JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTRE

JECRC Campus, Shri Ram ki Nangal, Via-Vatika, Tonk Road, Jaipur

Department of Mechanical Engineering

Name of Subject: Mechanical Vibrations

Subject Code: 6ME-5-12

Year:3rd Year, 6th Semester

Jaipur Engineering College and Research Center, Jaipur

Department of Mechanical Engineering

(Rajasthan Technical University, KOTA)

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Department of Mechanical Engineering

Vision and Mission of Institute:

VISION:

To become a renowned centre of outcome based learning, and work towards academic, professional, cultural and social enrichment of the lives of individuals and communities.

MISION:

- Focus on evaluation of learning outcomes and motivate students to inculcate research aptitude by project based learning.
- Identify, based on informed perception of Indian, regional and global needs, areas of focus and provide platform to gain knowledge and solutions.
- Offer opportunities for interaction between academia and industry.
- Develop human potential to its fullest extent so that intellectually capable and imaginatively gifted leaders can emerge in a range of professions.

Vision and Mission of Department:

Vision:

The Mechanical Engineering Department strives to be recognized globally for outcome based technical knowledge and to produce quality human resource, who can manage the advance technologies and contribute to society.

Mission:

M1:To impart quality technical knowledge to the learners to make them globally competitive mechanical engineers.

M2:To provide the learners ethical guidelines along with excellent academic environment for a long productive career.

M3:To promote industry-institute relationship.

PROGRAMEDUCATIONAL OBJECTIVES(PEOS)

PEO1: To equip graduates with a strong foundation in engineering sciences, with an emphasis on mechanical engineering principles, enabling them to analyze, design, and solve real-world engineering challenges.

PEO2: To prepare graduates with sound scientific and engineering fundamentals to innovate and deliver effective solutions addressing practical challenges in mechanical engineering

PEO3: To inculcate in graduates a professional and ethical attitude, effective communication and teamwork skills, a multidisciplinary approach, entrepreneurial mindset, and the ability to connect engineering solutions with societal and environmental concerns.

PEO4: To provide students with an academic environment that fosters excellence, leadership, adherence to ethical standards, and encourages self-motivated lifelong learning essential for a successful professional career in mechanical

PEO5: To prepare students to excel in industry and higher education by providing quality education grounded in strong technical knowledge and high moral values

Program Specific Outcomes (PSOs)

PSO1: Graduates will be able to design, analyze, and fabricate electric and hybrid vehicles using modern engineering tools and sustainable practices.

PSO2: Graduates will be able to apply design principles and computational techniques, including programming and data structures, to analyze and solve mechanical engineering problems.

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Program Outcomes (POs)

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

PO4:Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

PO7:Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

PO8:Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10:Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11:Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

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Department of Mechanical Engineering

SYLLABUS

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

Syllabus

3rd Year - VI Semester: B.Tech. : Mechanical Engineering

6ME4-03: MECHANICAL VIBRATIONS

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	1
2	Introduction to Sound: Frequency dependent human response to sound, Sound pressure dependent human response, Relationship among sound power, sound intensity and sound pressure level.	2
	Introduction to Noise: Auditory and Non auditory effects of Noise, Major sources of the noise, Industrial noise sources, Industrial noise control strategies.	3
	Introduction to Vibration: Importance and scope of vibrations, terminology and classification, Concept of Degrees of freedom, Harmonic motion, vectorial representation, complex number representation, addition.	3
3	Undamped Single Degree of Freedom System: Derivation of equation of motion for one dimensional longitudinal, transverse and torsional vibrations without damping using Newton's second law, D' Alembert's principle and Principle of conservation of energy, Compound pendulum and centre of percussion.	3
	Damped vibrations of single degree of freedom systems: Viscous damping, under-damped, critically damped and over-damped systems, Logarithmic decrement.	3
	Vibration characteristics of Coulomb damped system and Vibration characteristics of Hysteretic damped systems.	2
3	Forced Vibrations of Single Degree of Freedom Systems: Forced vibration with constant harmonic excitation, Steady state and transient parts, Frequency response curves and phase angle plot, Forced vibration due to excitation of support.	4
	Vibration Isolation and Transmissibility: Force transmissibility, Motion transmissibility, Forced vibration with rotating and reciprocating unbalance, Materials used in vibration isolation.	4
5	System with Two Degrees of Freedom: principle mode of vibration, Mode shapes, Undamped forced vibrations of two degrees of freedom system with harmonic excitation, Vibration Absorber, Undamped dynamic vibration absorber and centrifugal pendulum absorber	5
	Critical Speed of Shaft: Critical speed of a light shaft without damping, critical speed of shaft having multiple discs, secondary critical speed.	3
6	Many Degrees of Freedom Systems (Exact analysis): Equation of Motion, The matrix method, Eigen Values and Eigen Vectors, Method of influence Coefficients and Maxwell's reciprocal theorem. Torsional vibrations of multi rotor system, vibrations of geared system, Generalized coordinates and coordinate coupling Many Degrees of Freedom Systems (approximate methods): Rayleigh's, Dunkerley's, Stodola's and Holzer's methods	5
	Vibrations of continuous systems: Transverse vibration of a string, Longitudinal vibration of a bar, Torsional vibration of a shaft.	3
	TOTAL	**41**

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Department of Mechanical Engineering

Subject: Mechanical Vibration **Code:5ME4-02**

COURSE OUTCOME

CO1: Explain the fundamental concepts of sound, noise, and vibration, including human response to sound.
CO2: Analyze the behavior of undamped and damped single degree of freedom (SDOF) systems under various conditions
CO3: Evaluate forced vibration responses of single degree of freedom systems and assess vibration isolation and transmissibility in rotating and reciprocating systems.
CO4: Examine multi-degree-of-freedom systems to determine natural frequencies, mode shapes, and design appropriate vibration absorbers for vibration control.
CO5: Apply analytical and approximate methods to study multi-degree-of-freedom and continuous systems
CO6: Analyze vibration control solutions using analytical methods and modern tools for real-world engineering systems

CO-PO MAPPING

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	1	1	1	1	1	2	2	2
CO2	3	3	3	2	2	1	1	1	1	1	2	3	3
CO3	3	3	3	3	3	1	1	1	2	1	2	3	3
CO4	3	3	3	3	3	1	1	2	2	1	3	3	3
CO5	3	3	3	3	3	1	1	2	2	1	3	3	3
CO6	3	3	3	3	3	1	1	2	3	2	3	3	3

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Course Plan

Name of the Course: Mechanical Vibrations
Code: 6ME-5-12
Faculty: Dr.Bhuvnesh Bhardwaj

Course Outcomes

CO1: Explain the fundamental concepts of sound, noise, and vibration, including human response to sound.
CO2: Analyze the behavior of undamped and damped single degree of freedom (SDOF) systems under various conditions
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CO4: Examine multi-degree-of-freedom systems to determine natural frequencies, mode shapes, and design appropriate vibration absorbers for vibration control.
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CO6: Analyze vibration control solutions using analytical methods and modern tools for real-world engineering systems

Unit 1: Course Overview

Lec	Topic	CO	Specific Objectives	Expected Outcomes	Reference
1	Explain course objectives and syllabus	CO1	Introduce course structure	Understand course scope	Course File
2	Explain applications of vibration	CO1	Discuss applications	Relate to engineering	Notes
3	Define basic terms of vibration	CO1	Introduce terminology	Understand basics	V.P. Singh Ch.1 p.1–3

Unit 2: Undamped Free Vibration (SDOF)

Lec	Topic	CO	Specific Objectives	Expected Outcomes	Reference
4	Define vibration system elements	CO2	Identify components	Model system	V.P. Singh Ch.1 p.3–10
5	Derive equation of motion	CO2	Apply Newton law	Form equation	V.P. Singh Ch.2 p.20–28
6	Define natural frequency	CO2	Calculate frequency	Predict response	V.P. Singh p.28–35
7	Solve energy method problems	CO2	Apply energy method	Solve numericals	V.P. Singh p.35–42
8	Explain torsional vibration	CO2	Analyze shaft	Solve problems	Pujara Ch.2 p.40–48
9	Solve equivalent system problems	CO2	Simplify systems	Model complex systems	V.P. Singh p.42–50

10	PYQ/ competitive examinations	CO2	Apply knowledge to solve difficult/complex problems	Solve numerical	GATE/PYQ

Unit 3: Damped Free Vibration

Lec	Topic	CO	Specific Objectives	Expected Outcomes	Reference
11	Define damping and its types	CO2	Explain damping	Identify damping	V.P. Singh Ch.3 p.60–65
12	Derive damped vibration equation	CO2	Apply equation	Solve problems	V.P. Singh p.65–75
13	Explain logarithmic decrement	CO2	Calculate damping	Measure damping	V.P. Singh p.75–82
14	Compare damping cases	CO2	Classify damping	Predict response	V.P. Singh p.82–90
15	Explain Coulomb damping	CO2	Describe friction	Analyze system	Pujara p.90–96
16	PYQ/ competitive examinations	CO2	Apply knowledge to solve difficult/complex problems	Solve numerical	GATE/PYQ

Unit 4: Forced Vibration

Lec	Topic	CO	Specific Objectives	Expected Outcomes	Reference
17	Explain forced vibration concept	CO3	Define excitation	Understand response	V.P. Singh Ch.4 p.100–105
18	Solve undamped forced vibration	CO3	Derive amplitude	Analyze response	V.P. Singh p.105–115
19	Solve damped forced vibration	CO3	Apply damping	Calculate amplitude	V.P. Singh p.115–125
20	Explain resonance condition	CO3	Define resonance	Predict critical speed	V.P. Singh p.125–132
21	Explain vibration isolation	CO3	Define transmissibility	Design isolator	Pujara p.120–130
22	Analyze rotating unbalance	CO3	Apply force analysis	Solve numericals	V.P. Singh p.132–140
23	PYQ/ competitive examinations	CO3	Apply knowledge to solve difficult/complex problems	Solve numerical	GATE/PYQ

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Unit 5: Multi Degree of Freedom Systems

Lec	Topic	CO	Specific Objectives	Expected Outcomes	Reference
24	Explain two DOF system	CO4	Form equations	Solve system	V.P. Singh Ch.5 p.150–160
25	Determine natural frequencies	CO4	Solve frequency	Interpret results	V.P. Singh p.160–170
26	Explain mode shapes	CO4	Define modes	Understand pattern	V.P. Singh p.170–178
27	Apply matrix method	CO4	Use matrices	Solve problems	Pujara p.150–160
28	Explain influence coefficients	CO4	Apply method	Solve numericals	Pujara p.160–168
29	Design vibration absorber	CO4	Explain absorber	Control vibration	V.P. Singh p.178–185
30	PYQ/ competitive examinations	CO4	Apply knowledge to solve difficult/complex problems	Solve numerical	GATE/PYQ

Unit 6: Continuous Systems & Control

Lec	Topic	CO	Specific Objectives	Expected Outcomes	Reference
31	Explain longitudinal vibration	CO5	Derive equation	Analyze bar	V.P. Singh Ch.6 p.200–210
32	Explain transverse vibration	CO5	Analyze beam	Solve problems	V.P. Singh p.210–220
33	Explain torsional vibration	CO5	Apply torsion	Solve numericals	Pujara p.200–210
34	Apply Rayleigh method	CO5	Estimate frequency	Solve approx.	V.P. Singh p.220–230
35	Explain vibration control methods	CO6	Define techniques	Reduce vibration	V.P. Singh Ch.7 p.250–260
36	Explain modern tools	CO6	Introduce tools	Analyze systems	NPTEL
37	Solve case studies	CO6	Apply concepts	Solve problems	Case studies
38	PYQ/ competitive examinations	CO2	Apply knowledge to solve difficult/complex	Solve numerical	GATE/PYQ

			problems		
39	Condition monitoring/fault analysis	CO1-CO6	Knowledge related to fault analysis using vibration measurement	Able to get knowledge related to condition monitoring	Research papers

Reference Books

1. V.P. Singh – Mechanical Vibrations, Dhanpat Rai & Company (P) Ltd., New Delhi
2. K.G. Pujara – Mechanical Vibrations, S. Chand & Company Ltd., New Delhi
3. S. S. Rao – Mechanical Vibrations, Pearson Education, USA