INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad -500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**MACHINE DESIGN**				
Course Code	AME015				
Programme	B.Tech				
Semester	VI	ME			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Dr.G.V.R.Seshagiri Rao, Professor, ME				
Course Faculty	Mr. B.Vijay krishna, Assistant Professor , ME				

I. COURSE OVERVIEW:

The Machine design focus mainly on design of power transmitting elements like gears, connecting rod, crankpin, crankshafts, pistons, cylinders, bearings, belts, ropes, chain's, pulleys, Power screws and nuts. Design basis is strength and stiffness of the parts and selection of material for manufacture of machine elements.

Mechanical design is creating new devices or improving existing ones in an attempt to provide the "best" or "optimum "design. In other words, mechanical design may be de need as an iterative decision-making process that has as its objective the creation and optimization of a new or improved mechanical engineering system or device for the fulfillment of a human need or desire, with due regard for conservation of resources and environmental impact.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AME002	II	Engineering Mechanics	4
UG	AME005	III	Mechanics of solids	4
UG	AME003	V	Design of Machine Members	4

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Machine Design	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✘	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✘	Seminars	✘	Mini Project	✔	Videos
✘	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five units and each unit carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each unit. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	Theory		Total Marks
Type of Assessment	CIE Exam	Quiz / AAT	
CIA Marks	25	05	30

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration consisting of two parts. Part–A shall have five compulsory questions of one mark each. In part–B, four out of five questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz / Alternative Assessment Tool (AAT):
Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are be answered by choosing the correct answer from a given set of choices (commonly four). Marks shall be awarded considering the average of two quizzes for every course. The AAT may include seminars, assignments, term paper, open ended experiments, five minutes video and MOOCs.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	**Engineering knowledge**: Capability to apply the knowledge of mathematics, science and engineering and Mechanical Engineering principles related to combustion engines.	3	Presentation on Real-world problems
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using Thermodynamics concepts and principles.	2	Seminar
PO 3	**Design/ development of solutions:** Design, implement, and evaluate a Mechanical Engineering component, to meet desired needs within realistic constraints	1	Assignments
PO 4	**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.	1	Publication

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills:** To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	3	Seminar/Project reviews
PSO 2	**Problem-Solving Skills:** An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability	2	Project works/Major and Mini
PSO 3	**Successful Career and Entrepreneurship:** To build the nation, by imparting technological inputs and managerial skills to become technocrats.	2	Internship/Industrial visit/Work shops

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Ability to identify design variables and performance factors in the study of journal bearings.
II	Ability to identify different types of rolling contact bearings, their basic features, related terminology and designations
III	Ability to select rolling contact bearings for a given application
IV	Awareness of the basic features of prime movers and the means of power transmission commonly used in mechanical engineering
V	Ability to analyze and design all types of gears for given application

IX. COURSE OUTCOMES (COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	Understand various design variables and factors in the study of bearings	CLO 1	Explain various lubrication process, Illustrate various parts of bearing
		CLO 2	Analyze heat dissipation in bearings
		CLO 3	Select the lubricants for various applications
		CLO 4	Discuss types of bearings for required application.
		CLO 5	Describe static and dynamic rating of roller bearings
CO 2	Ability to analyze and design of I.C Engines components.	CLO 6	Explain various parts of connecting Rod
		CLO 7	Illustrate about thrust acting on a connecting Rod

COs	Course Outcome	CLOs	Course Learning Outcome
		CLO 8	Categorize & Describe about stresses induced and find suitable cross section
		CLO 9	Classify the various types of Crankshafts.
		CLO 10	Calculate the sizes of different parts of crankshaft and crank pin
CO 3	Identify the various power transmission systems	CLO 11	Explain the various parts of the piston and forces acting on each of these parts
		CLO 12	Construct the piston diagram and generate formulae
		CLO 13	Describe the various types of belt drives and transmission power and V.R
		CLO 14	Describe the construction of ropes
		CLO 15	Define the efficiency of power transmission and explain factors effecting efficiency
CO 4	Analyze of forces and design of various gears.	CLO 16	Distinguish different pulleys for belt and rope drives
		CLO 17	Describe load transmission between gear teeth and Illustrate dynamic load factors
		CLO 18	Compare the equations for compressive and bending strength
		CLO 19	Explain the Procedure design of spur gears
		CLO 20	Describe the governing equation and find the dynamic and wear strength
CO 5	Ability to identify the different types screws and its terminology.	CLO 21	Explain Procedure for design of helical and bevel gears
		CLO 22	Describe the terminology of power screws
		CLO 23	Describe construction and explain failure mechanism
		CLO 24	Design of Differential screw
		CLO 25	Ball screw-possible failures

X. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AME015.01	CLO 1	Understand various design variables and factors in the study of bearings	PO 1	3
AME015.02	CLO 2	Explain various lubrication process	PO 1	3
AME015.03	CLO 3	Illustrate various parts of bearing	PO 1	3
AME015.04	CLO 4	Analyze heat dissipation in bearings	PO1	3
AME015.05	CLO 5	Select the lubricants for various applications	PO 1	3
AME015.06	CLO 6	Discuss types of bearings for required application.	PO 1	3
AME015.07	CLO 7	Describe static and dynamic rating of roller bearings	PO 2	2
AME015.08	CLO 8	Explain various parts of connecting Rod	PO 2	2
AME015.09	CLO 9	Illustrate about thrust acting on a connecting Rod	PO1	3
AME015.10	CLO 10	Categorize & Describe about stresses induced and find suitable cross section	PO 2	2
AME015.11	CLO 11	Classify the various types of Crankshafts.	PO 1	3
AME015.12	CLO 12	Calculate the sizes of different parts of crankshaft and crank pin	PO 1	3
AME015.13	CLO 13	Explain the various parts of the piston and forces acting on each of these parts	PO 1	3
AME015.14	CLO 14	Construct the piston diagram and generate formulae	PO 1	3
AME015.15	CLO 15	Describe the various types of belt drives and transmission power and V.R	PO 1	3

AME015.16	CLO 16	Describe the construction of ropes	PO 1	3
AME015.17	CLO 17	Define the efficiency of power transmission and explain factors effecting efficiency	PO 2	2
AME015.18	CLO 18	Distinguish different pulleys for belt and rope drives	PO 1	3
AME015.19	CLO 19	Describe load transmission between gear teeth and Illustrate dynamic load factors	PO 1	3
AME015.20	CLO 20	Compare the equations for compressive and bending strength	PO 1	3
AME015.21	CLO 21	Explain the Procedure design of spur gears	PO 1	3
AME015.22	CLO 22	Describe the governing equation and find the dynamic and wear strength	PO 2	2
AME015.23	CLO 23	Explain Procedure for design of helical and bevel gears	PO 1	3
AME015.24	CLO 24	Describe the terminology of power screws	PO 1	3
AME015.25	CLO 25	Describe construction and explain failure mechanism	PO 2	2

XI. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

Course Outcomes (COs)	Program Outcomes (POs)			
	PO 1	PO 2	PO3	PO4
CO 1	3	2	**3**	1
CO 2	**2**		1	
CO 3		3	2	1
CO 4	3	2	3	1
CO 5		3	2	**1**

3 = High; 2 = Medium; 1 = Low

XII. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

(CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1		2											3		
CLO 2		2												2	
CLO 3		2												2	
CLO 4		2												2	
CLO 5		2											3		
CLO 6			2										3		
CLO 7		2											3		
CLO 8		2												2	
CLO 9			2										3		
CLO 10		2												2	

(CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 11			2											2	
CLO 12	3												3		
CLO 13	3												3		
CLO 14			2										3		
CLO 15	3												3		
CLO 16			2										3		
CLO 17				2									3		
CLO 18	3												3		
CLO 19	3													2	
CLO 20	3												3		
CLO 21	3													2	
CLO 22			2												
CLO 23	3												3		
CLO 24	3													2	
CLO 25		2												2	

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XIII. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO1,PO2 PO3,PO6	SEE Exams	PO1,PO2,PO3,PO6, PSO1,PSO2	Assignments	PO 2	Seminars	PO 2
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	PO 3						

XIV. ASSESSMENT METHODOLOGIES-INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XV. SYLLABUS

UNIT-I	BEARINGS
Bearings: Types of journal bearings, basic modes of lubrication, bearing modulus, full and partial bearings, Clearance ratio, Heat dissipation of bearings, bearing materials, Journal bearing design. Ball and roller bearing, Static load- dynamic load, equivalent radial load-design and selection of ball and roller bearings.	
UNIT-II	**DESIGN OF IC ENGINE PARTS**
Connecting rod: thrust in connecting rod-stress due to whipping action on connecting rod ends-cranks and crank shafts, strength and proportions of over hung and center cranks-crank pins, crank shafts, piston, forces acting on piston-construction design and proportions of piston.	
UNIT-III	**POWER TRANSMISSION SYSTEMS, PULLEYS**
Transmission of power by belt and rope drives, transmission efficiencies, Belts-Flat and V belts-ropes-pulleys for belt and rope drives, materials- chain drives.	
UNIT-IV	**SPUR GEAR**
Load concentration factor-dynamic load factor, surface compressive strength-bending strength-design analysis of spur gear, check for plastic deformation, check for dynamic and wear considerations. Helical and Bevel Gear Drives: Load concentration factor-dynamic load factor, Analysis of helical and bevel gears, check for plastic deformation, check for dynamic and wear considerations. Design of Worm gears: worm gear-properties of worm gears-selections of materials-strength and wear rating of worm gears-force analysis-friction in worm gears-thermal considerations	
UNIT-V	**DESIGN OF POWER SCREWS**
Design of screw, design of nut, compound screw, differential screw, ball screw-possible failures	
Text Books:	
1. P. Kannaiah, (2012), Machine Design, 2nd Edition, Scitech Publications India Pvt. Ltd, New Delhi, India. 2. V. Bandari (2011), A Text Book of Design of Machine Elements, 3rd edition, Tata McGraw hill education (P) ltd, New Delhi, India.	
Reference Books:	
1. Shigley, J.E, (2011), Mechanical Engineering Design, 9th Edition, Tata McGraw-Hill, New Delhi, India. 2. S. M.D. Jalaludin, (2011), Machine Design, 3rd Edition, Anuradha Publishers, Kumbakonam, Chennai, India. 3. R. L. Norton (2006), Machine Design (An Integrated approach), 2nd edition, Pearson Publishers, Chennai, India. 4. R.S. Khurmi, A. K. Gupta, "Machine Design", S. Chand & Co, New Delhi, 1st Edition, 2014. 5. PSG College, "Design Data: Data Book of Engineers", 1st Edition, 2012.	

XVI COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1-2	Types of journal bearings	CLO 1	T1:19.1 R1:1.6
3	Basic modes of lubrication	CLO 1	T1:19.5 R1:1.7
4-6	Bearing modulus-full and partial bearings,	CLO 1	T1:19.2 R1:1.6
7-8	Clearance ratio	CLO 2	T1:19.7 R1:4.4
9-10	Heat dissipation in bearing	CLO 3	T1:19.6 R1:4.7

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
11	Bearing materials, Journal bearing design	CLO 4	T1:19.8 R1:4.8
12-13	Types of rolling contact bearings	CLO 5	T1:19.3 R1:5.4
14	Selection of bearing type	CLO 2	T1:19.5 R1:5.8
15	Static and dynamic loading of ball and roller bearings	CLO 6	T219.1 R1:6.8
16	Transmission of power by belt drives	CLO 6	T2:202
17	Construction of rope drives	CLO 7	R1:6.8
18	Transmission efficiencies.	CLO 8	T2:20.
19	Belts-Flat and V belts	CLO 8	R1:6.8
20	Pulleys for belt and rope drives, materials	CLO 9	T2:20.4
21	Design of Chain drives	CLO 10	T2:21.4
22	Thrust in Connecting Rod	CLO 9	T2:28.12 R1:7.5
22-23	Stress due to Whipping action on Connecting rod ends.	CLO 11	T2:28.13 R2:7.5
24-25	Cranks and crankshafts, Strength and proportions of crankshafts	CLO 12	T2:28.14 R1:7.5
26-27	Design of Piston, Forces acting on piston	CLO 12	T2:28.14 R2:7.5
28	Construction design and proportions of piston	CLO 13	T2:28.15 R2:9.4
29	Spur Gear Drives: Design of spur gears	CLO 14	T2:28.17
30	Load concentration factor-dynamic load factor	CLO 15	T2:28.17
31	Surface compressive strength-bending strength	CLO 16	T2:28.18
32-33	Design analysis of spur gear	CLO 17	T2:28.18
34-35	Estimation of center distance, module and face width, check for plastic deformation	CLO 18	T2:28.22
36-37	Check for dynamic and wear considerations	CLO 18	T2:28.24
38	Helical and Bevel Gear Drives: Load concentration factor-dynamic factor	CLO 19	T2:28.25
39-40	Design analysis of Helical and Bevel gear	CLO 20	T2:28.27
41-43	Check considerations for dynamic strength	CLO 18	T2:28.28
44	Design of Worm gears: worm gear- properties of worm gears-selections of materials	CLO 21	T2:28.29 R1:12.3
45	Strength and wear rating of worm gears- force analysis	CLO 22	T2:28.31 R1:12.7
46	Friction in worm gears-thermal considerations	CLO 22	T1:28.29
47-48	Design of power screws : Design of screw	CLO 23	T1:25.1
49-50	Square, ACME, Buttress screws	CLO 24	T1:25.2
51	Design of nut	CLO 25	T1:25.2
52-53	Design of Compound screw	CLO 25	T1:25.3
54	Design of differential screw	CLO 25	T2:25.3
55	ball screw-possible failures	CLO 25	T3:25.3

XVII. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	To improve standards and analyze the concepts.	Seminars	PO 1,PO 2	PSO 1
2	Concepts related to design of combustion chambers	Seminars / NPTEL	PO 2,PO 3	PSO 2
3	Encourage students to solve real time applications and prepare towards competitive examinations.	NPTEL	PO 2,PO 6	PSO 3

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