Ref No:

SRI KRISHNA INSTITUTE OF TECHNOLOGY, BENGALURU

COURSE PLAN

Academic Year 2019-20

Program:	B E – Mechanical Engineering
Semester :	6
Course Code:	17ME64
Course Title:	Design of Machine Elements - 2
Credit / L-T-P:	4 / 3-2-0
Total Contact Hours:	65
Course Plan Author:	Prof. Sreenivasan .A

Academic Evaluation and Monitoring Cell

#29, Hesaraghatta Main road, Chimney Hills, Chikkabanavara P.O.,
Bengaluru – 560090, Karnataka, INDIA
Phone / Fax :+91 80 23721477 -STD- 080 23721315
Web:www.skit.org.in
E-mail: skit1princi@gmail.com / principal@skit.org.in

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Note : Remove “Table of Content” before including in CP Book
Each Course Plan shall be printed and made into a book with cover page
Blooms Level in all sections match with A.2, only if you plan to teach / learn at higher levels

A.17ME64 Design of Machine Elements-2

1. Course Overview

Degree:	BE	Program:	ME
Semester:	6	Academic Year:	2019-20
Course Title:	Design of Machine Elements - 2	Course Code:	17ME64
Credit / L-T-P:	04 /3-2-0	SEE Duration:	180 minutes
Total Contact Hours:	65	SEE Marks:	100Marks
CIA Marks:	40	Assignment	2 / Module
Course Plan Author:	Prof. Sreenivasan .A	Sign ..	Dt::23-01-2020
Checked By:		Sign ..	Dt:
CO Targets	CIA Target : ...... %	SEE Target:	.... %

Note: Define CIA and SEE % targets based on previous performance.

2. Course Content

Content / Syllabus of the course as prescribed by University or designed by institute. Identify 2 concepts per module as in G.

Module	Content	Teaching Hours	Identified Module Concepts	Blooms Learning Levels
1	**Curved Beams:** Stresses in Curved Beams of standard cross sections used in crane hook, punching presses and clamps, Closed rings and Links. **Cylinders & Cylinder Heads:** Review of Lames equation, compound cylinders, stresses due to different types of fit on cylinders, cylinder heads and flats.	10	Stresses in Curved Beams Analysis of Cylinders	L4
2	**Belts:** Materials of construction of flat and V belts, power rating of belts, concept of slip and creep, initial tension, effect of centrifugal tension, maximum power condition. Selection of flat and V belts- length & cross section from manufacturers' catalogues. Construction and application of timing belts. **Wire ropes:** Construction of wire ropes, stresses in wire ropes, and selection of wire ropes. (Only theoretical treatment) **Chain drive:** Types of power transmission chains, modes of failure for chain, and lubrication of chains. (Only theoretical treatment) **Springs:** Types of springs, spring materials, stresses in helical coil springs of circular and non-circular cross sections. Tension and compression springs, concentric springs; springs under fluctuating loads. **Leaf Springs**: Stresses in leaf springs, equalized stresses, and nipping of leaf springs. Introduction to torsion and Belleville springs	14	Power Transmission Springs analysis	L4
3	**Gear drives:** Classification of gears, materials for gears, standard systems of gear tooth, gear failure modes and lubrication of gears. **Spur Gears:** Definitions, stresses in gear tooth: Lewis equation and form factor, design for strength, dynamic load and wear. **Helical Gears:** Definitions, transverse and normal module, formative number of teeth, design based on strength, dynamic load and wear. **Bevel Gears:** Definitions, formative number of teeth, design based on strength, dynamic load and wear.	16	Gear Analysis	L4
4	**Worm Gears:** Definitions, types of worm and worm gears, and materials for worm and worm wheel. Design based on			

	strength, dynamic, wear loads and efficiency of worm gear drives. **Design of Clutches:** Types of clutches and their applications, single plate and multi-plate clutches. (Numerical examples only on single and multi-plate clutches) **Design of Brakes:** Types of Brakes, Block and Band brakes, self locking of brakes, and heat generation in brakes.	15	Analysis of Brakes & Clutches	L4
5	**Lubrication and Bearings:** Lubricants and their properties, bearing materials and properties; mechanisms of lubrication, hydrodynamic lubrication, pressure development in oil film, bearing modulus, coefficient of friction, minimum oil film thickness, heat generated, and heat dissipated. Numerical examples on hydrodynamic journal and thrust bearing design. **Antifriction bearings:** Types of rolling contact bearings and their applications, static and dynamic load carrying capacities, equivalent bearing load, load life relationship; selection of deep grove ball bearings from the manufacturers' catalogue; selection of bearings subjected to cyclic loads and speeds; probability of survival.	10	Hydrodynamic Lubrication Antifriction bearings	L4
-	**Total**	**65**		**-**

3. Course Material

Books & other material as recommended by university (A, B) and additional resources used by course teacher (C).
1. Understanding: Concept simulation / video ; one per concept ; to understand the concepts ; 15 – 30 minutes
2. Design: Simulation and design tools used – software tools used ; Free / open source
3. Research: Recent developments on the concepts – publications in journals; conferences etc.

Modules	Details	Chapters in book	Availability
A	**Text books (Title, Authors, Edition, Publisher, Year.)**	**-**	**-**
1, 2, 3, 4, 5	1. Richard G. Budynas, and J. Keith Nisbett, "Shigley's Mechanical Engineering Design", McGraw-Hill Education, 10 th Edition, 2015.		In Lib
1, 2, 3, 4, 5	2. Juvinall R.C, and Marshek K.M, "Fundamentals of Machine Component Design", John Wiley & Sons, Third Edition, Wiley student edition, 2007.		In Lib
1, 2, 3, 4, 5	3. V. B. Bhandari, "Design of Machine Elements", 4th Ed., Tata Mcgraw Hill, 2016.		In Lib
B	**Reference books (Title, Authors, Edition, Publisher, Year.)**	**-**	**-**
1, 2, 3, 4, 5	1. J.NRobert L. Norton "Machine Design- an integrated approach", Pearson Education, 2 nd edition.		In Lib
1, 2, 3, 4, 5	2.Spotts M.F., Shoup T.E "Design and Machine Elements", Pearson Education, 8 th edition, 2006.		In Lib
1, 2, 3, 4, 5	3. Orthwein W, "Machine Component Design", Jaico Publishing Co, 2003.		In Lib
1, 2, 3, 4, 5	4. Hall, Holowenko, Laughlin (Schaum's Outline Series), "Machine design" adapted by S.K.Somani, Tata McGraw Hill Publishing Company Ltd., Special Indian Edition, 2008.		In Lib
1, 2, 3, 4, 5	5. G. M. Maithra and L.V.Prasad, "Hand book of Mechanical Design", Tata McGraw Hill, 2nd edition,2004.		In Lib
C	**Concept Videos or Simulation for Understanding**	**-**	**-**
C1	http:s//youtu.be/xgiLe-gtObg		
C2	https://youtu.be/1P30w-I5Ttl, https://youtu.be/bAh1yRzrYjs		
C3	https://youtu.be/8bml2pK6Ra0		
C4	https://youtu.be/dl1q6WmXfLU		
C5	https://youtu.be/ohQZMCzeGmE, https://youtu.be/LxTV8CpgmQ		

D	**Software Tools for Design**	**-**	**-**
	Solid Edge		
E	**Recent Developments for Research**	**-**	**-**
F	**Others (Web, Video, Simulation, Notes etc.)**	**-**	**-**
1			
?			

4. Course Prerequisites

Refer to GL01. If prerequisites are not taught earlier, GAP in curriculum needs to be addressed. Include in Remarks and implement in B.5.

Students must have learnt the following Courses / Topics with described Content . . .

Modules	Course Code	Course Name	Topic / Description	Sem	Remarks	Blooms Level
1 to 5	17ME34	Mechanics of Materials	Stresses, Bending moments, Thick and Thin cylinders	3		Understand L2
1 to 5	17ME54	Design of Machine Elements - 1	Basics of Design	5		Understand L2

5. Content for Placement, Profession, HE and GATE

The content is not included in this course, but required to meet industry & profession requirements and help students for Placement, GATE, Higher Education, Entrepreneurship, etc. Identifying Area / Content requires experts consultation in the area.

Topics included are like, a. Advanced Topics, b. Recent Developments, c. Certificate Courses, d. Course Projects, e. New Software Tools, f. GATE Topics, g. NPTEL Videos, h. Swayam videos etc.

Modules	Topic / Description	Area	Remarks	Blooms Level
1	Concepts of Stresses, types of stresses, Bending moment, Design of different mechanical components	Higher Study, GATE & other competetive examinations		Understand L2
3				
3				

B. OBE PARAMETERS

1. Course Outcomes

Expected learning outcomes of the course, which will be mapped to POs. Identify a max of 2 Concepts per Module. Write 1 CO per Concept.

Modules	Course Code.#	Course Outcome **At the end of the course, student should be able to . . .**	Teach. Hours	Concept	Instr Method	Assessment Method	Blooms' Level

1	17ME64.1	Apply design concepts to Analyse curved beams	10	Stresses in Curved Beams	Lecture/ Tutorial	CIA Assignment	Analyze L4
2	17ME64.2	Design Machine elements involving springs, belts and pulleys.s	14	Power Transmission	Lecture/ Tutorial	CIA Assignment	Analyze L4
2	17ME64.3	Design of different types of gears.	16	Power transmission between shafts	Lecture/ Tutorial	CIA Assignment	Analyze L4
4	17ME64.4	Apply design concepts to design brakes and clutches.	15	Analysis of Brakes & Clutches	Lecture/ Tutorial	CIA Assignment	Analyze L4
5	17ME64.5	Design of hydrodynamic bearings and slelection of antifriction bearing for diffeent applications.	10	Hydrodynamic Lubrication	Lecture/ Tutorial	CIA Assignment	Analyze L4
-	-	**Total**	**65**	-	-	-	**L4**

2. Course Applications

Write 1 or 2 applications per CO.
Students should be able to employ / apply the course learnings to . . .

Modules	Application Area Compiled from Module Applications.	CO	Level
1	Crane Hooks, C-Clamps, Punching Presses	CO1	L4
2	Automobiles, Machineries, Railway Wagons, Aircrafts	CO2	L4
3	Automobiles, Machine Tools	CO3	L4
4	Automobiles, Machine Tools	CO4	L4
5	Automobiles, Machineries	CO5	L4

3. Mapping And Justification

CO – PO Mapping with mapping Level along with justification for each CO-PO pair.
To attain competency required (as defined in POs) in a specified area and the knowledge & ability required to accomplish it.

Modules	Mapping		Mapping Level	Justification for each CO-PO pair	Level
-	**CO**	**PO**	-	**'Area': 'Competency' and 'Knowledge' for specified 'Accomplishment'**	-
1	CO1	PO1	-	'Engineering Knowledge:' - Acquisition of Engineering Knowledge of Curved Beams is essential to accomplish solutions to complex engineering problems in Mechanical Engineering.	L2
1	CO1	PO2	-	'Problem Analysis': Analyzing problems require knowledge / understanding of stresses and distribution of stresses in curved beams to accomplish solutions to complex engineering problems in Mechanical Engineering.	L4
1	CO1	PO3	-	'Design / Development of Solutions': Design & development of solutions require knowledge / understanding & analysis of Curved Beams, stress, and stress distribution to accomplish solutions to complex engineering problems in Mechanical Engineering.	L4
2	CO2	PO1		'Engineering Knowledge:' - Acquisition of Engineering Knowledge of Power transmission is essential to accomplish solutions to complex engineering problems in Mechanical Engineering.	L2
2	CO2	PO2		'Problem Analysis': Analyzing problems require knowledge / understanding of power transmission by Belt, Rope, Chain drives to accomplish solutions to complex engineering problems in Mechanical Engineering.	L4
2	CO2	PO3		Design / Development of Solutions': Design & development of solutions	L4

				require knowledge / understanding & analysis of Helical & Leaf Springs to accomplish solutions to complex engineering problems in Mechanical Engineering.	
3	CO3	PO1		'Engineering Knowledge:' - Acquisition of Engineering Knowledge of Gears is essential to accomplish solutions to complex engineering problems in Mechanical Engineering.	L2
3	CO3	PO2		'Problem Analysis': Analyzing problems require knowledge / understanding of power transmission through Spur Gears to accomplish solutions to complex engineering problems in Mechanical Engineering.	L4
3	CO3	PO3		'Design / Development of Solutions': Design & development of solutions require knowledge / understanding & analysis of Spur & Helical Gears to accomplish solutions to complex engineering problems in Mechanical Engineering.	L4
4	CO4	PO1		'Engineering Knowledge:' - Acquisition of Engineering Knowledge of Clutches & Brakes is essential to accomplish solutions to complex engineering problems in Mechanical Engineering.	L2
4	CO4	PO2		'Problem Analysis': Analyzing problems require knowledge / understanding of Clutches & Brakes to accomplish solutions to complex engineering problems in Mechanical Engineering.	L4
4	CO4	PO3		'Design / Development of Solutions': Design & development of solutions require knowledge / understanding & analysis of Clutches & Brakes to accomplish solutions to complex engineering problems in Mechanical Engineering.	L4
5	CO5	PO1		'Engineering Knowledge:' - Acquisition of Engineering Knowledge of Lubrication & Bearings is essential to accomplish solutions to complex engineering problems in Mechanical Engineering.	L2
5	CO5	PO2		'Problem Analysis': Analyzing problems require knowledge / understanding of Lubrication & Bearings to accomplish solutions to complex engineering problems in Mechanical Engineering.	L4
5	CO5	PO3		'Design / Development of Solutions': Design & development of solutions require knowledge / understanding & analysis of Ball & Roller Bearings to accomplish solutions to complex engineering problems in Mechanical Engineering.	L4

4. Articulation Matrix

CO – PO Mapping with mapping level for each CO-PO pair, with course average attainment.

-	-	Course Outcomes	Program Outcomes															-
Modules	CO.#	**At the end of the course student should be able to . . .**	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	Level
1	17ME64.1	Apply design concepts to Analyse curved beams	2	1	1	-	-	-	-	-	-	-	-	-	-	-	-	L4
2	17ME64.2	Design Machine elements involving springs, belts and pulleys.s	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	L4
3	17ME64.3	Design of different types of gears.	3	2	2	-	-	-	-	-	-	-	-	-	-	-	-	L4
4	17ME64.4	Apply design concepts to design brakes and clutches.	3	2	2	-	-	-	-	-	-	-	-	-	-	-	-	L4
5	17ME64.5	Design of hydrodynamic bearings and slelection of antifriction bearing for diffeent applications.	3	3	3	-	-	-	-	-	-	-	-	-	-	-	-	L4
-	**17ME64**	**Average attainment (1, 2, or 3)**	**2.4**	**2.1**	**2.1**													**-**
-																		

5. Curricular Gap and Content

Topics & contents not covered (from A.4), but essential for the course to address POs and PSOs.

Modules	Gap Topic	Actions Planned	Schedule Planned	Resources Person	PO Mapping
1					
2					
3					
4					
5					

6. Content Beyond Syllabus

Topics & contents required (from A.5) not addressed, but help students for Placement, GATE, Higher Education, Entrepreneurship, etc.

Modules	Gap Topic	Area	Actions Planned	Schedule Planned	Resources Person	PO Mapping
1						
1						
2						
2						
3						
3						
4						
4						
5						
5						

C. COURSE ASSESSMENT

1. Course Coverage

Assessment of learning outcomes for Internal and end semester evaluation. Distinct assignment for each student. 1 Assignment per chapter per student. 1 seminar per test per student.

Modules	Title	Teach. Hours	No. of question in Exam						CO	Levels
			CIA-1	CIA-2	CIA-3	Asg	Extra Asg	SEE		
3	Gear Drives, Design of Spur, Helical & Bevel Gears	16	2	-	-	1	1	2	CO3	L4
4	Design of Worm Gears, Brakes & Clutches	15	2	-	-	1	1	2	CO4	L4
5	Lubrication & Bearings, Antifriction Bearings	10	-	2	-	1	1	2	CO5	L4
1	Curved Beams, Cylinder & Cylinder Heads	10	-	2	-	1	1	2	CO1	L4
2	Belt Drives, Rope & Chain drives, Springs	14	-	-	4	1	1	2	CO2	L4
-	**Total**	**65**	**4**	**4**	**4**	**5**	**5**	**10**	**-**	**-**

2. Continuous Internal Assessment (CIA)

Assessment of learning outcomes for Internal exams. Blooms Level in last column shall match with A.2.

Modules	Evaluation	Weightage in Marks	CO	Levels

1, 2	CIA Exam – 1	30	CO3, CO4	L4, L4
3, 4	CIA Exam – 2	30	CO5, CO1	L4, L4
5	CIA Exam – 3	30	CO2	L4
1, 2	Assignment - 1	10	CO3, CO4	L4, L4
3, 4	Assignment - 2	10	CO5, CO1	L4, L4
5	Assignment - 3	10	CO2	L4
1, 2	Seminar - 1			
3, 4	Seminar - 2			
5	Seminar - 3			
1, 2	Other Activities – define – Slip test			
3, 4	**Final CIA Marks**	**40**	**-**	**-**
5	Quiz - 3		-	-
1 - 5	Other Activities – Mini Project	-	-	-
	Final CIA Marks	**40**	**-**	**-**

D1. TEACHING PLAN - 1

Module - 3

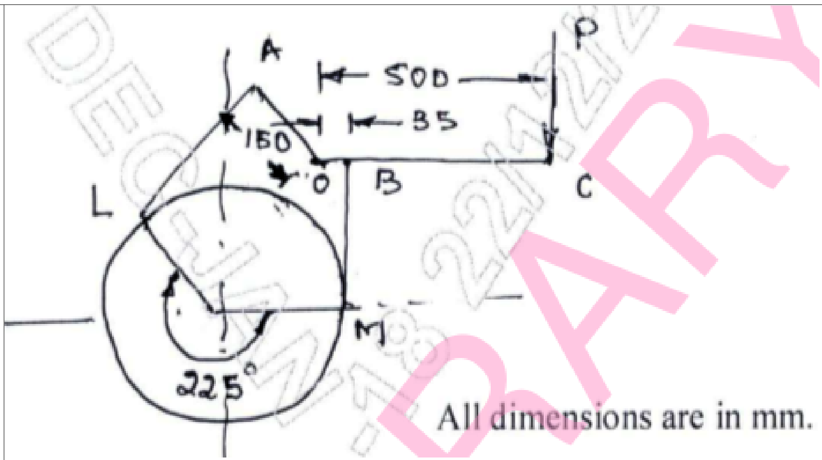
Title:	Gear Drives, Design of Spur, Helical & Bevel Gears	Appr Time:	14 Hrs
a	***Course Outcomes***	**CO**	**Blooms**
-	At the end of the topic the student should be able to . . .	-	**Level**
1	Design of different types of gears.	CO3	L4
b	***Course Schedule***	-	-
Class No	**Portion covered per hour**	**-**	**-**
1	Gear Drives: Introduction to Subject, Module, course objectives and outcomes,	CO3	L2
2	Classification of gears, materials for gears, standard systems of gear tooth,	CO3	L2
3	Spur Gears: Definitions, stresses in gear tooth:	CO3	L2
4	Design for strength, dynamic load and wear load. Procedure for Gear design.		
5	Design of Spur Gears	CO3	L4
6	Design of Spur Gears	CO3	L4
7	Design of Spur Gears	CO3	L4
8	Design of Spur Gears	CO3	L4
9	Helical Gears: Definitions, transverse and normal module, formative number of teeth, design based on strength, dynamic load and wear.	CO3	L2
10	Design of Helical Gears	CO3	L4
11	Design of Helical Gears	CO3	L4
12	Design of Helical Gears	CO3	L4
13	Bevel Gears: Definitions, formative number of teeth, design based on strength, dynamic load and wear.	CO3	L2
14	Design of Bevel Gears	CO3	L4
15	Design of Bevel Gears	CO3	L4
16	Design of Bevel Gears		
c	**Application Areas**	**-**	**-**

-	Students should be able employ / apply the Module learnings to . . .	-	-
1	Automobiles, Machine Tools	CO3	L4
d	**Review Questions**	-	-
-	The attainment of the module learning assessed through following questions	-	-
1	Derive an equation for Beram strength of a Spur Gear tooth.	CO3	L2
2	Discuss the used materials for gears	CO3	L2
3	Design a pair of spur gears to transmit 20 kW from a shaft rotating at 1000 rpm to a parallel shaft which is to rotate at 310 rpm. Assume number of teeth on pinion 31 and 20˚ full depth tooth form.	CO3	L4
4	A 12 kw motor running at 1170rpm drives a fan through a pair of spur gears (Forged steel SAE 1030 pinion & CI gear) with a reduction ratio of 3.9:1. Design the gear and check for dynamic & wear loads.	CO3	L4
5	It is required to transmit 15 KW power from a shaft running at 1200 rpm to a parallel shaft with speed reduction of 3. The centre distance of shafts is to be 300 mm. The material used for pinion is steel (ad = 200 MPa) and for gear is CI (ad =140 MPa) . Service factor is 1.25 and tooth profile is 20˚ full depth involute. Design the spur gear and check the design for dynamic and wear.	CO3	L4
6	Design a pair of spur gear to transmit a power of 18 kW from a shaft running at 1000 rpm to a parallel shaft to be run at 250 rpm maintaining a distance of 160 mm between the shaft centres. Suggest suitable surface hardness for the gear pair.	CO3	L4
7	Explain virtual number of teeth and derive the equation for virtual number of teeth for Helical gears.	CO3	L2
8	A pair of steel helical gear is to transmit 15 kW at 5000 rpm of the pinion both the gears are made of the same material, hardened steel with allowable bending stress of 120 MPa. The gears are to be operated at a centre distance of 200 mm, speed reduction ration is 4:1. The teeth are 20˚ FDI profile on transverse plane (diameter plane), helix angle is 45˚. The gears are manufactured to class-3 accuracy (precision class). Face width can be taken as 16 times the normal module. The wear strength has to be more than the dynamic load.	CO3	L4
9	Design a pair of helical gears to transmit power of 15 kW at 3200 rpm with speed reduction 4 : 1 pinion is made of cast steel 0.4% C-untreated. Gear made of high grade CI Helix angle is limited to 26˚ and not less than 20 teeth are to be used on either gear. Check the gears for dynamic and wear considerations.	CO3	L4
10	Design a pair of bevel gears to connect two shafts at 60 ˚ . The power transmitted is 25 kW at 900 rpm of pinion. The reduction ratio desired is 5:1. The teeth are 20 ˚ full depth involute and pinion has 24 teeth. Check the design for dynamic and wear considerations.	CO3	L4
11	A Pair of straight bevel gears are used to transmit 15kw at 1500rpm input speed. The number of teeth on pinion is 20 and the speed ratio is 5. Design the gears for strength only assuming 14 i˚ full depth form.	CO3	L4
12	Design a pair of bevel gears to transmit a power of 25 kW from a shaft rotating at 1200 rpm to a perpendicular shaft to be rotated at 400rpm.	CO3	L4
e	**Experiences**	-	-
1			
2			
3			

Module – 4

Title:	Worm Gears, Clutches & Bakes	Appr Time:	7 Hrs
a	***Course Outcomes***	**CO**	**Blooms**
-	At the end of the topic the student should be able to . . .	-	**Level**
1	Apply design concepts to design brakes and clutches	CO4	L4
b	***Course Schedule***	-	-
Class No	**Portion covered per hour**	**-**	**-**
17	Introduction to Worm Gears, Terminology, procedure for design of Worm Gears	CO4	L2
18	Design of Worm Gears	CO4	L4
19	Design of Worm Gears	CO4	L4
20	Design of Worm Gears	CO4	L4
21	Design of Worm Gears	CO4	L4
22	Introduction to Brakes, Types of Brakes, Numericals on Simple Band brakes.	CO4	L2
23	Design of Simple Bank brakes	CO4	L4
24	Design of Simple Band brakes	CO4	L4
25	Design of Differential band brakes	CO4	L4
26	Design of differential band brakes	CO4	L4
27	Introduction to Clutches, types of clutches, numericals on Single plate clutch	CO4	L2
28	Design of single plate clutches	CO4	L4
29	Design of single plate clutches	CO4	L4
30	Design of single plate clutches		
31	Design of Multiplate clutches		
c	**Application Areas**	**-**	**-**
-	Students should be able employ / apply the Module learnings to . . .	-	-
1	Automobiles, Machine Tools	CO4	L4
d	**Review Questions**	-	-
-	The attainment of the module learning assessed through following questions	-	-
1	Design a worn gear reducer unit which consists of a hardened steel worm and a phosphor bronze gear having 20˚ stub involute teeth. The centre distance is to be 200 mm and the transmission ratio is 10 and the worm speed is 2000 rpm. Assume the temperature of gear and ambient temperature as 65˚ and 25˚ respectively.	CO4	L4
2	A two teeth right hand worm transmits 2kW at 1500rpm to a 36 teeth wheel. The module of the wheel is 5mm and the pitch diameter of the worm is 60mm. The normal pressure angle is 14.5˚. The coefficient of friction is found to be 0.06. i) Find the centre distance, the lead and lead angle. ii) Determine the forces. iii) Determine the efficiency of the drive.	CO4	L4
3	Design a worm gear drive to transmit a power of 2kW at 1000 rpm. The speed ratio is 20 and centre distance is 200mm. Assume the number of teeth on worm wheel to be 40 and - number of starts on worm to be 2. Assume hardened steel worm and phosphor bronze wheel for which ac, = 55 N/mm 2 . Check the gear from stand point of strength and wear if load stress factor, K = 0.69 MPa. If the amount of Heat generated is 1.7 kW, check whether artificial cooling arrangement is necessary or not for a temperature rise of 40˚ K	CO4	L4
4	A two teeth right hand worm transmits 2 kW at 1500 rpm to a 36 teeth wheel. The module of the wheel is 5 mm and the pitch diameter of the worm is 60 mm. The pressure angle is 14.5˚. The co-efficient of friction is found to be 0.06. I) Find the centre distance, the lead and the lead angle. ii) Determine the forces.	CO4	L4
5	The following data refer to a worm and worm gear drive:	CO4	L4

	i) centre distance = 200 mm ii) pitch circle diameter of the worm = 80 mm iii) Number of start = 4 iv) Axial module = 8 mm v) transmission ratio = 20 vi) the worm gear is made of phosphor bronze with an allowable bending stress = 55 MPa vii) the worm is made of hardened and ground steel viii) tooth form is 20° full depth involute. Determine i) Number of teeth on the worm gear ii) lead angle iii) face width of worm gear to 15 kW of power at 1750 rpm of the worm based on beam strength of the worm gear.		
6	Complete the design and determine the input capacity of worm gear speed reducer unit which consists of hardened steel worm and phosphor bronze gear having 20° stub involute teeth. The centre distance is to be 200 mm and transmission ratio is 10, speed of the worm is 2000 rpm.	CO4	L5
7	A multiplate clutch consists of 5 steel and 4 bronze plates. The inner and outer diameters of friction discs are 75mm and 150mm respectively. The coefficient of friction is 0.1 and allowable pressure is to be limited to 0.3 MPa. Assuming uniform pressure. Calculate: i) The required axial force. ii) Power that can be transmitted at 750 rpm.	CO4	L4
8	A multiple clutch with steel and bronze is to transmit 8kW at 1440rpm. The inner diameter of the contact is 80mm and the outer diameter of contact is 140mm. The clutch plate operates in oil with expected coefficient of friction of 0.1 and allowable pressure of 0.35MPa. Assume uniform wear theory. Determine the number of steel and bronze plates, axial force required, average pressure, actual maximum pressure.	CO4	L4
9	A simple band broke of drum diameter 600mm has a band passing over it with an angle of contact of 225°, while one end is connected to the fulcrum, the other end is connected to the brake lever at a distance of 400mm from the fulcrum. The brake lever is 1 m long. The brake is to absorb a power of 15 KW at 720rpm. Design the brake lever of rectangular cross-section, assuming depth to the thrice the width. Take allowable stress 80 MPa.	CO4	L4
10	A simple band brake of drum diameter 600 mm has a band passing over it with an angle of contact of 225°, while one end is connected to the fulcrum, the other end is connected to the brake lever at a distance of 400 mm from the fulcrum. The brake lever is 1 m long. The brake is to absorb a power of 15 kW at 720 rpm. Design the brake lever of rectangular cross section assuming depth to be thrice the width. Take allowable stress 80 MPa.	CO4	L4
11	A plate clutch with a maximum diameter of 600 mm has maximum lining pressure of 0.35 MPa. The power to be transmitted at 400 rpm is 135 kW and 0.3. Find inside diameter and spring force required to engage the clutch, if the spring with spring index 6 and material of spring the wire diameter if 6 springs are used.	CO4	L4
12	In a multiple disc clutch the radial width of the friction material is to be 0.2 of maximum radius. The co-efficient of friction is 0.25. The clutch is to transmit 60 KW at 3000 rpm. Its maximum diameter is 250 mm and the axial force is limited to 600 N. Determine i) number of driving and driven discs ii) mean unit pressure on each contact surface. Assume uniform wear.	CO4	L4
13	A differential band brake as shown in Fig.Q6(b), has an angle of contact of 225°. The band has a compressed woven lining and bears against a CI drum of 350 mm diameter. The brake is to sustain a torque of 350 N-m and the coefficient of friction between the band and the drum is 0.3. Find: (i) The necessary force, F for the clockwise and anticlockwise rotation of the drum and (ii) The value of "OA" for the brake to be self locking, when the drum rotates clockwise.	CO4	L4

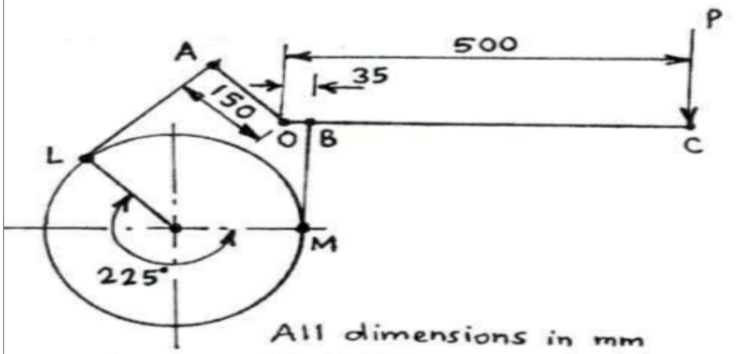
			
14	The torque absorbed in the band break shown in Fig. Q6 (b) is 400 x10' Nmm. Design the band and lever taking cof= 0.27 and diameter of drum as 400 mm. The allowable stress in band may be taken as 70 N/mm'.	CO4	L4
15	A band break arrangement is shown in Fig.Q6(b). It is used to generate a maximum braking torque of 200 N-m. Determine the actuating force 'P', if the coefficient of friction is 0.25. The angle of wrap of the band is 270°. Determine the maximum intensity of pressure, if the band width is 30 mm.	CO4	L4
e	**Experiences**	-	-
1			
2			
3			
4			
5			

E1. CIA EXAM – 1

a. Model Question Paper -1

Crs Code:	17ME64	Sem:	VI	Marks:	30	Time:	75 minutes
Course:	Design of Machine Elements - 2						

-	-	Note: Answer all questions, each carry equal marks. Module : 1, 2	Marks	CO	Level
1		Design a pair of Spur Gears to transmit 20kW of power while operating for 8 to 10 hrs/day sustaining medium shock, from a shaft rotating at 1000rpm to a parallel shaft which is to rotate at 310rpm. Assume the number of teeth on pinion to be 31 and 20° full depth involute tooth profile. The material for pinion is C40 steel, untreated whose σ_o =206.81N/mm² and for the gear is Cast steel, 0.2%C, untreated whose σ_o =137.34 N/mm². Check the design for Dynamic load if load factor, C=522.464 N/mm and also for wear load taking load stress factor, K=0.279 N/mm². Suggest suitable hardness.	15	CO3	L4
		OR			
2		Design a Helical gear pair to transmit a power of 15kW from a shaft rotating at 1000rpm to another shaft to run at 160rpm. Assume involute profile with a pressure angle of 20°. The material for pinion is forged steel SAE1030 whose σ_o = 172.375MPa and the material for the gear is cast steel 0.20%C untreated with σ_o =137.34 Mpa. The gears operate under a condition of medium shocks for a period of 10hrs/day. Check for dynamic load, if load factor C=580N/mm. and also for wear load.	15	CO3	L4
3	a	A simple band brake of drum diameter 600mm has a band passing over it with an angle of contact of 225°, while one end is connected to the fulcrum, the other end is connected to the brake lever at a distance of	08	CO4	L4

		300mm from the fulcrum. The brake lever is 1 m long. The brake is to absorb a power of 15 KW at 720rpm. Design the brake lever of rectangular cross-section, assuming depth to the thrice the width. Take allowable stress 80 MPa.			
	b	A multiplate clutch consists of 5 steel and 4 bronze plates. The inner and outer diameters of friction discs are 75mm and 150mm respectively. The coefficient of friction is 0.1 and allowable pressure is to be limited to 0.3 MPa. Assuming uniform wear, Calculate: i) The required axial force. ii) Power that can be transmitted at 750 rpm.	07	CO4	L4
		OR			
4		A differential band brake as shown in Fig.Q.2(a), has an angle of contact of 225 The band has a compressed woven lining and bears against a cast iron drum of 350mm diameter. The brake is to sustain a torque of 350 N.m. and the co-efficient of friction between the band and the drum is 0.3. Find: i) The necessary force, P for the clockwise and anticlockwise rotation of the drum and ii) The value of `0A' for the brake to be self locking, when the drum rotates clockwise.  Fig.Q.2(a)	8	CO4	L4
		A Single plate friction clutch of both sides effective has 0.3 m outer diameter and 0.16 m inside diameter. The co-efficient of friction is 0.2 and it runs at 1000 rpm. Find the power transmitted for uniform wear and uniform pressure distribution cases if the allowable maximum pressure is 0.08 MPa.	7	CO4	L4

b. Assignment -1

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions							
Crs Code:	17ME64	Sem:	VI	Marks:	10	Time:	90 – 120 minutes
Course:	DESIGN OF MACHINE ELEMENTS -2				Module : 3, 2		

Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.

SNo	USN	Assignment Description	Marks	CO	Level
1		A 12 kw motor running at 1170rpm drives a fan through a pair of spur gears (Forged steel SAE 1030 pinion & CI gear) with a reduction ratio of 3.9:1. Design the gear and check for dynamic & wear loads.	10	CO3	L4
2		It is required to transmit 15 KW power from a shaft running at 1200 rpm to a parallel shaft with speed reduction of 3. The centre distance of shafts is to be 300 mm. The material used for pinion is steel (ad = 200 MPa) and for gear is CI (ad =140 MPa) . Service factor is 1.25 and tooth profile is 20° full depth involute. Design the spur gear and check the design for dynamic and wear.	10	CO3	L4
3		Design a pair of helical gears to transmit power of 15 kW at 3200 rpm with speed reduction 4 : 1 pinion is made of cast steel 0.4% C-untreated. Gear made of high grade CI Helix angle is limited to 26° and not less than 20 teeth are to be used on either gear. Check the gears for dynamic and	10	CO3	L4

		wear considerations.			
4		Design a pair of bevel gears to connect two shafts at 60 ˚ . The power transmitted is 25 kW at 900 rpm of pinion. The reduction ratio desired is 5:1. The teeth are 20 ˚ full depth involute and pinion has 24 teeth. Check the design for dynamic and wear considerations.	10	CO3	L4
5		Design a worn gear reducer unit which consists of a hardened steel worm and a phosphor bronze gear having 20˚ stub involute teeth. The centre distance is to be 200 mm and the transmission ratio is 10 and the worm speed is 2000 rpm. Assume the temperature of gear and ambient temperature as 65˚ and 25˚ respectively.	10	CO4	L4
6		A two teeth right hand worm transmits 2kW at 1500rpm to a 36 teeth wheel. The module of the wheel is 5mm and the pitch diameter of the worm is 60mm. The normal pressure angle is 14.5˚. The coefficient of friction is found to be 0.06. i) Find the centre distance, the lead and lead angle. ii) Determine the forces. iii) Determine the efficiency of the drive.	10	CO4	L4
7		A simple band broke of drum diameter 600mm has a band passing over it with an angle of contact of 225˚, while one end is connected to the fulcrum, the other end is connected to the brake lever at a distance of 400mm from the fulcrum. The brake lever is 1 m long. The brake is to absorb a power of 15 KW at 720rpm. Design the brake lever of rectangular cross-section, assuming depth to the thrice the width. Take allowable stress 80 MPa.	10	CO4	L4
8		A simple band brake of drum diameter 600 mm has a band passing over it with an angle of contact of 225˚, while one end is connected to the fulcrum, the other end is connected to the brake lever at a distance of 400 mm from the fulcrum. The brake lever is 1 m long. The brake is to absorb a power of 15 kW at 720 rpm. Design the brake lever of rectangular cross section assuming depth to be thrice the width. Take allowable stress 80 MPa.	10	CO4	L4
9		A multiplate clutch consists of 5 steel and 4 bronze plates. The inner and outer diameters of friction discs are 75mm and 150mm respectively. The coefficient of friction is 0.1 and allowable pressure is to be limited to 0.3 MPa. Assuming uniform pressure. Calculate: i) The required axial force. ii) Power that can be transmitted at 750 rpm.	10	CO4	L4
10		A plate clutch with a maximum diameter of 600 mm has maximum lining pressure of 0.35 MPa. The power to be transmitted at 400 rpm is 135 kW and 0.3. Find inside diameter and spring force required to engage the clutch, if the spring with spring index 6 and material of spring the wire diameter if 6 springs are used.	10	CO4	L4
11					
12					
13					
14					
15					

D2. TEACHING PLAN - 2

Module – 5

Title:	Lubrication & Bearings	Appr Time:	12 Hrs
a	***Course Outcomes***	**CO**	**Blooms**
-	At the end of the topic the student should be able to . . .	-	**Level**
1	Design of hydrodynamic bearings and slelection of antifriction bearing for diffeent applications	CO5	L4
b	***Course Schedule***		
Class No	**Portion covered per hour**	**-**	**-**
32	Introduction to Bearings, Types of bearing, Antifriction bearings, Advantagees and disadvantages of antifriction bearing over sliding contact bearings.	CO5	L2
33	Static loading capacity, Dynamic loading capacity, Equivalent load, Procedure for selection of ball bearing, Numericals on selection of ball bearings.	CO5	L4
34	Numericals on selection of ball bearings.	CO5	L4
35	Numericals on selection of ball bearings.	CO5	L4
36	Introduction to lubrication, lubricants, types of lubricants, properties of a good lubricant, types of bearings. Hydrodynamic and hydrostatic journal bearings.	CO5	L2
37	Introduction to lightly loaded bearings, mechanism of pressure in an hydrodynamic lubricated bearing, Petroffs equation.	CO5	L2
38	Numericals on lightly loaded bearings.	CO5	L4
39	Bearing modulus, coeficient of friction, summerfelds number, heat generated and heat dissipatated in journal bearings.	CO5	L4
40	Numericals on hydrodynamic journal bearings.	CO5	L4
41	Numericals on hydrodynamic journal bearings.	CO5	L4
c	**Application Areas**	**CO5**	**-**
-	Students should be able employ / apply the Module learnings to . . .	CO5	-
1	Engines, Machineries	CO5	L4
2	Automobiles.	CO5	L4
d	**Review Questions**	-	-
-	The attainment of the module learning assessed through following questions	-	-
2	Explain I) Static load capacity ii) Dynamic load capacity and iii) Life of ball bearing.	CO5	L2
3	Enumerate the advantages and disadvantages of rolling contact bearing over sliding contact bearings.	CO5	L2
4	Select a deep groove ball bearing required for a shaft of diameter 50mm to withstand a radial load of 5kN and a thrust load of 2 kN at a speed of 900rpm. The bearing works for 40hrs per week for 2.5 years.	CO5	L4
5	A single row deep groove ball bearing is subjected to a radial force of 7kN and thrust force of 2.2kN. The shaft rotates at 1200rpm. The expected life of the bearing is 20000hrs. The diameter of the shaft is 75mm. Select a suitable ball bearing for this application. Take X=0.56 and Y=1.8.	CO5	L4
6	Select a deep groove ball bearing required for a shaft diamete of 45mm to withstand a radial load of 6kN and a thrust load of 3kN at a speed of 300rpm. The beaing works for 8hrs a day for 3 years.	CO5	L4
7	Select a suitable ball bearing to carry a radial load of 3.5kN and a thrust load of 3kN at 1750rpm. The bearing will be used for 8hrs a day, 6days a week for 5 years.	CO5	L4
8	Definr hydrodynamic lubrication. Explain the principle of hydrodnamic lubrication.	CO5	L4
9	Derive Petroffs equation for coefficient of friction in lightly loaded journal bearing.	CO5	L4
10	A lightly loaded journal bearing is to support a radial load of 1kN. The diameter	CO5	L4

	of the shaft is 50mm and length of the bearing is 60mm. The oil used as the lubricant is SAE 30 at 70oC. Determine the coefficient of friction and power loss in the bearing if the speed is 750rpm and the diametral clearance is 0,001.		
11	A lightly loaded journal bearing has the following specifications. Journal dia = 70mm, Bearing length = 55mm, Diametral clearance = 0.01mm, Speed = 22000rpm, Radial load = 1kN. The power loss in the bearing is found to be 3.5KW. Determine I) Voscosity of oil ii) Coefficient of friction at operating conditions.	CO5	L4
12	A lightly loaded full journal bearing has the following specifications. Bearing doa = 80mm, Bearing Length =60mm, Diametral clearance = 0.12mm, Jolurnal speed = 24000rpm, Voscosity of the lubricating oil = 4CP, Radial load = 900rpm. Determine Frictional force, Torque, Power loss, Coefficient of friction.	CO5	L4
13	Design the main bearing of a steam turbine running at 1800rpm. The diameter of journal is 40mm. The load on the journal is 3kN. Operating temperature of oil film is 60oC	CO5	L4
14	A 75mm long full journal bearing of diameter 75mm supports a load of 12kN on a journal rotating at 1800rpm. Assuming ratio of 1000 and an oil having viscosity 0.01N-s/m2 at the operating te,petrature, detemine the coeficient of friction by using I) Mckee equation ii) Raimondi and Boyd curve iii) also determine the amount of heat generated using the c o f as calculated by Mckee equation.	CO5	L4
15	A 75mm long full journal bearing of diameter 75mm supportgs a radial load of 12kN at a shaft speed of 1800rpm. The diametral clearance ratio is 0.001. The viscosity of oil is 0.01PaS. Detemine Sommerfelds number, Coefficient of friction, Amount of heat generated, minimum oil film thickness and quantity of oil flow through the bearing.	CO5	L4
e	**Experiences**	-	-
1			
2			
3			

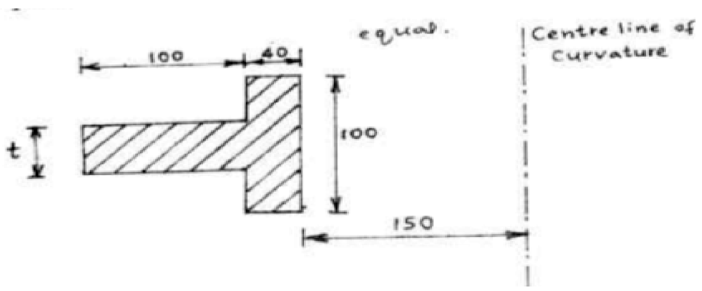
Module – 1

Title:	Curved Beams, Cylinder & cylinder heads	Appr Time:	13 Hrs
a	***Course Outcomes***	**CO**	**Blooms**
-	At the end of the topic the student should be able to . . .	-	**Level**
1	Apply design concepts to Analyse curved beams	CO1	L4
b	***Course Schedule***		
Class No	**Portion covered per hour**	**-**	**-**
42	Introduction to Curved beams, Applications, stress in curved beams, difference between straight and curved beams	CO1	L3
43	Numericals on curved beams	CO1	L4
44	Numericals on curved beams	CO1	L4
45	Numericals on curved beams	CO1	L4
46	Numericals on curved beams	CO1	L4
47	Introduction to Cylinders and Cylinder heads, Lames equation.	CO1	L2
48	Numericals on Cylinders and compound cylinders	CO1	L4
49	Numericals on Cylinders and compound cylinders	CO1	L4
50	Streses due to different types of fits on cylinders, Numericals	CO1	L4
51	Numericals on different types of fits on cylinders	CO1	L4
c	**Application Areas**	**-**	**-**
-	Students should be able employ / apply the Module learnings to . . .	-	-
1	C Clamps, Machines, Crane hooks	CO1	L4
d	**Review Questions**	-	-

-	The attainment of the module learning assessed through following questions	-	-
1	Give the differences between a straight and curved beams.	CO1	L2
2	Compute the combined stresses at the inner and outer fibres in the critical cross section of a crane hook which is required to lift load upto 25 kN. The hook has trapezoidal cross section with parallel sides 60mm and 30mm, the distance between them being 90mm. The inner radius of the hook is 100mm. The load line is nearer to the inner surface of the hook by 25mm than the centre of curvature at the critical section. What will be the stresses at inner and outer fibre, if the beam is treated as straight beam for the given load?	CO1	L4
3	A Crane hook of trapezoidal cross-section with an inner side of 120mm and outer side of 60mm. The depth of the section is 90mm. The centre of curvature is at a distance of 120mm from the inner edge of the section and the line of action of load is at a distance of 135mm from the inner edge. Determine the safe load that the hook can carry if it is made of steel having an allowable stress of 90 MPa.	CO1	L4
4	Determine the value of 't' in the cross section of a curved machine member shown in Fig. Q 1(a), so that the normal stresses due to bending at extreme fibers are numerically equal. Also determine the normal stresses so induced at extreme fibers due to a bending moment of 10 KN — m.	CO1	L4
5	The cross section of a steel crane hook is a trapezium with an inner side of 50 mm and outer side of 25 mm. The depth of the section is 64 mm. The centre of curvature of the section is at a distance of 64 mm from the inner edge of the section and the line of action of load is 50 mm from the same edge. Determine the maximum load hook can carry if the allowable strength is limited to 60 MPa.	CO1	L4
6	A cast iron cylinder of internal diameter 200 mm and thickness 50 mm is subjected to a pressure of 5 N/mm'. Calculate the tangential and radial stresses at the inner, middle and outer surface.	CO1	L4
7	A cast iron cylindrical pipe of outside diameter — 300 mm and inside diameter 200 mm is subjected to an internal pressure of 20 N/mm2 and external fluid pressure of 5 N/inm2. Determine the tangential and radial stresses at the inner, middle and outer surface. Sketch the tangential and radial distribution across its thickness.	CO1	L4
8	A cylinder is provided with a heat of flat circular steel plate of 500 mm diameter and is supported around the edge. It is subjected to a uniform pressure of 5 N/mm2. The allowable working stress for the material is 70 N/mm2 and Poisson's ratio is 0.3. Determine the i) Thickness of thick cylinder wall and ii) Thickness of the circular flat cylinder head.	CO1	L4
9	A circular plate made of steel and of diameter 200 mm with thickness 10 mm is subjected to a load inducing a pressure of 4 MPa. Taking E = 201 kN /mm2, Poisson's ratio = 0.3, determine : i) The maximum stress, its location and maximum deflection when the edges of the plate are supported ii) The maximum stress, its location and maximum deflection when the edge of the plate is fi ed.	CO1	L4
10	A tube, with 50mm and 75mm inner and outer diameters respectively is reinforced by shrinking a jacket of outer diameter 100mm. The compound tube has to withstand an internal pressure of 35Mpa. Calculate the shrinkage allowance such that the maximum tangential stress in each tube has same magnitude. Also calculate the shrinkage pressure and show the distribution of tangential stresses. Assume E = 207 kN/mm 2.	CO1	L4
e	**Experiences**	-	-
1			
2			

E2. CIA EXAM – 2

a. Model Question Paper - 2

Crs Code:	15ME64	Sem:	VII	Marks:	30	Time:	75 minutes	
Course:	DESIGN OF MACHINE ELEMENTS-2							
-	-	**Note: Answer all questions, each carry equal marks. Module : 3, 4**				**Marks**	**CO**	**Level**
1	a	Derive Petroff's equation for coefficient of friction for a lightly loaded bearing.				5	CO5	L2
	b	Select a deep groove ball bearing required for a shaft diameter of 50mm to withstand a radial load of 5kN and a thrust load of 2kN at a speed of 900rpm. The bearing works for 40hrs/ week and for 2.5 years.				10	CO5	L4
		OR						
2	a	A lightly loaded journal bearing is to support a radial load of 1kN. The diameter of the shaft is 50mm and length of the bearing is 60mm. The oil used as the lubricant is SAE 30 at 70oC. Determine the coefficient of friction and power loss in the bearing if the speed is 750rpm and the diametral clearance is 0,001.				8	CO5	L4
	b	A 75mm long full journal bearing of diameter 75mm supports a load of 12kN on a journal rotating at 1800rpm. Assuming ratio of 1000 and an oil having viscosity 0.01N-s/m2 at the operating te,petrature, detemine the coeficient of friction by using I) Mckee equation ii) Raimondi and Boyd curve iii) also determine the amount of heat generated using the c o f as calculated by Mckee equation.				7	CO5	L4
3	a	Differenciate between a straight beam and curved beam.				4	CO1	L2
	b	Determine the value of stem thickness 't' in the T — cross section of a curved beam shown in Fig.Q.1(b) such that the normal stresses due to bending at the extreme inner and outer fibres are numerically equal. 				11	CO1	L4
		OR						
		Compute the combined stresses at the inner and outer fibres in the critical cross section of a crane hook which is required to lift loads upto 25 kN. The hook has trapezoidal cross section with parallel sides 60 mm and 30 min, the distance between them being 90 mm. The inner radius of the hook is 100 mm. The load line is nearer to the inner surface of the hook by 25 mm than the centre of curvature at the critical section.				15	CO1	L4

b. Assignment – 2

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions								
Crs Code:	17ME64	Sem:	VI	Marks:	5	Time:	90 – 120 minutes	
Course:	DESIGN OF MACHINE ELEMENTS-2			Module :5, 1				
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.								
SNo	**USN**	**Assignment Description**				**Marks**	**CO**	**Level**
1		A single row deep groove ball bearing is subjected to a radial				10	CO5	L4

		force of 7kN and thrust force of 2.2kN. The shaft rotates at 1200rpm. The expected life of the bearing is 20000hrs. The diameter of the shaft is 75mm. Select a suitable ball bearing for this application. Take X=0.56 and Y=1.8.			
2		A lightly loaded full journal bearing has the following specifications. Bearing doa = 80mm, Bearing Length =60mm, Diametral clearance = 0.12mm, Jolurnal speed = 24000rpm, Voscosity of the lubricating oil = 4CP, Radial load = 900rpm. Determine Frictional force, Torque, Power loss, Coefficient of friction.	10	CO5	L4
3		Design the main bearing of a steam turbine running at 1800rpm. The diameter of journal is 40mm. The load on the journal is 3kN. Operating temperature of oil film is 60oC	10	CO5	L4
4		A 75mm long full journal bearing of diameter 75mm supports a load of 12kN on a journal rotating at 1800rpm. Assuming ratio of 1000 and an oil having viscosity 0.01N-s/m2 at the operating te,petrature, detemine the coeficient of friction by using I) Mckee equation ii) Raimondi and Boyd curve iii) also determine the amount of heat generated using the c o f as calculated by Mckee equation.	10	CO5	L4
5		Crane hook of trapezoidal cross-section with an inner side of 120mm and outer side of 60mm. The depth of the section is 90mm. The centre of curvature is at a distance of 120mm from the inner edge of the section and the line of action of load is at a distance of 135mm from the inner edge. Determine the safe load that the hook can carry if it is made of steel having an allowable stress of 90 MPa.	10	CO1	L4
6		A cast iron cylindrical pipe of outside diameter — 300 mm and inside diameter 200 mm is subjected to an internal pressure of 20 N/mm2 and external fluid pressure of 5 N/inm2. Determine the tangential and radial stresses at the inner, middle and outer surface. Sketch the tangential and radial distribution across its thickness.	10	CO1	L4
7					
8					
9					
10					

D3. TEACHING PLAN - 3

Module – 3

Title:	Belt Drives, Rope & Chain drives, Springs	Appr Time:	10 Hrs
a	***Course Outcomes***	**CO**	**Blooms**
-	At the end of the topic the student should be able to . . .	-	**Level**
1	Design Machine elements involving springs, belts and pulleys.	CO2	L4
b	***Course Schedule***	-	-
Class No	**Portion covered per hour**	**-**	**-**

52	Introduction to springs, Types of springs, Spring materials, stresses & deflection in helical springs of circular section.	CO2	L2
53	Numericals on circular Helical springs	CO2	L4
54	Numericals on circular Helical springs	CO2	L4
55	Introduction to noncircular helical springs, numericals	CO2	L4
56	Numericals on non circular helical springs	CO2	L4
57	Numericlas on concentric helical springs.	CO2	L4
58	Introduction to lea springs, Stresses and deflection in leaf springs	CO2	L4
59	Construction of Semielliptical leaf springs, numericals	CO2	L4
60	Numericals n semiellipctical leaf springs.	CO2	L4
61	Introduction to belt drives, flat belt drives	CO2	L4
62	Numericals on flat belt drives	CO2	L4
63	Numericals on flat belt drives	CO2	L4
64	Introduction to v belt drives, procedure for design	CO2	L4
65	Numericals on design of v belt drives	CO2	L4
c	**Application Areas**	**-**	**-**
-	Students should be able employ / apply the Module learnings to . . .	-	-
1	Floor Mills, Machineries, Automobiles	CO2	L4
d	**Review Questions**	-	-
-		-	-
1	Derive an expression for stress and deflection induced in an helical spring.	CO2	L2
2	Design a helical compression spring for a service load ranging from 2250N to 2750N. The axial deflection of the spring for the load range is 6mm. Assume a spring index of 5, permissible shear stress of 420 MPa and modulus of rigidity of 84N/mm.	CO2	L4
3	Helical compression spring i s subjected to 1960 N force, as to deflect by 50 mm. Under this load the outside diameter is not to exceed 70 mm and inside diameter not less than 20 mm. Take allowable shear stress is 430 MPa, spring index is 6. Design the spring.	CO2	L4
4	A multi leaf spring with camber is fitted to the chassis of an automobile over a span of 1.2m to absorb shocks due to a max load of 20 kN. The spring material can sustain a max. Stress of 0.4 GPa. All the leaves of the spring were to receive the same stress. The spring is required at least 2 full length leaves out of 8 leaves. The leaves were assembled with bolts over a span of 150mm width at the middle. Design the spring for a max. deflection of 50mm	CO2	L4
5	Design a valve spring of a petrol engine for the following operating conditions. Spring load when the valve is open — 400N Spring load when the valve is closed — 250N Maximum inside dia of spring — 25mm Length of spring when the valve is open — 40mm Length of spring when the valve is closed — 50rrun Maximum permissible stress = 400MPa	CO2	L4
6	A truck spring has 12 leaves, two of which are full length leaves. The spring supports are 1.05m apart and the central band is 85mm wide. The central load is 5.4 kN and the permissible stress in spring material is 280 MPa. If the ratio of total depth to width of the spring is 3, determine the thickness & width of the spring leaves and also the deflection of the spring.	CO2	L4
7	Two shafts l meter apart are connected by a v-belt to transmit 90 KW at 1200 rpm of a driver pulley of 300mm effective diameter. The driven pulley rotates at 400 rpm. The angle of groove is 40° and the coefficient of friction between the belt and the pulley rim 0.25. The area of the belt section is 400mm2 and the permissible stress is 2.1 MPa. Density of the belt material is 1100 kg/m3 . Calculate the number of belts required and the length of the belt.	CO2	L4
8	Select a v-belt drive to transmit 9 kW from a shaft rotating at 1200rpm to a	CO2	L2

	parallel shaft to run at 300rpm. The diameter of smaller pulley is 120mm. The centre distance between shafts is 1.2m.		
9	A nylon core flat belt 200 mm wide weighing 20 N/m, connecting a 300mm diameter pulley to a 900 mm diameter driven pulley at a shaft spacing of 6 m, transmits 55.2 kW at a belt speed of 25 m/sec i) calculate the belt length and the angles of wrap ii) compute the belt tensions based on a co-efficient of friction 0.38.	CO2	L4
10	Two shafts one metre apart are connected by a V — belt to transmit 90 kW at 1200 rpm of a driver pulley of 300 mm effective diameter. The driven pulley rotates at 400 rpm. The angle of groove is 40° and the co-efficient of friction between the belt and the pulley rim is 0.25. The area of the belt section is 400 mm2 and the permissible stress is 2.1 MPa. Density of belt material is 1100 kg/m3. Calculate the number of belts required and the length of the belt.	CO2	L4
e	**Experiences**	-	-
1			
2			
3			
4			
5			

E3. CIA EXAM – 3

a. Model Question Paper - 3

Crs Code:	15ME64	Sem:	VI	Marks:	30	Time:	75 minutes
Course:	DESIGN OF MACHINE ELEMENTS-2						

-	-	Note: Answer all questions, each carry equal marks. Module:1	Marks	CO	Level
1	a	Derive an expression for stress and deflection induced in an helical spring.	5	CO2	L2
	b	Design a helical compression spring for a service load ranging from 2250N to 2750N. The axial deflection of the spring for the load range is 6mm. Assume a spring index of 5, permissible shear stress of 420 MPa and modulus of rigidity of 84N/mm.	10	CO2	L4
2	a	Derive an expressions for stress and deflectionin leaf springs	5	CO2	L2
	b	Two shafts l meter apart are connected by a v-belt to transmit 90 KW at 1200 rpm of a driver pulley of 300mm effective diameter. The driven pulley rotates at 400 rpm. The angle of groove is 40° and the coefficient of friction between the belt and the pulley rim 0.25. The area of the belt section is 400mm2 and the permissible stress is 2.1 MPa. Density of the belt material is 1100 kg/m3 . Calculate the number of belts required and the length of the belt.	10	CO2	L4
3	a	A railway wagon weighing 40 kN and moving with a speed of 10 km/hour has to be stopped by four buffer springs in which the maximum compression allowed is 200 mm. Find the number of	7	CO4	L4

		turns in each spring of mean diameter 150 mm. The diameter of spring wire is 25 mm. Take G = 82.7Gpa.			
	b	Select a V-belt drive to transmit 9 kW from a shaft rotating at 1200rpm to a parallel shaft to run at 300rpm. The diameter of smaller pulley is 120mm. The centre distance between shafts is 1.2m.	8	CO3	L4
		OR			
4	a	Select a V-belt drive to transmit 18 KW at 1500 rpm to another pulley to run at 750 rpm.	8	CO3	L4
	b	A multi leaf spring with camber is fitted to the chassis of an automobile over a span of 1.2m to absorb shocks due to a max load of 20 kN. The spring material can sustain a max. Stress of 0.4 GPa. All the leaves of the spring were to receive the same stress. The spring is required at least 2 full length leaves out of 8 leaves. The leaves were assembled with bolts over a span of 150mm width at the middle. Design the spring for a max. deflection of 50mm.	7	CO4	L4

b. Assignment – 3

Note: A distinct assignment to be assigned to each student.

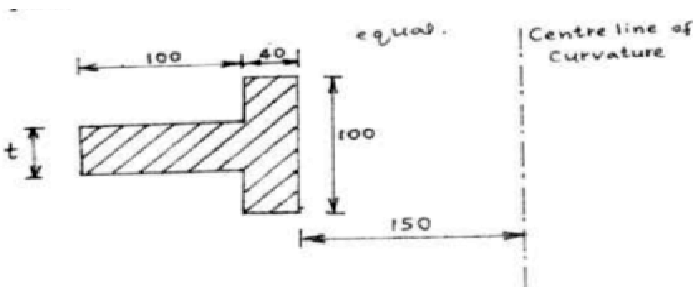
Model Assignment Questions							
Crs Code:	17ME64	Sem:	VI	Marks:	5	Time:	90 – 120 minutes
Course:	DESIGN OF MACHINE ELEMENTS-2				Module : 5		
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.							

SNo	USN	Assignment Description	Marks	CO	Level
1		Design a helical compression spring for a service load ranging from 2250N to 2750N. The axial deflection of the spring for the load range is 6mm. Assume a spring index of 5, permissible shear stress of 420 MPa and modulus of rigidity of 84N/mm.	10	CO2	L4
2		Helical compression spring i s subjected to 1960 N force, as to deflect by 50 mm. Under this load the outside diameter is not to exceed 70 mm and inside diameter not less than 20 mm. Take allowable shear stress is 430 MPa, spring index is 6. Design the spring.	10	CO2	L4
3		A multi leaf spring with camber is fitted to the chassis of an automobile over a span of 1.2m to absorb shocks due to a max load of 20 kN. The spring material can sustain a max. Stress of 0.4 GPa. All the leaves of the spring were to receive the same stress. The spring is required at least 2 full length leaves out of 8 leaves. The leaves were assembled with bolts over a span of 150mm width at the middle. Design the spring for a max. deflection of 50mm	10	CO2	L4
4		Select a v-belt drive to transmit 9 kW from a shaft rotating at 1200rpm to a parallel shaft to run at 300rpm. The diameter of smaller pulley is 120mm. The centre distance between shafts is 1.2m.	10	CO2	L4
5		A nylon core flat belt 200 mm wide weighing 20 N/m, connecting a 300mm diameter pulley to a 900 mm diameter driven pulley at a shaft spacing of 6 m, transmits 55.2 kW at a belt speed of 25 m/sec i) calculate the belt length and the angles of wrap ii) compute the belt tensions based on a co-efficient of friction 0.38.	10	CO2	L4
6					
7					
8					
9					

F. EXAM PREPARATION

1. University Model Question Paper

Course:	DESIGN OF MACHINE ELEMENTS-2					Month / Year	July / 2020
Crs Code:	17ME64	Sem:	VI	Marks:	100	Time:	180 minutes

Module	Note	Answer all FIVE full questions. All questions carry equal marks.	Marks	CO	Level
1	a	Differenciate between a straight beam and curved beam.	5	CO1	L2
	b	Compute the combined stresses at the inner and outer fibres in the critical cross section of a crane hook which is required to lift load upto 25 kN. The hook has trapezoidal cross section with parallel sides 60mm and 30mm, the distance between them being 90mm. The inner radius of the hook is 100mm. The load line is nearer to the inner surface of the hook by 25mm than the centre of curvature at the critical section. What will be the stresses at inner and outer fibre, if the beam is treated as straight beam for the given load?	15	CO1	L4
		OR			
2	a	Determine the value of stem thickness 't' in the T — cross section of a curved beam shown in Fig.Q.1(b) such that the normal stresses due to bending at the extreme inner and outer fibres are numerically equal. 	12	CO1	L4
	b	A cast iron cylinder of internal diameter 200 mm and thickness 50 mm is subjected to a pressure of 5 N/mm'. Calculate the tangential and radial stresses at the inner, middle and outer surface.	8	CO1	L4
3	a	Derive an expression for stress and deflection induced in an helical spring.	5	CO2	L2
	b	wo shafts l meter apart are connected by a v-belt to transmit 90 KW at 1200 rpm of a driver pulley of 300mm effective diameter. The driven pulley rotates at 400 rpm. The angle of groove is 40° and the coefficient of friction between the belt and the pulley rim 0.25. The area of the belt section is 400mm2 and the permissible stress is 2.1 MPa. Density of the belt material is 1100 kg/m3 . Calculate the number of belts required and the length of the belt.	15	CO2	L4
		OR			
4	a	Select a V-belt drive to transmit 18 KW at 1500 rpm to another pulley to run at 750 rpm.	10	CO3	L4
	b	A multi leaf spring with camber is fitted to the chassis of an automobile over a span of 1.2m to absorb shocks due to a max load of 20 kN. The spring material can sustain a max. Stress of 0.4 GPa. All the leaves of the spring were to receive the same stress. The spring is required at least 2 full length leaves out of 8 leaves. The leaves were assembled with bolts over a span of 150mm width at the middle. Design the spring for a max. deflection of 50mm.	10	CO4	L4
5		Design a pair of Spur Gears to transmit 20kW of power while	15	CO3	L4

		operating for 8 to 10 hrs/day sustaining medium shock, from a shaft rotating at 1000rpm to a parallel shaft which is to rotate at 310rpm. Assume the number of teeth on pinion to be 31 and 20° full depth involute tooth profile. The material for pinion is C40 steel, untreated whose σ_o =206.81N/mm² and for the gear is Cast steel, 0.2%C, untreated whose σ_o =137.34 N/mm². Check the design for Dynamic load if load factor, C=522.464 N/mm and also for wear load taking load stress factor, K=0.279 N/mm². Suggest suitable hardness.			
		OR			
6		Design a Helical gear pair to transmit a power of 15kW from a shaft rotating at 1000rpm to another shaft to run at 160rpm. Assume involute profile with a pressure angle of 20°. The material for pinion is forged steel SAE1030 whose σ_o = 172.375MPa and the material for the gear is cast steel 0.20%C untreated with σ_o =137.34 Mpa. The gears operate under a condition of medium shocks for a period of 10hrs/day. Check for dynamic load, if load factor C=580N/mm. and also for wear load.	15	CO3	L4
7		Design a worm gear drive to transmit a power of 2kW at 1000 rpm. The speed ratio is 20 and centre distance is 200mm. Assume the number of teeth on worm wheel to be 40 and - number of starts on worm to be 2. Assume hardened steel worm and phosphor bronze wheel for which ac, = 55 N/mm 2 . Check the gear from stand point of strength and wear if load stress factor, K = 0.69 MPa. If the amount of Heat generated is 1.7 kW, check whether artificial cooling arrangement is necessary or not for a temperature rise of 40° K	20	CO4	L4
		OR			
8	a	A simple band brake of drum diameter 600mm has a band passing over it with an angle of contact of 225°, while one end is connected to the fulcrum, the other end is connected to the brake lever at a distance of 300mm from the fulcrum. The brake lever is 1 m long. The brake is to absorb a power of 15 KW at 720rpm. Design the brake lever of rectangular cross-section, assuming depth to the thrice the width. Take allowable stress 80 MPa.	10	CO4	L4
	b	A multiplate clutch consists of 5 steel and 4 bronze plates. The inner and outer diameters of friction discs are 75mm and 150mm respectively. The coefficient of friction is 0.1 and allowable pressure is to be limited to 0.3 MPa. Assuming uniform wear, Calculate: i) The required axial force. ii) Power that can be transmitted at 750 rpm.	10	CO4	L4
9	a	Derive Petroff's equation for coefficient of friction for a lightly loaded bearing.	5	CO5	L2
	b	Select a deep groove ball bearing required for a shaft diameter of 50mm to withstand a radial load of 5kN and a thrust load of 2kN at a speed of 900rpm. The bearing works for 40hrs/ week and for 2.5 years.	10	CO5	L4
		OR			
10	a	A lightly loaded journal bearing is to support a radial load of 1kN. The diameter of the shaft is 50mm and length of the bearing is 60mm. The oil used as the lubricant is SAE 30 at 70oC. Determine the coefficient of friction and power loss in the bearing if the speed is 750rpm and the diametral clearance is 0,001.	8	CO5	L4

	b	A 75mm long full journal bearing of diameter 75mm supports a load of 12kN on a journal rotating at 1800rpm. Assuming ratio of 1000 and an oil having viscosity 0.01N-s/m2 at the operating te,petrature, detemine the coeficient of friction by using I) Mckee equation ii) Raimondi and Boyd curve iii) also determine the amount of heat generated using the c o f as calculated by Mckee equation.	7	CO5	L4

2. SEE Important Questions

Course:	DESIGN OF MACHINE ELEMENTS-2					Month / Year	May /2020
Crs Code:	17ME64	Sem:	6	Marks:	100	Time:	180 minutes

	Note	Answer all FIVE full questions. All questions carry equal marks.	-	-	
Module	Qno.	Important Question	**Marks**	**CO**	**Year**
1		Compute the combined stresses at the inner and outer fibres in the critical cross section of a crane hook which is required to lift load upto 25 kN. The hook has trapezoidal cross section with parallel sides 60mm and 30mm, the distance between them being 90mm. The inner radius of the hook is 100mm. The load line is nearer to the inner surface of the hook by 25mm than the centre of curvature at the critical section. What will be the stresses at inner and outer fibre.	20	CO1	2017
		OR			
2	a	Differenciate between a straight beam and curved beam.	06	CO1	2017
	b	A cast iron cylindrical pipe of outside diameter 300 mm and inside diameter 200 mm is subjected to an internal fluid pressure of 20 N/mm2 and external fluid pressure of 5 N/mm2. Determine the tangential and radial stresses at the inner, middle and outer surface. Sketch the tangential and radial stress distribution across its thickness	14	CO1	2015
3	a	Two shafts l meter apart are connected by a v-belt to transmit 90 KW at 1200 rpm of a driver pulley of 300mm effective diameter. The driven pulley rotates at 400 rpm. The angle of groove is 40° and the coefficient of friction between the belt and the pulley rim 0.25. The area of the belt section is 400mm2 and the permissible stress is 2.1 MPa. Density of the belt material is 1100 kg/m3 . Calculate the number of belts required and the length of the belt	10	CO2	2012
	b	A Railway Wsagon weighing 50kN and moving with a speed of 8 km/hr has to be stopped by four buffer springs in which the maximum compression allowed is 220 mm. Find the number of turns or coils in each spring of mean diameter 150mm. The diameter of spring wire is 25 mm. Take G = 84 GPa. Also find the shear stress.	10	CO2	2015
		OR			
4	a	A multi leaf spring with camber is fitted to the chassis of an automobile over a span of 1.2 m to absorb shocks due to a maximum load of 20 kN. The spring material can sustain a maximum stress of 0.4 GPa. All the leaves of the spring were to receive the same stress. The spring is required at least 2 full length leaves out of 8 leaves. The leaves are assembled with bolts over a span of 150 mm width at the middle. Design the spring for a maximum deflection of 50 mm.	10	CO2	2015
	b	Select a v-belt drive to transmit 9 kW from a shaft rotating at 1200rpm to a parallel shaft to run at 300rpm. The diameter of smaller pulley is 120mm. The centre distance between shafts is 1.2m.	10	CO4	2012
5		Design a pair of spur gears to transmit a power of 18 kW from a shaft running at 1000rpm to a parallel shaft to be run at 250 rpm maintaining a distance of 160mm between the shaft centers. Suggest suitable surface hardness for the gear pair.	20	CO3	2017
		OR			

6		Design a pair of bevel gears to connect two shafts at 60 ° . The power transmitted is 25 kW at 900 rpm of pinion. The reduction ratio desired is 5:1. The teeth are 20 ° full depth involute and pinion has 24 teeth. Check the design for dynamic and wear considerations.	20	CO3	
7	a	Under what circumstances the bevel gears are used. Give a detailed classification of Bevel gears.	05	CO4	2018
	b	Design a worn gear reducer unit which consists of a hardened steel worn and a phosphor bronze gear having 20° stub involute teeth. The centre distance is to be 200 mm and the transmission ratio is 10 and the worn speed is 2000 rpm. Assuming the temperature of gear and ambient temperature as 65° and 25° respectively.	15	CO4	2018
		OR			
8	a	A simple band broke of drum diameter 600mm has a band passing over it with an angle of contact of 225°, while one end is connected to the fulcrum, the other end is connected to the brake lever at a distance of 400mm from the fulcrum. The brake lever is 1 m long. The brake is to absorb a power of 15 KW at 720rpm. Design the brake lever of rectangular cross-section, assuming depth to the thrice the width. Take allowable stress 80 MPa.	10	CO4	
	b	In a multiple disc clutch, the radial width of the friction material is to be 0.2 of the maximum radius. The coefficient of friction is 0.250. The clutch is to transmit 60 kW at 3000 rpm. Its maximum diameter is 250 mm and the axial force is limited to 600 N. Determine i) Number of driving and driven discs ii) Mean unit pressure on each contact surface. Assume uniform wear.	10	CO4	2013
9	a	Derive the Petroffs equation for a lightly loaded journal bearing	05	CO5	2018
	b	A bearing for an axial flow compressor is to carry a radial load of 4905 N and thrust load of 2452 N. The service imposes light shock and the bearing is used for 40 hr/week for 5 years. The speed of shaft is 300 rpm and diameter of shaft is 60 mm. Select a suitable bearing	15	CO5	2018
		OR			
10	a	A lightly loaded full journal bearing has the following specifications. Bearing doa = 80mm, Bearing Length =60mm, Diametral clearance = 0.12mm, Jolurnal speed = 24000rpm, Voscosity of the lubricating oil = 4CP, Radial load = 900rpm. Determine Frictional force, Torque, Power loss, Coefficient of friction.	10	CO5	2012
	b	single row deep groove ball bearing is subjected to a radial force of 7kN and thrust force of 2.2kN. The shaft rotates at 1200rpm. The expected life of the bearing is 20000hrs. The diameter of the shaft is 75mm. Select a suitable ball bearing for this application. Take X=0.56 and Y=1.8.	10	CO5	

G. Content to Course Outcomes

1. TLPA Parameters

Table 1: TLPA – Example Course

Module-#	Course Content or Syllabus (Split module content into 2 parts which have similar concepts)	Content Teaching Hours	Blooms' Learning Levels for Content	Final Blooms' Level	Identified Action Verbs for Learning	Instruction Methods for Learning	Assessment Methods to Measure Learning
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*
1	**Curved Beams:** Stresses in Curved Beams of standard cross sections used in crane hook, punching presses and clamps, Closed rings and Links. **Cylinders & Cylinder Heads:** Review of	10	- L2 - L4	L4	Compute	- Lecture - Tutorial -	- Assignment - -

	Lames equation, compound cylinders, stresses due to different types of fit on cylinders, cylinder heads and flats.						
2	**Belts:** Materials of construction of flat and V belts, power rating of belts, concept of slip and creep, initial tension, effect of centrifugal tension, maximum power condition. Selection of flat and V belts- length & cross section from manufacturers' catalogues. Construction and application of timing belts. **Wire ropes:** Construction of wire ropes, stresses in wire ropes, and selection of wire ropes. (Only theoretical treatment) **Chain drive:** Types of power transmission chains, modes of failure for chain, and lubrication of chains. (Only theoretical treatment) **Springs:** Types of springs, spring materials, stresses in helical coil springs of circular and non-circular cross sections. Tension and compression springs, concentric springs; springs under fluctuating loads. **Leaf Springs**: Stresses in leaf springs, equalized stresses, and nipping of leaf springs. Introduction to torsion and Belleville springs	14	- L2 - L4	L4	Compute	- Lecture -	- Assignment -
3	**Gear drives:** Classification of gears, materials for gears, standard systems of gear tooth, gear failure modes and lubrication of gears. **Spur Gears:** Definitions, stresses in gear tooth: Lewis equation and form factor, design for strength, dynamic load and wear. **Helical Gears:** Definitions, transverse and normal module, formative number of teeth, design based on strength, dynamic load and wear. **Bevel Gears:** Definitions, formative number of teeth, design based on strength, dynamic load and wear.	16	- L2 - L4	L4	Compute	- Lecture -	- Assignment
4	**Worm Gears:** Definitions, types of worm and worm gears, and materials for worm and worm wheel. Design based on strength, dynamic, wear loads and efficiency of worm gear drives. **Design of Clutches:** Types of clutches and their applications, single plate and multi-plate clutches. (Numerical examples only on single and multi-plate clutches) **Design of Brakes:** Types of Brakes, Block and Band brakes, self locking of brakes, and heat generation in brakes.	15	- L2 - L5	L4	Design	- Lecture - Tutorial -	- Assignment - -
5	**Lubrication and Bearings:** Lubricants and their properties, bearing materials and properties; mechanisms of lubrication, hydrodynamic lubrication, pressure development in oil film, bearing modulus, coefficient of friction, minimum oil film thickness, heat generated, and heat dissipated. Numerical examples on hydrodynamic journal and thrust bearing	10	- L2 - L4	L4	Compute	- Lecture - -	- Assignment - -

	design. **Antifriction bearings:** Types of rolling contact bearings and their applications, static and dynamic load carrying capacities, equivalent bearing load, load life relationship; selection of deep grove ball bearings from the manufacturers' catalogue; selection of bearings subjected to cyclic loads and speeds; probability of survival.						

2. Concepts and Outcomes:

Table 2: Concept to Outcome – Example Course

Module-#	Learning or Outcome from study of the Content or Syllabus	Identified Concepts from Content	Final Concept	Concept Justification (What all Learning Happened from the study of Content / Syllabus. A short word for learning or outcome)	CO Components (1.Action Verb, 2.Knowledge, 3.Condition / Methodology, 4.Benchmark)	Course Outcome **Student Should be able to ...**
A	*I*	*J*	*K*	*L*	*M*	*N*
	Curved Beams: Cylinders & Cylinder Heads:	- - - -	Stresses analysis in curved beams	Analysysing the stresses induced in curved beams	- Understand - stresses at inner & outer fibres - - - -	Understand the stresses induced in curved beams due to eccentric loads A
2	**Belts:**. **Wire ropes:** **Chain drive:** **Springs:** **Leaf Springs**:	- - - -	Design Machine elements involving springs, belts and pulleys.	Implement proper type of power transmission Understand the concepts of springs	- Analyze - forces on power drives - - - Understand - types of springs and stresses in springs - -	Analyze the forces on power drives and select them. Understand the applications of springs and select them.
	Gear drives: **Spur Gears** **Helical Gears:** **Bevel Gears:**	- - - -	Design of different types of gears.	Have knowledge of Gear drives Understand power transmission in inclined shafts	- Understand - Types of Gear drives - Apply - Design Bevel geasrs - -	Understand parallel and inclined teeth on gears and their applications Selection of Bevel Gears
	Worm Gear: **Design of Clutches:** **Design of Brakes:**	- - - -	Apply design concepts to design brakes and clutches.	Power transmission between perpendicular shafts Examine the field of use of clutches and brakes	- Apply concepts of gear in power transmission - - - Analyze types of clutch & brake in power transmission	Describe the use of Worm gear drives Analyze clutches & brake in power transmission
	Lubrication and Bearings: Antifriction bearings:	- -	Design of hydrodynamic bearings and	Explain the theory of lubrication Compare the advantages and	- Understand - analyse of bearings - Understand	Explain the working of bearings in different applications

			slelection of antifriction bearing for diffeent applications.	disadvantages of using antifriction bearings	- and use antifriction bearing for specific applications	Compare and selection of antifriction bearings.