Course Syllabus
Gyanmanjari Institute of Technology
Semester-5(B. Tech)

Subject: Machine Design-I – BETME15313.

Type of course: Professional Core.

Prerequisite: Solid Mechanics & Kinematics of Machinery.

Rationale: This course equips students with fundamental design and analysis skills for gears, gearboxes, bearings, and IC engine components, essential for power transmission and industrial applications. It covers gear selection, stress analysis (Lewis's formula, AGMA standards), failure modes, and material selection, along with gearbox design, bearing lubrication theories (Petroff's, Reynolds' equations), and load-carrying capacities. Students will also learn IC engine component design, focusing on cylinders, pistons, connecting rods, crankshafts, and valve mechanisms. With a balance of theory and practical applications, the course prepares students for industry-relevant challenges in mechanical system design.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks					Total Marks
				Theory Marks		Practical Marks		CA	
CI	T	P	C	ESE	MSE	V	P	ALA	
4	0	2	5	60	30	10	20	30	150

Legends: CI-Classroom Instructions; T – Tutorial; P - Practical; C – Credit; ESE - End Semester Examination; MSE- Mid Semester Examination; V – Viva; CA - Continuous Assessment; ALA- Active Learning Activities.

Course Content:

Unit No	Course content	Hrs.	% Weightage
1	**Gear Design** Recitation: Classification of gears, Selection of type of gears, Law of Gearing, Gear terminology, Standard system of gear tooth, force analysis, Interference and undercutting, number of teeth, gear tooth failures, selection of material. Spur and Helical Gears: Stress in gear tooth: Lewis formula, AGMA bending stress equation and AGMA pitting resistance formula, Gear quality and selection aspects. Bevel and Worm gears: Specifications and design of bevel and worm gears	15	25
2	**Design of Gear Box** Comparison and Choice of progression (Arithmetic, Geometric, Harmonic and Logarithmic), general design procedure, determination and fixation of spindle speeds, selection of the best structure diagram, selection of gear layout and ray diagram, determination of number of teeth on gears	15	25
3	**Bearings** **Journal Bearings**-Classification of bearings. Journal bearing Types, Lubrication: types of lubrication, Lubricants, Effect of pressure and temperature on viscosity, Stable lubrication, thin and thick film lubrication. Hydrostatic Bearing: Viscous flow through rectangular slot, step bearing, energy losses. Hydrodynamic Bearing: Lubrication theory (Petroff's Equation, Reynolds' Equation), Design of bearings with Raimondi and Boyd method, power and heat generation, bearing materials **Roller Contact Bearings**-Classification, Static load carrying capacity, Strobeck's equation, Dynamic load carrying capacity, Equivalent bearing load, Load-Life relation, Selection of bearing life, Load factor, Selection of bearing from catalogue, Design for cyclic loads and speeds, Bearing with probability of survival other than 90%, Selection of taper roller bearing, Bearing failure, Lubrication of rolling contact bearing	20	30
4	**IC Engine Components** Design of cylinder and Cylinder head, Design of piston, Design of connecting rod, Design of crankshaft and Design of valve-gear mechanism	10	20

Continuous Assessment:

Sr. No	Active Learning Activities	Marks
1	**Design of Engineering components** Design and analyze on a component given by faculty by studying its critical parameters to optimize performance and durability using Microsoft Excel and upload it on the GMIU web portal.	10
2	**Gear Model Creation** Students will create physical models of different gears (spur, helical, bevel, worm) using materials like cardboard, wood, or 3D printing. They will demonstrate meshing and motion transfer between gears and explain their working principles in a short video and upload it on the GMIU web portal.	10
3	**Analysis on IC Engine Design** Faculty will assign different IC Engine configurations (i.e. 110 cc, 125 cc) and students have to prepare a detailed report of their designing parameters in a PDF file and upload it on the GMIU web portal.	10
	Total	30

Suggested Specification table with Marks (Theory):60

Distribution of Theory Marks (Revised Bloom's Taxonomy)						
Level	**Remembrance (R)**	**Understanding (U)**	**Application (A)**	**Analyze (N)**	**Evaluate (E)**	**Create (C)**
Weightage	15 %	20 %	20 %	15 %	15 %	15 %

Course Outcome:

After learning the course, the students should be able to:	
CO1	Analyze gears considering selection and stress.
CO2	Design gearboxes by selecting speed progression, gear layout, and calculating gear teeth.
CO3	Select journal and rolling contact bearings considering lubrication, load capacity, life estimation, and performance factors.
CO4	Understand principles for selecting and analyzing IC engine components

List of Practical:

Sr. No	Descriptions	Unit No	Hrs.
1	**Design of spur gears** Calculate gear tooth dimensions and stresses to design efficient spur gears for power transmission.	1	4
2	**Design of helical gears** Analyze load distribution and bending stresses to design helical gears with improved smoothness and strength.	1	2
3	**Design of bevel gear.** Determine geometry and stresses for bevel gears to enable power transmission between intersecting shafts.	1	2
4	**Design of worm gear.** Design worm gears focusing on speed reduction, torque capacity, and contact stress.	1	2
5	**Aspects of gear selection.** Evaluate gear types based on application, load, speed, and operational requirements to select suitable gears.	1	2
6	**Design of gearbox.** Develop gearbox layouts and calculate gear ratios to meet desired speed and torque specifications.	2	4
7	**Design of journal bearing.** Analyze lubrication, load capacity, and heat dissipation to design reliable journal bearings.	3	4
8	**Selection of rolling contact bearing.** Select rolling bearings by considering load ratings, life expectancy, and operating conditions.	3	4
9	**Gear load life calculation: Fundamentals and Analysis.** Perform life estimation and load analysis to predict gear durability under various operating conditions.	3	2
10	**Design of IC engine components.** Apply mechanical design principles to key engine parts like pistons, connecting rods, and crankshafts for optimal performance.	4	4
		Total	30

Instructional Method:

The course delivery method will depend upon the requirement of content and need of students. The teacher in addition to conventional teaching method by black board, may also use any of tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.

Students will use supplementary resources such as online videos, NPTEL/SWAYAM videos, e-courses, Virtual Laboratory
The internal evaluation will be done on the basis of Active Learning Assignment
Practical/Viva examination will be conducted at the end of semester for evaluation of performance of students in laboratory.

Reference Books:

[1] Machine Design-An Introduction, Norton R. L., Pearson.

[2] Design of Machine Elements, Bhandari V. B., Mc Graw-Hill.

[3] Machine Design Data Book, Bhandari V. B., Mc Graw-Hill.