JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTRE

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JECRC Campus, Shri Ram Ki Nangal, Via-Vatika, Tonk Road, Jaipur
Department of Mechanical Engineering

Name of Subject: Design of Machine Elements-II (DME-II)

Subject Code: 6ME4-04

Year: 3rd Year, 6th Semester

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VISION AND MISSION OF THE INSTITUTE

VISION OF JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTRE

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

MISSION OF JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTRE

M1: Focus on evaluation of learning outcomes and motivate students to inculcate research aptitude by project based learning.

M2: Identify, based on informed perception of Indian, regional and global needs, areas of focus and provide platform to gain knowledge and solutions.

M3: Offer opportunities for interaction between academia and industry.

M4: 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 THE DEPARTMENT

VISION OF DEPARTMENT OF MECHANICAL ENGINEERING

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 OF DEPARTMENT OF MECHANICAL ENGINEERING

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.

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PROGRAM EDUCATIONAL 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 toWK4)

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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SYLLABUS

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

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

6ME4-04: DESIGN OF MACHINE ELEMENTS- II

Credit: 3 **Max. Marks: 100(IA:30, ETE:70)**
3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	1
2	Fatigue Considerations in Design: Variable load, loading pattern, endurance stresses, Influence of size, surface finish, notch sensitivity and stress concentration.	3
	Goodman line, Soderberg line, Design of machine members subjected to combined, steady and alternating stresses.	3
	Design for finite life, Design of Shafts under Variable Stresses, Bolts subjected to variable stresses.	2
3	Design of IC Engine components: Piston, Cylinder, Connecting Rod and Crank Shaft.	8
4	Design of helical compression, tension, torsional springs, springs under variable stresses.	4
	Design of belt, rope and pulley drive system,	4
5	Design of gear teeth: Lewis and Buckingham equations, wear and dynamic load considerations.	4
	Design and force analysis of spur, helical, bevel and worm gears, Bearing reactions due to gear tooth forces.	4
6	Design of Sliding and Journal Bearing: Methods of lubrication, hydrodynamic, hydrostatic, boundary etc. Minimum film thickness and thermal equilibrium.	4
	Selection of anti-friction bearings for different loads and load cycles, Mounting of the bearings, Method of lubrication.	4
	TOTAL	41

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COURSE OUTCOMES (COs)

Subject: Design of Machine Elements II **Code:** 6ME4-04

Course Outcomes:

On successful completion of this course the student will be able to:

CO1: Apply fatigue considerations for variable loading in designing machine elements.

CO2: Analyze and design I.C. engine components considering functional and strength requirements.

CO3: Design helical springs (compression, tension, torsional) subjected to static and variable stresses for mechanical applications.

CO4: Design and evaluate flexible drive systems such as belts, ropes, and pulleys for effective power transmission.

CO5: Design and analyze gear tooth strength considering dynamic loads, wear, and force analysis of different gears.

CO6: Design and select sliding and journal bearings using lubrication theories.

CO-PO/PSO MAPPING

CO-PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	2	2	1	1	1	1	1	2	3	3
CO2	3	3	3	3	2	1	1	1	1	1	2	3	3
CO3	3	3	3	3	2	1	1	1	1	1	2	3	3
CO4	3	3	3	3	3	1	1	1	1	1	3	3	3
CO5	3	3	3	3	3	1	1	1	1	1	3	3	3
CO6	3	3	3	3	3	1	1	1	1	1	3	3	3

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COURSE PLAN

Name of the Course: Design of Machine Elements – II

Code of the course: 6ME4-04

Name of Faculty: Lalit Kumar Sharma

Course Outcome

CO1: Apply fatigue considerations for variable loading in designing machine elements.
CO2: Analyze and design I.C. engine components considering functional and strength requirements.
CO3: Design helical springs (compression, tension, torsional) subjected to static and variable stresses for mechanical applications.
CO4: Design and evaluate flexible drive systems such as belts, ropes, and pulleys for effective power transmission.
CO5: Design and analyze gear tooth strength considering dynamic loads, wear, and force analysis of different gears.
CO6: Design and select sliding and journal bearings using lubrication theories.

Unit No.	Topic	Lec. No.	CO	Specific Objective	Expected Outcome	Book Referred	From page to
-	Introduction: Objective, scope and outcome of the course	1	-	To introduce the scope and applications of machine element design	Students will understand the structure, applications, and learning outcomes of the course	T1	1–3
Unit - 01	Variable loading and loading patterns	2	1	To explain various types of loads and patterns in real applications	Able to differentiate between loading types and understand loading patterns	T2, T3	309-320, 287–340
	Endurance stress, Influence of size, surface finish	3	1	To explain fatigue strength factors	Students will learn endurance limits and factors affecting fatigue life	T2	314-320
	Notch sensitivity and stress concentration	4	1	To understand the role of geometrical discontinuities	Able to calculate stress concentration and its impact on fatigue	T3	121–178
	Goodman line and its application	5	1	Introduce failure criteria under fluctuating stresses	Able to use Goodman diagram for design	T2	333-334
	Soderberg line and comparison	6	1	Compare various fatigue failure criteria	Able to apply Soderberg and choose between different theories	T2	334-335
	Combined, steady and alternating stresses	7	1	To design components under multiple stress conditions	Students will handle mixed stress scenarios	T1	400–405
	Design for finite life	8	1	To understand limitations under finite cycles	Students will be able to design for limited life applications	T1, T3	405–408, 511–519
	Shaft design under variable stresses	9	1	Application of fatigue to shafts	Students will perform fatigue analysis on shafts	T2	380-391
	Bolts under variable stresses	10	1	Extend fatigue design to threaded fasteners	Design bolts under fluctuating loading	T3	373–428
BS-1	Introduction to Fracture Mechanics	11	1	To introduce fracture mechanics principles	Able to identify fracture type, crack growth, stress intensity factors, and their role in failure prevention.	NPTEL	
Unit - 02	Design of piston: forces and design criteria	12	2	Start with reciprocating IC engine components	Students will understand piston loads and basic dimensions	T1	688–695

	Design of piston (contd.)	13	2	Complete piston geometry	Students will finish piston design calculations	T1	696–700
	Design of cylinder	14	2	Study forces and geometry of engine cylinder	Students can design cylinder dimensions	T1	700–704
	Cylinder head, studs and gaskets	15	2	Ancillary parts of cylinder	Students understand complete assembly design	T1	705–707
	Design of connecting rod (forces)	16	2	Load analysis of connecting rod	Students can calculate rod forces	T1	708–711
	Design of connecting rod (buckling)	17	2	Buckling and cross-section design	Students can analyze stability of rod	T1	711–715
	Crank shaft design: forces and reactions	18	2	Analysis of loads on crankshaft	Able to calculate crank forces	T1	715–718
	Crank shaft design: geometry	19	2	Crankshaft geometry and strength	Students will finalize crankshaft design	T1	719–722
Unit - 03	Helical compression and tension spring	20	3	Basics of spring design	Students can design axial load springs	T2	525-535, 543-547
	Torsional springs	21	3	Design of torque-resisting springs	Students understand torque spring behavior	T2	557-564
	Springs under variable stresses	22	3	Fatigue in springs	Students can analyze spring life	T2	543-547
	Multi-leaf and special springs	23	3	Practical spring types	Students will explore leaf springs and advanced forms	T1	533–536
	Belt drive elements	24	4	Introduction to belts and forces	Students will understand flat and V-belt design	T1	609–613
	Belt drive design calculations	25	4	Belt length, tensions, power	Able to compute belt system parameters	T1	614–619
	Rope drives and design	26	4	Rope geometry and design	Students can design wire rope drives	T1	620–623
	Pulley design	27	4	Pulley dimensions and stresses	Students will finalize pulley dimensions	T1	623–626
Unit - 04	Gear tooth design using Lewis equation	28	5	Basics of gear tooth stress	Students can compute tooth stress	T2	710-719
	Buckingham equation, dynamic and wear load	29	5	Real gear loading effects	Students handle dynamic forces	T1	633–636
	Spur and helical gear force analysis	30	5	Spur/helical load and reactions	Students understand force flow in gearsets	T2	710-719
	Bevel gear analysis	31	5	Geometry and forces of bevel gears	Students can analyze bevel gearsets	T1	640–644
	Worm gear analysis	32	5	Worm drive design	Students can compute worm gear parameters	T1	644–648
	Bearing reactions due to gear forces	33	5	Gear-induced bearing loads	Students assess load transmission to bearings	T1	648–651
Unit - 05	Sliding bearing: lubrication and types	34	6	Lubrication principles	Students will know types and roles of lubrication	T1	572–575
	Hydrodynamic and hydrostatic theory	35	6	Fluid film theory and equations	Able to use design equations for bearings	T1	576–580
	Boundary lubrication and thermal equilibrium	36	6	Thin film and heat generation	Students understand failure modes and heat limits	T1	580–583
	Journal bearing design steps	37	6	Practical design and materials	Students perform real-world bearing design	T1, T3	583–588, 496–535
	Anti-friction bearing types	38	6	Ball/roller bearing basics	Students recognize bearing codes and uses	T1	589–592
	Load cycle and selection of bearings	39	6	Equivalent load, life, selection	Students can choose bearings for applications	T1	593–596

BS-2	Sustainable and Eco-friendly Design	40	6	Introduce design for sustainability	Students will learn material-efficiency, energy-conscious, and life-cycle based design principles	T5	36-37, 187, 215

Reference Books:

T1 - V. B. Bhandari, Design of Machine Elements, Tata McGraw-Hill

T2 - J. E. Shigley & Charles R. Mischke, Mechanical Engineering Design, McGraw-Hill

T3 - R. S. Khurmi and J. K. Gupta, A Textbook of Machine Design, S. Chand & Company Ltd.

T4 - Martin Leary, Design for Additive Manufacturing: Concepts and Design Rules, Elsevier

T5 - Fabio Giudice, Guido La Rosa, Antonino Risitano, Product Design for the Environment: A Life Cycle Approach, CRC Press