification of Trademarks. Registration of a Trademark is Not Compulsory. Validity of Trademark.	
	20	Types of Trademark Registered in India. Trademark Registry. Process for Trademarks Registration. Prior Art Search. Famous Case Law: Coca-Cola Company vs. Bisleri International Pvt. Ltd.	
5	21	Industrial Designs: Eligibility Criteria. Acts and Laws to Govern Industrial Designs. Design Rights. Enforcement of Design Rights. Non-Protectable Industrial Designs India.	
	22	Protection Term. Procedure for Registration of Industrial Designs. Prior Art Search. Application for Registration. Duration of the Registration of a Design. Importance of Design Registration.	20
	23	Cancellation of the Registered Design. Application Forms. Classification of Industrial Designs. Designs Registration Trend in India. International Treaties. Famous Case Law: Apple Inc. vs. Samsung Electronics Co.	
	24	Geographical Indications: Acts, Laws and Rules Pertaining to GI. Ownership of GI. Rights Granted to the Holders. Registered GI in India. Identification of Registered GI. Classes of GI. Non-Registerable GI. Protection of GI. Collective or Certification Marks.	

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	25	Case Studies on Patents. Case study of Curcuma (Turmeric) Patent, Case study of Neem Patent, Case study of Basmati patent. IP Organizations In India. Schemes and Programmes	

13.0 Assignments, Pop Quiz, Mini Project, Seminars

Sl.No	Title	Outcome expected	Allied study	Week No.	Individual / Group activity	Reference: book/website /Paper
1	Assignment 1	Students will be able to demonstrate the mathematical modelling of electrical, mechanical and analogous systems and to apply block diagram and signal flow graph methods to obtain transfer function of systems.	Module 1, 2 & 3 of the syllabus	4	Individual Activity.	Text Book 1
2	Assignment 2	Students will be able to investigate the performance of a given system, determine the stability of the system and design control system using different controllers.	Module 4 & 5 of the syllabus	9	Individual Activity.	Text Book 2

15.0 QUESTION BANK

MODULE 1

1. Explain the term "Research" in the context of engineering.
2. Classify different types of engineering research and elaborate on the distinctive characteristics of each type. Provide examples to support your classifications.
3. Discuss the importance of finding and solving a worthwhile problem in engineering research. How does this contribute to the advancement of knowledge and technology?
4. Define research misconduct in the context of engineering research. Provide examples of behaviors that are considered research misconduct.
5. Discuss the importance of ethics in engineering research. How does ethical conduct contribute to the credibility and integrity of scientific inquiry?

MODULE 2

1. Define the term "Literature Review" in the context of research. Explain its significance in the research process.
2. Compare and contrast the features and functionalities of bibliographic databases such as Web of Science, Google Scholar, and Google. Discuss the strengths and limitations of each in the context of academic research.
3. Explain the functions and attributes of citations in academic writing. How do citations contribute to the credibility and reliability of a research paper?
4. Discuss the impact of titles and keywords on citations. How can researchers optimize these elements to enhance the visibility and accessibility of their work?

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5. Discuss the ethical considerations of citing datasets in research papers.

MODULE 3

1. Explain the role of Intellectual Property in the economic development of society. How does it contribute to fostering innovation and creativity?
2. Analyze the challenges and benefits associated with the globalization of Intellectual Property. How does the global nature of IP impact both developed and developing nations?
3. Discuss a historical overview of Intellectual Property in India, highlighting key milestones and developments.
4. Examine the rights associated with patents. How do patents grant exclusive rights to inventors, and what limitations exist?
5. Discuss the considerations involved in the decision-making process of whether or not to patent an invention.

MODULE 4

1. Analyze the rights of the author in copyright. Discuss the implications of copyright infringements and why it is considered a criminal and cognizable offense.
2. Explain the process of copyright registration, including the fee structure and the significance of the copyright symbol.
3. Analyze the concept of joint authorship in copyright. What implications does joint authorship have on copyright ownership and protection?
4. List the eligibility criteria for a trademark. Who is eligible to apply for a trademark, and what are the key requirements?
5. Discuss the necessity for the registration of a trademark. What are the implications of not registering a trademark, and under what circumstances might registration be beneficial?

MODULE 5

1. Discuss the acts and laws that govern industrial designs. How do these legal frameworks safeguard design rights?
2. Analyze the concept of design rights. What rights are associated with industrial designs, and how do they differ from other forms of intellectual property?
3. Describe the procedure for the registration of industrial designs, including the steps involved in the application process.
4. Examine the identification and classification of registered GIs in India. How are GIs categorized, and how does this classification impact their protection?
5. Analyze the protection mechanisms for Geographical Indications. How are GIs safeguarded from misuse or unauthorized use?

16.0 University Result

Examination	O	A+	A	B+	B	C	E	F	% Passing

Prepared by	Checked by		
Dr. K. M.Akkoli	Dr. S. N. Topannavar	HOD	Principal

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Subject Title	**ENVIRONMENTAL STUDIES**		
Subject Code	21CIV57	**IA Marks**	50
Number of Lecture Hrs /	01(L)+1(T)	**Exam Marks**	50
Total Number of Lecture Hrs	15	**Exam Hours**	01
		CREDITS – 01	

FACULTY DETAILS:		
Name: Dr. M. S. Hanagadakar Dr. S. J. Walaki Dr. Tanuja S.B	Designation: i) Assoc. Professor ii) Asst. Professor iii) Asst. Professor	Experience: i) 18.0 ii) 6.0 iii)6.0
No. of times course taught: i) 08 ii) 03 iii)01	**Specialization:** i) Physical Chemistry ii) Organic Chemistry iii) Physical chemistry	

1.0 Prerequisite Subjects:

Fundamentals of Chemistry, Physics, Mathematics, Biology, Engineering, Anthropology, Sociology, (Social problems), Economics (production, consumption, and transfer of wealth), management, Ecology Knowledge are required.

2.0 Course Learning Objectives

1. Recognize major concepts in environmental sciences and demonstrate in-depth understanding of the environment.
2. Develop analytical skills, critical thinking, and demonstrate problem-solving skills using scientific techniques.
3. Demonstrate the knowledge and training for entering graduate or professional schools, or the job market.

3.0 Course Outcomes

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

Course Code	Course Outcome	RBT level	POs
C309.1	Understand the principles of ecology and environmental issues that apply to air, land, and water issues on a global scale.	L1,L2	1,2,3,6,7,9 ,10,12
C309.2	Develop critical thinking and/or observation skills, and apply them to the analysis of a problem or question related to the environment.	L1, L2	1,2,3,6,7,9, 10,12
C309.3	Demonstrate ecology knowledge of a complex relationship between biotic and abiotic components.	L1, L2	1,2,3,6,7,9, 10,12
C309.4	Apply their ecological knowledge to illustrate and graph a problem and describe the realities that managers face when dealing with complex issues.	L1, L2	1,2,3,6,7,9, 10,12
C309.5	Understand the principles of ecology and environmental issues that apply to air, land, and water issues on a global scale.	L1,L2	1,2,3,6,7,9, 10,12
Total Hours of instruction		**25**	

4.0 Course Content

Module-1

Ecosystems (Structure and Function): Forest, Desert, Wetlands, Riverine, Oceanic and Lake.

Biodiversity: Types, Value; Hot-spots; Threats and Conservation of biodiversity, Forest Wealth, and Deforestation.

Module -2

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Advances in Energy Systems (Merits, Demerits, Global Status and Applications)**:** Hydrogen, Solar, OTEC, Tidal and Wind.

Natural Resource Management (Concept and case-studies): Disaster Management, Sustainable Mining, Cloud Seeding, and Carbon Trading.

Module -3

Environmental Pollution (Sources, Impacts, Corrective and Preventive measures, Relevant Environmental Acts, Case-studies)**:** Surface and Ground Water Pollution; Noise pollution; Soil Pollution and Air Pollution.

Waste Management & Public Health Aspects: Bio-medical Wastes; Solid waste; Hazardous wastes; E-wastes; Industrial and Municipal Sludge.

Module -4

Global Environmental Concerns:(Concept, policies and case-studies):Ground water depletion/recharging, Climate Change; Acid Rain; Ozone Depletion; Radon and Fluoride problem in drinking water; Resettlement and rehabilitation of people, Environmental Toxicology.

Module -5

Latest Developments in Environmental Pollution Mitigation Tools (Concept and Applications): G.I.S. & Remote Sensing, Environment Impact Assessment, Environmental Management Systems, ISO14001; Environmental Stewardship- NGOs.

Field work: Visit to an Environmental Engineering Laboratory or Green Building or Water Treatment Plant or Waste water treatment Plant; ought to be followed by understanding of process and its brief documentation.

5.0 Relevance to future subjects

Sl. No.	Semester	Subject	Topics
01	Common to all	Common to all engineering Subjects	Sustainable development, waste management, Pollution control, Energy systems, Environmental issues.

6.0 Relevance to Real World

Sl.No	Real World Mapping
01	All engineering applications / projects leading to the sustainable development, waste management, pollution control, to resolve global related issues.

7.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
01	NPTEL	http://nptel.ac.in/courses

8.0 Books Used and Recommended to Students

Text Books

1. Benny Joseph (2005), "Environmental Studies", Tata McGraw – Hill Publishing Company Limited.

2. R.J.Ranjit Daniels and Jagadish Krishnaswamy, (2009), "Environmental Studies", Wiley India Private Ltd., New Delhi.

3. R Rajagopalan, "Environmental Studies – From Crisis to Cure", Oxford University Press, 2005,

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4. Aloka Debi, "Environmental Science and Engineering", Universities Press (India) Pvt. Ltd. 2012.

Reference Books

1. Raman Sivakumar, "Principals of Environmental Science and Engineering", Second Edition, Cengage learning Singapore, 2005

2. P. Meenakshi, "Elements of Environmental Science and Engineering", Prentice Hall of India Private Limited, New Delhi, 2006

3. S.M. Prakash, "Environmental Studies", Elite Publishers Mangalore, 2007

4. Erach Bharucha, "Text Book of Environmental Studies", for UGC, University press, 2005

5. G.Tyler Miller Jr., "Environmental Science – working with the Earth", Tenth Edition, Thomson Brooks /Cole, 2004

6. G.Tyler Miller Jr., "Environmental Science – working with the Earth", Eleventh Edition, Thomson Brooks /Cole, 2006

7. Dr.Pratiba Sing, Dr.AnoopSingh and Dr.Piyush Malaviya, "Text Book of Environmental and Ecology", Acme Learning Pvt. Ltd. New Delhi.

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

Website and Internet Contents References

Web links and Video Lectures:

https://nptel.ac.in/courses/120/108/120108005/
https://nptel.ac.in/courses/120/108/120108002/
https://nptel.ac.in/courses/120/108/120108004/
https://nptel.ac.in/courses/105/102/105102089/
https://www.my-mooc.com/en/categorie/environmental-science
https://academicearth.org/environmental-studies/

10.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	Environmental-science	http://nlspub.ac.in/category/journals/journal-of-environmental-law-policy-and-development/
2	Environmental-research	https://www.journals.elsevier.com/environmental-research

11.0 Examination Note

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

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Continuous Internal Evaluation:
Three Unit Tests each of 20 Marks (duration 01 hour)
1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester
Two assignments each of 10 Marks
4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester
Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for 20 Marks (duration 01 hours)
6. At the end of the 13th week of the semester
The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be scaled down to 50 marks
(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).
CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.
Semester End Examination:
Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (duration 01 hours)
Question paper pattern:
1. The Question paper will have 50 objective questions.
2. Each question will be for 01 marks
3. Students will have to answer all the questions on an OMR Sheet.
4. The Duration of the Exam will be 01 hour

12.0 Course Delivery Plan

Module No.	Lecture No.	Content of Lecturer	% of Portion
1	1	**Ecosystems** (Structure and Function):, Wetlands, Riverine	20
	2	Forest and Desert	
	3	Oceanic and Lake	
	4	**Biodiversity:** Types, Value; Hot-spots; Threats and Conservation of biodiversity.	
	5	Forest Wealth, and Deforestation	
2	6	**Advances in Energy Systems** (Merits, Demerits, Global Status and Applications)**:** Hydrogen,	20
	7	Solar and OTEC	
	8	Tidal and Wind.	
	9	**Natural Resource Management** (Concept and case-studies): Disaster Management.	
	10	Sustainable Mining, Cloud Seeding, and Carbon Trading.	
3	11	**Environmental Pollution** (Sources, Impacts, Corrective and Preventive measures, Relevant Environmental Acts, Case-studies)**:** Surface and Ground	20
	12	Water Pollution and Noise pollution	
	13	Soil Pollution and Air Pollution.	
	14	**Waste Management & Public Health Aspects:** Bio-medical Wastes; Solid waste	
	15	Hazardous wastes; E-wastes; Industrial and Municipal Sludge	
4	16	**Global Environmental Concerns:**(Concept, policies and case-studies):Ground water depletion/recharging.	20
	17	Climate Change; Acid Rain and Ozone Depletion	

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	18	Radon and Fluoride problem in drinking water	
	19	Resettlement and rehabilitation of people	
	20	Environmental Toxicology.	
5	21	**Latest Developments in Environmental Pollution Mitigation Tools (Concept and Applications):** G.I.S. & Remote Sensing.	**20**
	22	Environment Impact Assessment,	
	23	Environmental Management Systems, ISO14001, Environmental Stewardship- NGOs.	
	24	**Field work:** Visit to an Environmental Engineering Laboratory or Green Building or Water Treatment Plant or Waste water treatment Plant.	
	25	Ought to be followed by understanding of process and its brief documentation.	

13.0 Assignments

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

14.0 QUESTION BANK

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Module-1

1. The term 'Environment' has been derived from the French word which means to encircle or surround
a) Environ b) Oikos c) geo d) Aqua
2. The objective of environmental education is
a) Raise consciousness about environmental conditions b) To teach environmentally appropriate behavior c) Create an environmental ethic d) All of the above
3. Which of the following conceptual spheres of the environment is having the least storage capacity for matter?
a) Atmosphere b) Lithosphere c) Hydrosphere d) Biosphere
4. Which of the following components of the environment are effective transporters of matter?
a) Atmosphere and Hydrosphere b) Atmosphere and Lithosphere
c) Hydrosphere and Lithosphere d) Biosphere and Lithosphere
5. Biosphere is
a) The solid shell of inorganic materials on the surface of the earth
b) The thin shell of organic matter on the surface of earth comprising of all the living things
c) The sphere which occupies the maximum volume of all of the spheres d) all of these.
6. Atmosphere consists of 79 per cent Nitrogen and 21 per cent Oxygen by
a) Volume b) weight c) Density d) All the three
7. Which of the following is a biotic component of an ecosystem?
a) Fungi b) solar light c) temperature d) humidity
8. In an ecosystem, the flow of energy is
a) Bi-directional b) Cyclic c) Unidirectional d) Multidirectional
9. Which Pyramid is always upright?
a) Energy b) biomass c) numbers d) food chain
10. In complex ecosystems the degree of species diversity is
a) Poor b) high c) medium d) none

Module-2

1. Which of the following is considered as an alternate fuel?
a) CNG b) Kerosene c) Coal d) Petrol
2. Solar radiation consists of
a) UV b) Visible light c) Infrared d) All of these
3. Reduction in usage of fuels cannot be brought about by
a) Using alternate fuels b) Changing lifestyles c) Reducing car taxes d) Both a) & b)
4. Which of the following is a hazard of a nuclear power plant?
a) Accident risk when tankers containing fuel cause spill
b) Radioactive waste of the power plant remains highly toxic for centuries
c) Release of toxic gases during processing d) All of these
5. The most important fuel used by nuclear power plant is
a) U – 235 b) U- 238 c) U – 245 d) U – 248
6. Biogas is produced by
a) Microbial activity b) Harvesting crop c) Both a) & b) d) None of these
7. Oil and Gas are preferred because of
a) Easy transportation b) Cheap c) Strong smell d) All of these
8. Biomass power generation uses
a) Crops b) Animal dung c) Wood d) All of these
9. Chernobyl nuclear disaster occurred in the year
a) 1984 b) 1952 c) 1986 d) 1987
10. Which of the following is not a renewable source of energy?
a) Fossil fuels b) Solar energy c) Tidal wave energy d) Wind energy

Module-3

1. Environmental pollution is due to
a) Rapid Urbanization b) deforestation c) Afforestation d) a & b
2. Which of the following are natural sources of air pollution?
a) Volcanic eruption b) solar flair c) earth quake d) all
3. Which of the following are biodegradable pollutants?
a) Plastics b) Domestic sewage c) detergent d) all

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4. The liquid waste from baths and kitchens is called
a) Sullage b) Domestic sewage c) Storm waste d) Run off
5. Noise pollution can be minimized by
a) Urbanization b) Maintaining silence c) Reducing noise at source d) none
6. BOD Means
a) Biochemical oxygen demand b) chemical oxygen demand c) biophysical oxygen demand d) all
7. Which of the following industry generates colored waste?
a) Software industry b) Textile industry c) Biomedical industry d) none
8. Physical pollution of water is due to
a) Dissolved oxygen b) Turbidity c) pH d) none of these
9. Which of the following source is surface water?
a) Springs b) streams c) deep wells d) all
10. Deforestation can
a) Increase the rain fall b) Increase soil fertility c) Introduce silt in the rivers d) None of these
11. Which of the following is non point source of water pollution?
a) Factories b) Sewage treatment plant c) Urban and Sub-urban land d) all of the above

Module-4

1. Acid rain can be controlled by
a) Reducing $SO_2$and NO_2emissions. b) Reducing oxygen emission.
c) Increasing number of lakes. c) Increasing the forest cover.
2. Atmospheric oxidation of $SO_2$to $SO_3$is influenced by
a) Sunlight. b) Humidity c) presence of hydrocarbons d) all of these
3. Reduction in brightness of the famous Taj Mahal is due to
a) Global warming. b) Air pollution c) Ozone depletion d) Afforestation.
27. The Effect of Acid rain
a) Reduces soil fertility. b) increases atmospheric temperature.
c) Causing respiratory problems d) skin cancer
4. The process of movement of nutrients from the soil by the Acid rain iscalled
a) Transpiration. b) Evapo transpiration c) Leaching d) Infiltration.
5. Ozone layer is present in
a) Troposphere b) Stratosphere c) Mesosphere d) Thermosphere
6. Which of the following statements about ozone is true?
a) Ozone is a major constituent of photochemical smog
b) Ozone protects us from the harmful uv radiation of sun
c) Ozone is highly reactive d) All of the above
7. Major compound responsible for the destruction of stratospheric ozone layer is
a) Oxygen b) CFC c) Carbon dioxide d) Methane
8. Ozone layer thickness is measured in
a) PPM b) PPB c) Decibels d) Dobson units
9. Normal average thickness of stratospheric ozone layer across the globe is around
a) 200 DU b) 300 DU c) 400 DU d) 500 DU
10. Chloro Fluro Carbon's (CFC) are
a) Non toxic b) Non flammable c) Non carcinogenic d) All these
11. Ozone layers absorbs
a) UV rays b) infra red rays c) Cosmic rays d) CO
12. Which of the following is not an ill effect of acid rain?
a) Results in killing fish b) causes stone leprosy. c) Leaches nutrients from the soil. d) Causes cataract.

13. Formation of ozone layer is explained by
a) Rosenmund reaction b) Henderson's reaction c) Chapman's reaction. d) Perkin's reaction
14. Each Chlorine free Radical can destroy the following number of ozone molecules.
a) 1000 b) 10,000 c) 1, 00, 000 d) 100
15. Which of the following statements about ozone is true?
a) Ozone is a major constituent of photochemical smog b) Ozone is highly reactive
c) Ozone protects us from the harmful UV radiation of sun. d) All of these

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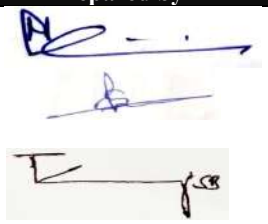
Module-5

1. Sustainable development means
a) Meeting present needs without compromising on the future needs b) Progress in human well beings
c) Balance between human needs and the ability of Earth to provide the resources d) All the above
2. The most important remedy to avoid negative impact due to industrialization is
a) Industry should be closed b) Don't allow new industrial units
c) Industry should treat all the wastes generated by it before disposal
d) Industries should be shifted far away from human habit tats.
3. Mining means
a) To conserve & preserve minerals b) To check pollution due to mineral resources
c) To extract minerals and ores d) None
4. E.I.A. can be expanded as
a) Environment & Industrial Act b) Environment & Impact Activities
c) Environmental Impact Assessment d) Environmentally Important Activity
5. E.I.A. is related to
a) Resource conservation b) Efficient equipment/process
c) Waste minimization d) All of the above
6. In order to protect the health of people living along the adjoining areas of roads, one should.
a) Plant trees alongside of the roads b) Not allow diesel driven vehicles
c) Shift them (people) to other places d) None of the above
7. The pollution caused by transportation/vehicular activities depends on
a) Type of the vehicle's engine b) Age of the vehicle
c) Traffic congestion d) All of the above
8. Sustainable development will not aim at
a) Social economic development which optimizes the economic and societal benefits available in the present, without spoiling the likely potential for similar benefits in the future
b) Reasonable and equitably distributed level of economic well being that can be perpetuated continually
c) Development that meets the needs of the present without compromising the ability of future generations
d) Maximizing the present day benefits through increased resource meet their own needs consumption
10. Which of the following is a key element of EIA?
a) Scoping b) Screening c) Identifying and evaluating alternatives d) all of these

Prepared by	Checked by		
			
Dr. M. S. Hanagadakar Dr. S. J. Walaki Dr. Tanuja. S.B	Dr. M. S. Hanagadakar	**HOD**	**Principal**

Subject Title	**Basics of MATLAB**		
Subject Code	**21ME581**	**IA Marks**	**50**
Teaching Hours/Week (L:T:P:	**0:0:2*:0**	**Exam Marks**	**50**
Total Hours of Pedagogy	**14 sessions**	**Exam Hours**	**02**
CREDITS – 01			

FACULTY DETAILS:		
Name: Prof. P. M. Kokitakar	**Designation:** Asst. Professor	**Experience:** 05 Years
No. of times course taught: 00	**Specialization:**Machine Design	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Mechanical Engineering	I/II	Technical Knowledge
02	Mechanical Engineering	VI/VII	Mechanical Vibrations

2.0 Course Objectives

- To know about fundamentals of MATLAB tool.
- To provide an overview to program curve fitting & solve Linear and Nonlinear Equations.
- To understand the concept and importance of Fourier transforms.
- To gain knowledge about MATLAB Simulink & solve Electrical engineering problems.

3.0 Course Outcomes

At the end of the course the students will be able to:

CO	Description
C428.1	Able to implement loops, branching, control instruction and functions in MATLAB programming environment.
C428.2	Able to program curve fitting, numerical differentiation and integration, solution of linear equations in MATLAB and solve electrical engineering problems.
C428.3	Able to understand implementation of ODE using ode 45 and execute Solutions of nonlinear equations and DFT in MATLAB.
C428.4	Able to simulate MATLAB Simulink examples

4.0 Course Content

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Sr. No	Experiments
1	**Introduction to MATLAB Programming:** Basics of MATLAB Programming, array operations in MATLAB, loops and execution of control,working with files: Scripts and functions, plotting and programming output, examples.
2	
3	**Numerical Methods and their applications:** Curve Fitting: Straight line fit, Polynomial fit.
4	
5	**Numerical Integration and Differentiation:** Trapezoidal method, Simpson method.
6	
7	**Linear and Nonlinear Equations:** Eigen values, Eigen vectors, Solution of linear algebraic equations using Gauss Elimination and LU decomposition, Solution of nonlinear equation in single variable using Gauss-Siedal and Newton-Raphson method.
8	
9	**Ordinary Differential Equations:** Introduction to ODE's, Euler's method, second orderRungaKutta method, MATLAB ode45 algorithm in single variable and multivariables. Transforms: Discrete Fourier Transforms,
10	
11	Application of MATLAB to analyse problems in basic engineering mechanics, mechanical vibrations, control system, statistics and dynamics of different circuits. MATLAB Simulink: Introduction to MATLAB Simulink, Simulink libraries, development of basic models in Simscape Power Systems
12	
13	

5.0 Relevance to future subjects

Sl No	Semester	Subject	Topics
01	VIII	Project work	• Mechatronics projects can be executed using MATLAB • Mathematical equations involving complex calculations can be solved very easily. • Helpful in Vibrational Analysis

6.0 Relevance to Real World

SL. No	Real World Mapping
1	Model-Based Design in MATLAB and Simulink to: Design and test machine controls and supervisory logic.
2	Matrix calculations and developing the algorithms.
3	Create models and applications

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7.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
01	Workshop /Seminar	Fundamentals of MATLAB required to students
02	Tutorial	Additional classes for Programming of MATLAB

8.0 Books Used and Recommended to Students

Text Books

1) Agam Kumar Tyagi, "MATLAB and Simulink for Engineers", OXFORD Higher Education.
2) Dr.Shailendra Jain, "Modeling& Simulation using MATLAB – Simulink", Wiley – India.

Reference Books

1) 1. Won Y.Tang, Wemun Cao, Tae-Sang Ching and John Morris, "Applied Numerical Methods Using MATLAB", A JohnWiley & Sons.
2) 2. Steven T. Karris, "Introduction to Simulink with Engineering Applications", Orchard Publications.

Additional Study material & e-Books

1) Ramin S. Esfandiari, "Applied Mathematics for Engineers, 6th edition"
2) AbdelwahabKharab, Ronald B. Guenther. "An Introduction to Numerical Methods: A MATLAB Approach, 5th edition"

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

Web links and Video Lectures (e-Resources):

1) www.mathworks.com
2) https://in.mathworks.com/help/matlab/getting-started-with-matlab.html
3) https://ctms.engin.umich.edu/CTMS/index.php?aux=Basics_Matlab
4) www.youtube.com/watch?v=O41BWhXFu8E
5) www.youtube.com/watch?v=83S48Fs9WhY

10.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	MathWorks Technical Articles	https://in.mathworks.com/company/technical-articles.html?q=&page=1
2	MATLAB Journal	https://www.purkh.com/mathlab-journal.html
3	Introduction to MATLAB	https://link.springer.com/chapter/10.1007/978-3-540-72749-1_2
4	MATLAB for Engineers	https://www.tandfonline.com/doi/full/10.11120/ened.2014.00026

11.0 Examination Note

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimumpassing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35%
(18 Marks out of 50) in the semester-end examination (SEE)

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Continuous Internal Evaluation (CIE):

CIE marks for the practical course is 50 Marks.
The split-up of CIE marks for record/ journal and test are in the ratio 60:40.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the
- evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the
- Laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be
- Evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8th week of the
- Semester and the second test shall be conducted after the 14th week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a
- weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability. Rubrics
- suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to 20 marks (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and average marks of two tests is the total CIE
marks scored by the student.

SemesterEndEvaluation(SEE):

SEE marks for the practical course is 50 Marks. SEE shall be conducted jointly by the two examiners of the same institute; examiners are appointed by the University
All laboratory experiments are to be included for practical examination. (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. OR based on the course requirement evaluation rubrics shall be decided jointly by examiners. Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.
Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners. General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Vivavoce20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaleddown to 50 marks (however, based on course type, rubrics shall be decided by the examiners)Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.
The duration of SEE is **03 hours.**Rubrics suggested in Annexure-II of Regulation book

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12.0 Course Delivery Plan

Experiment No	Session	Content of Lecturer	% of Portion
i	1	Study of Introduction To MATLAB	21.42
1	2	To write a MATLAB program to perform some basic operation on matrices such as addition, subtraction, multiplication and division.	
2	3	To write a MATLAB program to plot a Sine Wave	
3	4	To write a MATLAB program to execute a code using flow control	14.28
4	5	To Write a MATLAB program to fit a Straight line for a given values of x & y.	
5	6	To Write a MATLAB program to fit a second degree parabola $y=ax^2+bx+c$	14.28
6	7	Write a program for trapezoidal rule to solve $I=\int_0^6 \left(\frac{dx}{1+x^2}\right)$	
7	8	Write a program for Simpson's 1/3rd rule to solve $\int_{01}^{4}(e^x - x^3 - 2x + 1)dx$& Take n=1	14.28
8	9	Write a program to find the root of equation y=x-cosx by using Newton-Raphson Method	
9	10	Write a program for Euler's method to solve $dy/dx=x^2+y^2$ &y(0)=0 take h=0.1 Find y_g at x_g =0.5	14.28
10	11	Write a program for RungeKutta 4th order method to solve $dy/dx=x^2+y^2$ &y(1)=1.5 take h=0.1 Find y_g at x_g =1.3	
11	12	Write a program to Plot the response of a forced spring mass damper system	21.42
12	13	Compute and plot the linear response of a simple pendulum	
13	14	Introduction to MATLAB Simulink, Simulink Libraries. Development of Basic models in Simscape Power system	

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14.0 QUESTION BANK

1) What is MATLAB?

2) Explain the Features of MATLAB.

3) Explain the Advantages and Disadvantages of MATLAB.

4) Explain all Data Types used in MATLAB.

5) What is the difference between a script and a function in MATLAB? When would you use each?

6) How do you create a matrix in MATLAB?

7) What are the common matrix operations?

8) What are cell arrays in MATLAB? How are they different from regular arrays?

9) What is Simulink? How do you use it to model and simulate systems?

10) Create a simple MATLAB program for calculating the factorial of numbers by asking the input from the user.

11) List some basic Plots and Graphs of MATLAB?

12) How to write a MATLAB program to plot a Sine Wave

13) How to write a MATLAB program to execute a code using flow control

14) How to write a MATLAB program to execute a code using for loop

15) How to Write a MATLAB program to fit a Straight line for a given values of x & y.

Prepared by	Checked by		
			
Prof.P. M. Kokitakar	**Prof.D. N. Inamdar**	**HOD**	**Principal**