Ref No:

SRI KRISHNA INSTITUTE OF TECHNOLOGY, BENGALURU

COURSE PLAN

Academic Year 2019-20

Program:	B E – Mechanical Engineering
Semester :	5
Course Code:	17ME54
Course Title:	Design of Machine Elements -1
Credit / L-T-P:	4 / 3-2-0
Total Contact Hours:	65
Course Plan Author:	Mr. Sreenivasan A

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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

17ME54: Design of Machine Elements -1

A. COURSE INFORMATION

1. Course Overview

Degree:	BE	Program:	ME
Semester:	5	Academic Year:	2019-20
Course Title:	Design of Machine Elements -1	Course Code:	17ME54

Credit / L-T-P:	4 / 3-2-0	SEE Duration:	180 Minutes
Total Contact Hours:	65	SEE Marks:	60 Marks
CIA Marks:	40	Assignment	1 / Module
Course Plan Author:	Sreenivasan .A	Sign.	Dt:23-07-2019
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	**Fundamentals of Mechanical Engineering Design** Mechanical Engineering Design, Phases of Design. Engineering Materials and their Mech. Properties. Standards & Codes. Factor of Safety. Material selection. Static stresses: Static loads, Normal, Bending, shear and combined stresses.	5	Design Process, Stress analysis	L2
	Stress concentration & Stress concentration factor.	7	Analysis with Stress Concentration Factor	L4
2	**Design for Impact and Fatigue Loads** Impact Stress due to Axial, Bending and Torsional Loads.	5	Impact analysis	L4
	Fatigue failure: Endurance limit, S – N diagram, low cycle fatigue, high cycle fatigue, size factor surface effect, stress concentration effects. Fluctuating stresses, Goodman & Soderbergs relationship, stresses due to combined loading	7	Fatigue Analysis	L4
3	**Design of Shafts, Joints, Couplings and Keys** Design of shafts for strength & rigidity with steady loading. ASME codes for power transmission shafts under combined loads.	8	Power transmission Shafting	L4
	Design of keys, square, feather keys, Cotter & Knuckle joints, Couplings	6	Coupling & joints Analysis	L4
4	**Riveted Joints and Weld Joints** Rivets types, materials. Failure of riveted joints, joints efficiency. Boiler joints, Lozenze joints. Rivetted brackets, eccentrically loaded joints.	7	Analysis of Boiler Joints	L4
	Welded joints, strength of butt and fillet welds, welded brackets with transverse & parallel fillet welds, Eccentrically loaded welded joints	6	Analysis of Welded Joints	L4
5	**Threaded Fasteners and Power Screws** Stresses in threaded fasteners, Effect of initial tension. Design of threaded fasteners under static loads. Design of eccentrically loaded bolted joints.	6	Analysis of Threaded Fasteners	L4
	Types of power screws, Efficiency & Self locking Design of power screws. Design of Screw Jack. (Complete Design)	7	Analysis of Power screws	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.)**	-	-

1-5	Design of Machine Elements. V.B Bhandari, Tata McGraw Hill Publishing Company Ltd., New Delhi. 2Nd Edition 2007		In Lib / In Dept
1-5	Mechanical Engineering Design. Joseph E Shigley and Charles R. Mischke. McGraw Hill International Edition. 6Th Edition. 2009.		In Lib/ In dept
B	**Reference books (Title, Authors, Edition, Publisher, Year.)**	-	-
1-5	Machine Design. Robert L. Norton. Pearson Education Asia. 2001		In Lib
1-5	Engineering Design. George E Dieter, Linda C Scgmidt, Mcgraw Hill Education. Indian Edition. 2013		Not Available
1-5	Design of Machine Elements – I. Dr. M.H Annaiah. Dr. C N Chandrappa. Dr. J suresh Kumar. New AgeI nternational Publishers.		In lib
1-5	Design Data Hand Book. K. Lingaiah. Mcgraw Hill, 2nd Edition		In Lib, In Dept
1-5	Design Data Hand Book. K. Mahadevan and Balaveera Reddy, CBS Publication		In Lib, In Dept
C	**Concept Videos or Simulation for Understanding**	-	-
C1			
C2	https://www.youtube.com/watch?v=XhtM8tGheM		
C3	https://www.youtube.com/watch?v=Leq__wyYXdw		
C4	https://www.youtube.com/watch?v=0_gpDSjaHh4		
C5	https://www.youtube.com/watch?v=tnkX4WUi99k		
C6	https://www.youtube.com/watch?v=iSR9wgob6pk		
C7	https://www.youtube.com/watch?v=vqQIm_yN3wE		
C8	https://www.youtube.com/watch?v=U7lkHvTcV4U		
C9			
C10	https://www.youtube.com/watch?v=lt1KrTKFKvY		
D	**Software Tools for Design**	-	-
	Solid Edge		
	Ansys		
E	**Recent Developments for Research**	-	-
F	**Others (Web, Video, Simulation, Notes etc.)**	-	-
	https://www.youtube.com/watch?v=XhtM8tGheM		

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	15ME34	Mechanics of Materials	1. Knowledge on stress, strain, Theories of failures, Bending moment.	3		L3
-						
-						

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				
3				
3				
5				
-				
-				

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	17ME54.1	Understand Mechanical Engineering Design, Materials, material selection, Standards & Codes, Determine stresses induced in members subjected to simple and combined static loads	07	Design Process & stresses analysis	Lecture	Unit Test CIA	L4 Analyse
1	17ME54.2	Analyse Stress concentration and SCF.	05	Analysis with Stress concentration factor	Lecture and Tutorial	Assignment Unit Test CIA	L4 Analyze
2	17ME54.3	Analyse the members under Impact (axial, Bending & Torsional) loads).	05	Impact Analysis	Lecture and Tutorial	Assignment Unit Test CIA	L4 Analyze
2	17ME54.4	Design the components subjected to simple and combined Fatigue loading	07	Fatigue Analysis	Lecture and Tutorial	Assignment Unit Test CIA	L4 Analyze
3	17ME54.5	Design the shafts subjected to combined loading and select standard diameter for the shafts.	08	Power transmission Shafting	Lecture and Tutorial	Assignment Unit Test CIA	L4 Analyze
3	17ME54.6	Design of Keys, rigid and flexible coupling for transmitting torque and power. Design of Joints	07	Analysis of Coupling	Lecture and Tutorial	Assignment Unit Test CIA	L4 Analyze
4	15ME54.7	Analyse Boiler joints and design lap & butt rivetted boiler joints. Design of structural joints.	07	Boiler joint analysis	Lecture and Tutorial	Assignment Unit Test CIA	L4 Analyze
4	15ME54.8	Analyse welded joints and design parallel, transverse and eccentrically loaded welded joints.	06	Analysis of welded joints	Lecture and Tutorial	Assignment Unit Test CIA	L4 Analyze
5	15ME54.9	Design threaded fasteners and eccentrically loaded bolted joints	06	Threaded fasteners analysis	Lecture and Tutorial	Assignment Unit Test CIA	L4 Analyze
5	15ME54.10	Analyse power screws and design Screw	07	Analysis of	Lecture	Assignmen	L4

		Jack (Complete Design)		Power screws	and Tutorial	t Unit Test CIA	Analyze
-	**-**	**Total**	**65**	-	**-**	**-**	**L2-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	Bars, Brackets	CO1	L4
1	Plates, Shafts	CO2	L4
2	Forging Components, Blanking Machines	CO3	L4
2	Springs, Shafts	CO4	L4
3	Shafts in Automobiles & Machinery	CO5	L4
3	Motor & Pump, Turbine & Generator	CO6	L4
4	Boilers, Storage tanks, Bridges	CO7	L4
4	Frames, Brackets	CO8	L4
5	Bolts & Nuts	CO9	L4
5	Screw Jack	CO10	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	3	'Engineering Knowledge:' - Acquisition of Engineering Knowledge of Design, Material Selection, Stress is essential to accomplish solutions to Engineering problems subjected to combined loads in Mechanical Engineering.	L4
1	CO1	PO2	3	'Problem Analysis': Analyzing problems require knowledge / understanding of combined loads to accomplish solutions to members subjected to combined static loads.	L4
1	CO1	PO3	3	'Design / Development of Solutions': Design & development of solutions require knowledge / understanding & analysis of simple, combined static loads to accomplish solutions to complex engineering problems in Mechanical Engineering.	L4
1	CO2	PO1	3	'Engineering Knowledge:' - Acquisition of Engineering Knowledge of Stress concentration is essential to accomplish solutions to Engineering problems with machine elements having stress concentration in Mechanical Engineering.	L4
1	CO2	PO2	2	'Problem Analysis': Analyzing problems require knowledge / understanding of stress concentration to accomplish solutions to members with change in cross section & discontinuties.	L4
1	CO2	PO3	2	'Design / Development of Solutions': Design & development of solutions require knowledge / understanding & analysis of members with stress concentration to accomplish solutions to complex engineering problems in Mechanical Engineering.	L$
2	CO3	PO1	2	'Engineering Knowledge:' - Acquisition of Engineering Knowledge of Impact, Impact Stress is essential to accomplish solutions to Engineering problems subjected to impact loads in Mechanical Engineering.	L4
2	CO3	PO2	2	'Problem Analysis': Analyzing problems require knowledge / understanding of impact loads to accomplish solutions to members subjected to impact loads.	L4
2	CO3	PO3	2	'Design / Development of Solutions': Design & development of solutions require knowledge / understanding & analysis of impact loads to accomplish solutions to complex engineering problems in Mechanical Engineering.	L4
2	CO4	PO1	3	'Engineering Knowledge:' - Acquisition of Engineering Knowledge of Fatigue & Fatigue Stress is essential to accomplish solutions to Engineering problems subjected to fatigue loads in Mechanical Engineering.	L4

2	CO4	PO2	2	'Problem Analysis': Analyzing problems require knowledge / understanding of Fatigue & fatigue stress to accomplish solutions to members subjected to simple and combined fatigue loads.	L4
2	CO4	PO3	2	'Design / Development of Solutions': Design & development of solutions require knowledge / understanding & analysis of members under fatigue to accomplish solutions to complex engineering problems in Mechanical Engineering.	L4
3	CO5	PO1	3	'Engineering Knowledge:' - Acquisition of Engineering Knowledge of Shafts is essential to accomplish solutions to Engineering problems in Mechanical Engineering.	L4
3	CO5	PO2	3	'Problem Analysis': Analyzing problems require knowledge / understanding of Shafts to accomplish solutions to members subjected to bending, Torsion, Axial and combined loads.	L4
3	CO5	PO3	3	'Design / Development of Solutions': Design & development of solutions require knowledge / understanding & analysis of shafts to accomplish solutions to complex engineering problems in Mechanical Engineering.	L4
3	CO6	PO1	2	'Engineering Knowledge:' - Acquisition of Engineering Knowledge of Coupling, keys & joints is essential to accomplish solutions to Engineering problems in Mechanical Engineering.	L4
3	CO6	PO2	2	'Problem Analysis': Analyzing problems require knowledge / understanding of coupling, keys, joints to accomplish solutions to members with coupling,joints.	L4
3	CO6	PO3	2	'Design / Development of Solutions': Design & development of solutions require knowledge / understanding & analysis of coupling, keys and joints to accomplish solutions to complex engineering problems in Mechanical Engineering.	L4
4	CO7	PO1	2	'Engineering Knowledge:' - Acquisition of Engineering Knowledge of Rivets & rivetted joints is essential to accomplish solutions to Engineering problems in Mechanical Engineering.	L4
4	CO7	PO2	1	'Problem Analysis': Analyzing problems require knowledge / understanding of Rivetted joints to accomplish solutions to members formed of rivetted joints.	L4
4	CO7	PO3	1	'Design / Development of Solutions': Design & development of solutions require knowledge / understanding & analysis of rivetted joints to accomplish solutions to complex engineering problems in Mechanical Engineering.	L4
4	CO8	PO1	2	'Engineering Knowledge:' - Acquisition of Engineering Knowledge of Welding and welded joints is essential to accomplish solutions to Engineering problems formed with welded joints in Mechanical Engineering.	L4
4	CO8	PO2	1	'Problem Analysis': Analyzing problems require knowledge / understanding of Welded joints to accomplish solutions to members formed with welded joints.	L4
4	CO8	PO3	1	'Design / Development of Solutions': Design & development of solutions require knowledge / understanding & analysis of welded joints to accomplish solutions to complex engineering problems in Mechanical Engineering.	L4
5	CO9	PO1	2	'Engineering Knowledge:' - Acquisition of Engineering Knowledge of Threaded Fasteners is essential to accomplish solutions to Engineering problems in Mechanical Engineering.	L4
5	CO9	PO2	2	'Problem Analysis': Analyzing problems require knowledge / understanding of Threaded Fasteners to accomplish solutions to members subjected to combined loads.	L4
5	CO9	PO3	2	'Design / Development of Solutions': Design & development of solutions require knowledge / understanding & analysis of threaded fasteners to accomplish solutions to complex engineering problems in Mechanical Engineering.	L4
5	CO10	PO1	2	'Engineering Knowledge:' - Acquisition of Engineering Knowledge of Power screws is essential to accomplish solutions to Engineering problems in Mechanical Engineering.	L4
5	CO10	PO2	2	'Problem Analysis': Analyzing problems require knowledge / understanding of power screws to accomplish solutions to members subjected to loads.	L4
5	CO10	PO3	2	'Design / Development of Solutions': Design & development of solutions require knowledge / understanding & analysis of power screws to accomplish solutions to	L4

				complex engineering problems in Mechanical Engineering.	

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	17ME54.1	Design Process, Simple & Combined stresses	3	3	3	-	-	-	-	-	-	-	-	-				L4
1	17ME54.2	Analyse elements under Stress Concentration	3	2	2	-	-	-	-	-	-	-	-	-				L4
2	17ME54.3	Analyse members under Impact Analysis	2	2	2	-	-	-	-	-	-	-	-	-				L4
2	17ME54.4	Analyse members under Fatigue Analysis	3	2	2	-	-	-	-	-	-	-	-	-				L4
3	17ME54.5	Design of Power transmission Shafting	3	3	3	-	-	-	-	-	-	-	-	-				L4
3	17ME54.6	Analysis of Coupling & joints	2	2	2	-	-	-	-	-	-	-	-	-				L4
4	17ME54.7	Boiler joint analysis	2	1	1	-	-	-	-	-	-	-	-	-				L4
4	17ME54.8	Analysis of welded joints	2	1	1	-	-	-	-	-	-	-	-	-				L4
5	17ME54.9	Threaded fasteners analysis	2	2	2	-	-	-	-	-	-	-	-	-				L4
5	17ME54.10	Analysis of Power screws	2	2	2	-	-	-	-	-	-	-	-	-				L4
	17ME54	Average	**2.4**	**2.0**	**2.0**													**-**
-	*PO, PSO*	*1.Engineering Knowledge; 2.Problem Analysis; 3.Design / Development of Solutions; 4.Conduct Investigations of Complex Problems; 5.Modern Tool Usage; 6.The Engineer and Society; 7.Environment and Sustainability; 8.Ethics; 9.Individual and Teamwork; 10.Communication; 11.Project Management and Finance; 12.Life-long Learning; S1.Software Engineering; S2.Data Base Management; S3.Web Design*																

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		
1	Fundamentals of Mechanical Engineering Design	12	2	-	-	1	1	2	CO1, CO2	L2, L4
2	Design for Impact and Fatigue Loads	12	2	-	-	1	1	2	CO3, CO4	L2, L4
3	Design of Shafts, Joints, Couplings and keys	15	-	4	-	1	1	2	CO5, CO6	L2, L4
4	Riveted Joints and Weld Joints	13	-	-	2	1	1	2	CO7, C08	L2, L4
5	Threaded Fasteners and Power Screws	13	-	-	2	1	1	2	CO9, CO10	L2, L4
-	**Total**	**65**				**10**	**10**	**30**	**-**	**-**

2. Continuous Internal Assessment (CIA)

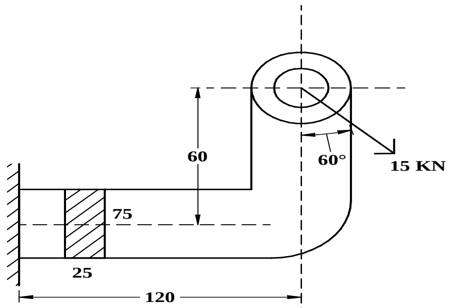
Assessment of learning outcomes for Internal exams. Blooms Level in last column shall match with A.2.

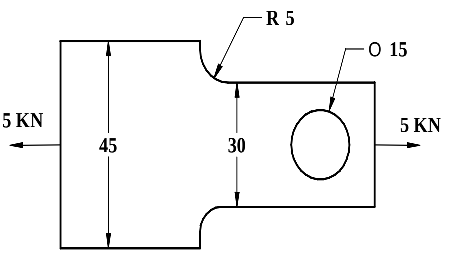
Modules	Evaluation	Weightage in Marks	CO	Levels
1, 2	CIA Exam – 1	30	CO1, CO2, CO3, CO4	L2, l4, l4, l4
3, 4	CIA Exam – 2	30	CO5, CO6	L4, L4
5	CIA Exam – 3	30	CO7, Co8, CO9, CO10	L4, L4, L4, L4
1, 2	Assignment - 1	10	CO1, CO2, CO3, CO4	L2, l4, l4, l4
3, 4	Assignment - 2	10	CO5, CO6	L4, L4
5	Assignment - 3	10	CO7, Co8, CO9, CO10	L4, L4, L4, L4
1, 2	Seminar - 1			
3, 4	Seminar - 2			
5	Seminar - 3			
1, 2	Other Activities – define – Slip test		CO1 to C10	L2, L3, L4
3, 4	Quiz - 2		-	-
5	Quiz - 3		-	-
1 - 5	Other Activities – Mini Project	-	CO9, CO10	L2, L2
	Final CIA Marks	**40**	**-**	**-**

D1. TEACHING PLAN - 1

Module - 1

Title:	Fundamentals of Mech. Engg. Design and Static stresses Stress concentration & Stress concentration factor.	Appr Time:	12 Hrs
a	***Course Outcomes***	**CO**	**Blooms**
-	At the end of the topic the student should be able to . . .	-	**Level**
1	Understand Mechanical Engineering Design, material selection, Standards & Codes, Determine stresses induced in members subjected to simple and combined static loads and compare with safe stresses.	CO1	L4
2	Understand Stress concentration and design members considering stress concentration.	CO2	L4
b	***Course Schedule***	-	-

Class No	Portion covered per hour	-	-
1	Introduction to Subject, Module, course objectives and outcomes, Engineering Design, Phases of design	C01	L2
2	Materials and their properties, selection of materials	C01	L2
3	Standards & Codes, Factor of Safety	C01	L2
4	Static Loads: Static stress, Normal, Bending, Shear Stresses & Combined stresses	C01	L2
5	Numericals on members subjected to simple loads.	CO1	L4
6	Numericals on Combined loads.	CO1	L4
7	Numericals on Combined loads.	CO1	L4
8	Stress concentration & Determination of Stress concentration factor	CO2	L2
9	Design of members taking stress concentration into account	CO2	L4
10	Design of members considering stress concentration into account	CO2	L4
11	Design of members considering stress concentration into account	CO2	L4
12	Design of members with stress concentration	CO2	L4
c	**Application Areas**	**-**	**-**
-	Students should be able employ / apply the Module learnings to . . .	-	-
1	Understanding Design, Material selection, standards and Codes, Bars, Brackets	CO1	L4
2	Plates, Shafts	CO2	L4
d	**Review Questions**	-	-
-	The attainment of the module learning assessed through following questions	-	-
1	Define Engineering Design & Explain the steps involved in design with a block diagram.	CO1	L2
2	Draw the stress strain diagram for a ductile and brittle material and show the salient points on them.	CO1	L2
3	List the factors influencing the selection of suitable material for a machine element.	CO1	L2
4	Define Factor of Safety. List the factors influencing the selection of an appropriate value for Factor of Safety.	CO1	L2
5	Define Standards and Codes.	CO1	L2
6	A machine element in the form of a cantilever beam has a rectangular cross section of depth 200mm. This beam is subjected to an axial load of 60kN and a transverse load of 50kN acting downwards at the free end of the beam, which has a span of 800mm. If the material of the beam is Carbon steel with a yield stress of 328.6 Mpa and the Factor of Safety is 3, determine the width of rectangular cross section.	CO1	L4
7	A bracket shown in fig. Is subjected to a pull of 15kN at 60 to the vertical. Determine the maximum tensile stress in the bracket. 	CO1	L4
8	What is stress concentration? Explain how stress concentration can be reduced with examples.	CO2	L2
9	Determine the maximum stress induced in a semi circular grooved shaft of dia 60mm and a groove of radius 5mm, if it is subjected to i) an axial load of 40kN ii) bending moment of 400 Nm iii) twisting moment of 500N-m taking stress concentration into account.	CO2	L4
10	A flat plate subjected to a tensile force of 5 kN is shown in the fig. The plate material is grey cast iron having ultimate stress value of 200MPa. Determine the thickness of the plate. Factor of safety is 2.5.	CO2	L4



e	**Experiences**	-	-
1			
2			
3			
4			
5			

Module – 2

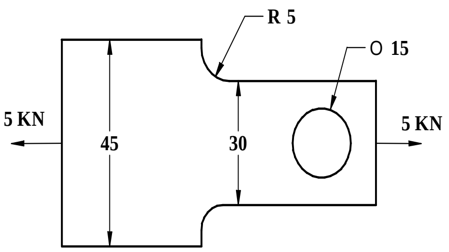
Title:	Design for Impact and Fatigue Loads	Appr Time:	7 Hrs
a	***Course Outcomes***	**CO**	**Blooms**
-	At the end of the topic the student should be able to . . .	-	**Level**
1	Understand Impact stresses & design members subjected to Impact stresses	CO3	L4
2	Understand Fatigue Stresses & design members under fatigue loads.	CO4	L4
b	***Course Schedule***	-	-
Class No	**Portion covered per hour**	-	-
13	Introduction to Impact loads, Derivation of expression for Impact stress & impact factor	CO3	L2
14	Numericals on members under Impact loads.	CO3	L4
15	Numericals on members subjected to impact loads.	CO3	L4
16	Numericals on members under Impact stresses.	CO3	L4
17	Numericals on members under impact loads.	CO3	L4
18	Introduction to Fatigue or cyclic loads, Types, S-N diagram,	CO4	L2
19	Derivation of Soderbergs Equation, Factors affecting Fatigue loads	CO4	L2
18	Design of members subjected to simple cyclic loads.	CO4	L4
19	Numericals on members under Fatigue loads.	CO4	L4
20	Numericals on members under Combined Fatigue loading.	CO4	L4
21	Design of members subjected to Combined Cyclic loads.	CO4	L4
22	Design of members subjected to Combined Cyclic loads.	CO4	L4
23	Design of members subjected to Combined Cyclic loads.	CO4	L4
24	Design of members subjected to Combined Cyclic loads.	CO4	L4
c	**Application Areas**	-	-
-	Students should be able employ / apply the Module learnings to . . .	-	-
1	Analysing members like Bars, Shafts, Beams	CO3	L4
2	Designing elements like shafts	CO4	L4
d	**Review Questions**	-	-
-		-	-
1	Derive an expression for impact or shock factor.	CO3	L2
2	A steel cantilever beam of rectangular cross section is loaded 400mm from the support. The width of the beam is 15mm and the depth is 20mm. Determine the maximum stress in the beam when a weight of 100N is dropped on the beam through a height of 5mm. Take the value of E=210GPa.	CO3	L4
3	An unknown weight falls through 15mm on to a collar rigidly attached to the lower end of	CO3	L4

	a vertical bar 2m long and 500mm square section. If the maximum instantaneous extension is 2mm, what are the corresponding stress and the value of unknown weight? Take the value of E=200GPa.		
4	Define endurance limit. State and explain the factors modifying it.	CO4	L2
5	Derive Soderbergs equation for machine subjected to variable stresses.	CO4	L2
6	A circular bar of 500mm length is supported freely at its ends. It is acted upon by a central concentrated cyclic load having a minimum value of 20kN and a maximum value of 50kN. Determine the diameter of bar taking a factor of safety of 2, size factor of 0.85 and surface finish factor of 0.9. The material properties of bar are ultimate stress=650MPa, yield strength=500Mpa and endurance strength=350MPa.	CO4	L4
7	A simply supported beam has a concentrated load at the centre which fluctuates from a value of P to 4P. The span of the beam is 500mm and its cross section is circular with a diameter of 60mm. Assuming the material of the beam has an ultimate stress of 700MPa, yield stress of 500MPa, endurance limit of 330MPa for reversed bending and a factor of safety of 1.3, calculate the maximum load P. Take a size factor of 0.85, surface finish factor of 0.9 and fatigue stress concentration factor of 1.	CO4	L4
8	A hot rolled steel shaft is subjected to a torsional load that varies from 330Nm clockwise to 110Nm counter clockwise and an applied bending moment at a critical section varies from 44Nm to -22Nm. Determine the required shaft diameter. The ultimate strength of the material is 55MPa and yield stress is 410MPa. Design factor of safety is 1.5. Take endurance limit as half the ultimate strength and size factor = 0.85.	CO4	L4
e	**Experiences**	-	-
1			
2			
3			
4			
5			

E1. CIA EXAM – 1

a. Model Question Paper -1

Crs Code:	17ME54	Sem:	5	Marks:	30	Time:	75 minutes
Course:	DESIGN OF MACHINE ELEMENTS - 1						

-	-	**Note: Answer all questions, each carry equal marks. Module : 1, 2**	**Marks**	**CO**	**Level**
1	a	Define Factor of safety and list the factors influencing the selection of appropriate value of Factor of Safety.	5	CO1	L1
	b	A flat plate subjected to a tensile force of 5 kN is shown in the fig.Q.1(b) The plate material is grey cast iron having ultimate stress value of 200MPa. Determine the thickness of the plate. Factor of safety is 2.5.  Fig. Q.1.(b)	10	CO2	L4
		OR			
2	a	What is stress concentration? Explain how stress concentration can be reduced with two examples.	5	CO2	L2
	b	A bracket shown in fig.Q.2.(b) Is subjected to a pull of 15kN at 60 to the vertical. Determine the maximum tensile stress in the bracket.	10	CO1	L4

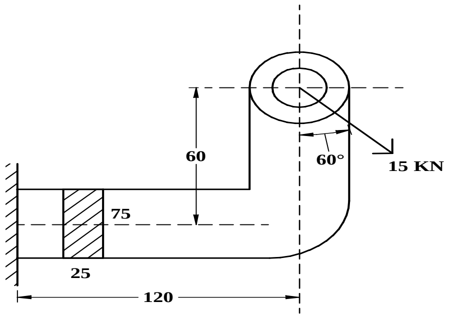


Fig.Q.2.(b)

3	a	Derive an expression for impact or shock factor.	5	CO3	L2
	b	A hot rolled steel shaft is subjected to a torsional load that varies from 330Nm (cw) to 110Nm (ccw) and an applied bending moment at a critical section varies from 440Nm to -220Nm. Determine the required shaft diameter. The ultimate strength of the material is 550MPa and yield stress is 410MPa. Design factor of safety is 1.5. Take endurance limit as half the ultimate strength and size factor = 0.85.	10	CO4	L4
		OR			
4	a	Derive Soderbergs equation for machine member subjected to variable stresses.	5	CO4	L2
	b	An unknown weight falls through 15mm on to a collar rigidly attached to the lower end of a vertical bar 2m long and 500mm square section. If the maximum instantaneous extension is 2mm, what are the corresponding stress and the value of unknown weight? Take the value of E=200GPa.	10	CO3	L4

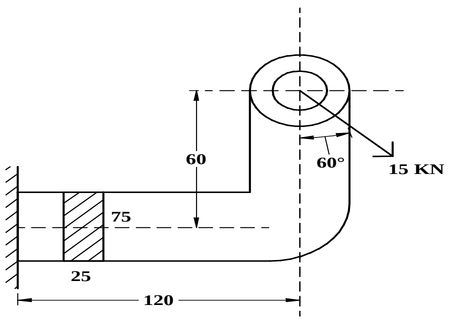
b. Assignment -1

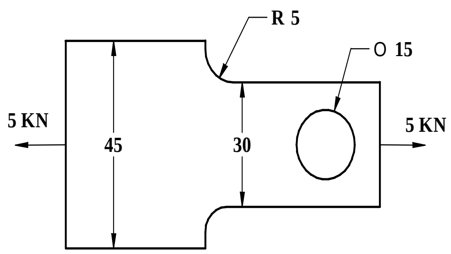
Note: A distinct assignment to be assigned to each student.

Model Assignment Questions

Crs Code:	17ME54	Sem:	5	Marks:	10	Time:	90 – 120 minutes
Course:	DESIGN OF MACHINE ELEMENTS -1			Module : 1, 2			

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

SNo	USN	Assignment Description	Marks	CO	Level
1		Define Engineering Design & Explain the steps involved in design with a block diagram.	5	CO1	L2
2		Draw the stress strain diagram for a ductile and brittle material and show the salient points on them.	5	CO1	L2
3		List the factors influencing the selection of suitable material for a machine element.	5	CO1	L2
4		Define Factor of Safety. List the factors influencing the selection of an appropriate value for Factor of Safety.	5	CO1	L2
5		Define Standards and Codes.	5	CO1	L2
6		A machine element in the form of a cantilever beam has a rectangular cross section of depth 200mm. This beam is subjected to an axial load of 60kN and a transverse load of 50kN acting downwards at the free end of the beam, which has a span of 800mm. If the material of the beam is Carbon steel with a yield stress of 328.6 Mpa and the Factor of Safety is 3, determine the width of rectangular cross section.	5	CO1	L4
7		A bracket shown in fig. Is subjected to a pull of 15kN at 60 to the vertical. Determine the maximum tensile stress in the bracket. 	5	CO1	L4
8		What is stress concentration? Explain how stress concentration can be reduced	5	CO2	L2

		with examples.			
9		Determine the maximum stress induced in a semi circular grooved shaft of dia 60mm and a groove of radius 5mm, if it is subjected to i) an axial load of 40kN ii) bending moment of 400 Nm iii) twisting moment of 500N-m taking stress concentration into account.	5	CO2	L4
10		A flat plate subjected to a tensile force of 5 kN is shown in the fig. The plate material is grey cast iron having ultimate stress value of 200MPa. Determine the thickness of the plate. Factor of safety is 2.5. 	5	CO2	L4
11		Derive an expression for impact or shock factor.	5	CO3	L2
12		A steel cantilever beam of rectangular cross section is loaded 400mm from the support. The width of the beam is 15mm and the depth is 20mm. Determine the maximum stress in the beam when a weight of 100N is dropped on the beam through a height of 5mm. Take the value of E=210GPa.	5	CO3	L4
13		An unknown weight falls through 15mm on to a collar rigidly attached to the lower end of a vertical bar 2m long and 500mm square section. If the maximum instantaneous extension is 2mm, what are the corresponding stress and the value of unknown weight? Take the value of E=200GPa.	5	CO3	L4
14		Define endurance limit. State and explain the factors modifying it.	5	CO4	L2
15		Derive Soderbergs equation for machine subjected to variable stresses.	5	CO4	L2
16		A circular bar of 500mm length is supported freely at its ends. It is acted upon by a central concentrated cyclic load having a minimum value of 20kN and a maximum value of 50kN. Determine the diameter of bar taking a factor of safety of 2, size factor of 0.85 and surface finish factor of 0.9. The material properties of bar are ultimate stress=650MPa, yield strength=500Mpa and endurance strength=350MPa.	5	CO4	L4
17		A simply supported beam has a concentrated load at the centre which fluctuates from a value of P to 4P. The span of the beam is 500mm and its cross section is circular with a diameter of 60mm. Assuming the material of the beam has an ultimate stress of 700MPa, yield stress of 500MPa, endurance limit of 330MPa for reversed bending and a factor of safety of 1.3, calculate the maximum load P. Take a size factor of 0.85, surface finish factor of 0.9 and fatigue stress concentration factor of 1.	5	CO4	L4
18		A hot rolled steel shaft is subjected to a torsional load that varies from 330Nm clockwise to 110Nm counter clockwise and an applied bending moment at a critical section varies from 44Nm to -22Nm. Determine the required shaft diameter. The ultimate strength of the material is 55MPa and yield stress is 410MPa. Design factor of safety is 1.5. Take endurance limit as half the ultimate strength and size factor = 0.85.	5	CO4	L4

D2. TEACHING PLAN - 2

Module – 3

Title:	Design of Shafts, Joints, Couplings and Keys	Appr Time:	15 Hrs
a	***Course Outcomes***	**CO**	**Blooms**
-	At the end of the topic the student should be able to . . .	-	**Level**
1	Design the shafts subjected to combined loading and select standard diameter for the shafts.	CO5	L4
2	Design coupling, keys & Joints for transmitting torque and power.	CO6	L4

b	***Course Schedule***		
Class No	**Portion covered per hour**	**-**	**-**
25	Introduction to Module, course objectives and outcomes	CO5	L2
26	Design of shafts for strength & rigidity with steady loading. ASME codes for power transmission shafts under combined loads.	CO5	L2
27	Numericals examples on design of shafts under combined loads.	CO5	L4
28	Numericals examples on design of shafts under combined loads.	CO5	L4
29	Numericals examples on design of shafts under combined loads.	CO5	L4
30	Numericals examples on design of shafts under combined loads.	CO5	L4
31	Numericals examples on design of shafts under combined loads.	CO5	L4
32	Design of shafts.	CO5	L4
33	Introduction to keys, types, failure of keys.	CO6	L2
34	Design of Keys.	CO6	L2
35	Design of Cotter Joints	CO6	L3
36	Design of Knuckle joints	CO6	L3
37	Introduction to couplings, Purpose, Types, Design of Couplings (Sleeve)	CO6	L4
38	Design of flange coupling	CO6	L4
39	Design of Flange coupling	CO6	L4
		CO6	L4
c	**Application Areas**	**-**	**-**
-	Students should be able employ / apply the Module learnings to . . .	-	-
1	Automobiles, Machinery	CO5	L4
2	Motor & Pump, Turbine & Generator	CO6	L4
d	**Review Questions**	-	-
-		-	-
1	Prove that a hollow shaft is stronger and stiffer than a solid shaft of same length, weight and material.	CO5	L2
2	Compare the weight, strength & stiffness of a hollow shaft of the same external diameter as that of solid shaft. The inside diameter of the hollow shaft being half the external diameter. Both the shafts have the same material and length.	CO5	L2
3	Design a shaft of the armature of a motor, if the magnetic pull on the shaft is equivalent to an UDL of 10N/mm length over the middle one third of the 600mm length of the shaft between bearings. The motor transmits a power of 15KW at 1200rpm. The allowable shear stress is 50MPa. Take K_b=1.5 and K_t=1.25.	CO5	L2
4	A commercial shaft 1m long supported between bearings has a pulley of 600mm diameter weighing 1kN, driven by a horizontal belt drive keyed to the shaft at a distance of 400mm to the left of the right bearing and receives 25kW at 1000rpm. Power from the shaft is transmitted from the 20^o spur pinion of a pitch circle diameter 200mm which is mounted at 200mm to the right of the left bearing to a gear such that tangential force on the gear acts vertically upwards. Take the ratio of the belt tension as 3. determine the standard size of the shaft based on maximum shear stress theory. Assume K_b=1.75, K_t=1.25.	CO5	L4
5	A shaft supported between the bearing 400mm apart get its drive through a gear drive. A gear is mounted 200mm to the right of the left bearing and is driven by a pinion just above it. The gear has a module of 10mm, number of teeth is equal to 40mm and pressure angle is 20^o the power received is 20kW at 500mm. Over hanging to the right bearing by 200mm there is a pulley of diameter 200mm, the belt drive is inclined at an angle of 30^o with the vertical and is away from the shaft. The ratio of belt tension is taken as 3. Design the shaf assuming that the allowable stress as 100MPa in tension and compression and 40MPa in shear.	CO5	L4

6	A shaft is supported by two bearings 1.5mts apart. A 20^0 involute gear of 175mm pitch circle dia is keyed to the shaft at a distance of 400mm to the left of right hand bearing and is driven by a gear directly behind the shaft. The tangential force on the gears acts vertically downwards. A 600 mm dia pulley is keyed to the shaft 600mm to the right of the left bearing and drives a machine pulley with a horizontal belt directly behind it. The ratio of tensions in the belt is 3:1. The drive transmits 45KW at 330rpm. Take K_b=K_t=1.5. Determine the diameter of the shaft taking allowable shear stress = 60MPa.	CO5	L4
7	Prove that a square key is equally strong in shear and compression.	CO6	L2
	Design a protected type of cast iron flange coupling for a steel shaft transmitting 30KW at 200rpm. The allowable shear stress in the shaft and key material is 40MPa. The maximum torque transmitted to be 20% greater than the full load torque. The allowable shear stress in the bolt is 60MPa and allowable shear stress in the flange is 20MPa.	CO6	L4
8	Design a Knuckle joint to connect two rods subjected to an axial load of 80 KN. The allowable stresses for the material of the joint are 80MPa in tension, 60MPa in Shear and 120 MPa in crushing.	CO6	L3
9	Design a socket and spigot type of cotter joint to connect two rods subjected to a steady axial pull of 100KN. The allowable stresses for the material of the joint are, in tension 80MPa, compression 120MPa and in shear is 60MPa.	CO6	L3
10	Design a Cast Iron protective Flange coupling to connect two shafts to transmit 7.5kW at 720rpm. Take the permissible shear stress fo shaft, bolt and key material = 33MPa. Permissible crushing stress for bolt and key material = 60MPa. Permissible shear stress for cast iron = 15 Mpa.	CO6	L4
11	Design a Flange coupling to connect the shafts of a motor and centrifugal ump for the following specifications: Pump output = 3000 ltrs/min, total head = 20m, Pump speed = 600 rpm, Pump efficiency = 70%. Select C-40 steel for shaft and C-35 steel for bolts with factor of safety 4. Use allowable shear stress in Cast Iron flanges = $15 N/mm^2$.	CO6	L4
12	What is coupling? What are the requirements of a good coupling.	CO6	L2
13	A rectangular sunk key 14mm wide x 10mm thick x 75mm long is required o transmit 1200 N-m torque from a 50mm diameter solid shaft. Determine vhether the length is sufficient or not if the permissible shear stress and rushing stresses are limited to 56MPa and 168MPa respectively.	CO6	L2
e	**Experiences**	-	-
1			
2			
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E2. CIA EXAM – 2

a. Model Question Paper - 2

Crs Code:	17ME54	Sem:	5	Marks:	30	Time:	75 minutes
Course:	DESIGN OF MACHINE ELEMENTS-1						

-	-	**Note: Answer all questions, each carry equal marks. Module : 3, 4**	**Marks**	**CO**	**Level**
1	a	A shaft is supported between two bearings 1.5mts apart. A 20^0 involute gear of 175mm pitch circle dia is keyed to the shaft at a distance of 400mm to the left of right hand bearing and is driven by a gear directly behind the shaft. The tangential force on the gears acts	15	CO5	L4

		vertically downwards. A 600 mm dia pulley is keyed to the shaft 600mm to the right of the left bearing and drives a pulley with a horizontal belt directly behind it. The ratio of tensions in the belt is 3:1. The drive transmits 45KW at 330rpm. Take K_b=K_t=1.5. Determine the diameter of the shaft taking allowable shear stress = 60MPa.			
		OR			
2	a	Compare the weight, strength & stiffness of a hollow shaft of the same external diameter as that of solid shaft. The inside diameter of the hollow shaft being half the external diameter. Both the shafts have the same material and length.	7	CO5	L3
	b	Design a shaft of the armature of a motor, if the magnetic pull on the shaft is equivalent to an UDL of 10N/mm over the middle one third of the 600mm length of the shaft between bearings. The motor transmits a power of 15KW at 1200rpm. The allowable shear stress is 50MPa. Take K_b=1.5 and K_t=1.25.	8	CO5	L4
3	a	Design a protected type of cast iron flange coupling for a steel shaft transmitting 30KW at 200rpm. The allowable shear stress in the shaft and key material is 40MPa. The maximum torque transmitted to be 20% greater than the full load torque. The allowable shear stress in the bolt is 60MPa and allowable shear stress in the flange is 20MPa.	8	CO6	L4
	b	Design and sketch the assembly of a cotter joint to connect two rods, subjected to an axial pull of 120 kN. The material selected for the joint has the following permissible stresses: 100 MPa in tension, 60 MPa in shear and 120 MPa in crushing.	7	CO6	L4
		OR			
4	a	Design a Flange coupling to connect the shafts of a motor and entrifugal pump for the following specifications: Pump output = 3000 ltrs/min, total head = 20m, Pump speed = 600 rpm, Pump efficiency = 70%. Select C-40 steel for shaft, bolts with factor of safety 4. Use allowable shear stress in Cast Iron flanges = 15N/mm^2.	7	CO6	L4
	b	Design a knuckle joint to connect two mild steel rods to sustain an axial pull of 100 kN. The pin and the rods are made of same material. Assume the working stresses in the material as 80 MPa in tension, 40 MPa in shear and 120 Mpa in crushing.	8	CO6	L4

b. Assignment – 2

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

Model Assignment Questions							
Crs Code:	17ME54	Sem:	5	Marks:	10	Time:	90 – 120 minutes
Course:	DESIGN OF MACHINE ELEMENTS - 1				Module : 3		
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.							

SNo	USN	Assignment Description	Marks	CO	Level
1		A shaft supported between bearing 400mm apart gets its drive through a gear drive. A gear is mounted 200mm to the right of the left hand bearing and is driven by a pinion just above it. The gear has a module of 10mm, number if teeth is equal to 40 and pressure angle=20°, the power received is 20kW at 500 rpm. Overhanging to the right hand bearing by 200mm there is a pulley of diameter 200mm, the belt drive is inclined at an angle of 30° with the vertical and is away from the shaft. The ratio of belt tension is taken as 3:1. Design a shaft assuming that the allowable stress as 100 N/mm2 in tension and 40 N/mm 2 in shear, for suddenly applied loads with minor shocks.	5	CO5	L4
2		A 45mm diameter, shaft is made of steel with a yield strength of 40 MPa. A parallel key of size 14mm wide and 9mm thick, made of steel with a yield strength of 340 MPa. Find the required length of key, if the shaft in loaded to transmit the maximum permissible torque. Design based on maximum	5	CO5	L4

		shear stress theory and take factor of safety as 2.			
3		A shaft is supported between two bearings located 0.6 m apart. Gear 'A' of pitch circle diameter 0.1 m is keyed to the shaft 0.1m to the right of the left bearing. Gear 'B' of 0.15 m diameter is keyed to the shaft 0.3 m to the right of the left bearing. Another gear 'C' of pitch circle diameter 0.08 m is keyed to the shaft 0.1m to the left of the right bearing. Gear 'B' receives 10 kW power at 500 rpm from a mating gear mounted directly below it. Gear 'A' delivers 6 kW power to another gear mounted directly infront of it, such that the tangential force acts vertically upwards. The gear 'C' delivers the remaining power to its mating gear mounted directly behind it, such that the tangential force acts vertically downwards. All gears are of 20° full depth involute form. The shaft is made of steel which has an ultimate strength of 510 MPa and a yield strength of 330MPa. Determine the required diameter of the shaft under steady load condition using ASME Code.	5	CO5	L4
4		Design a knuckle joint to connect two mild steel rods to sustain an axial pull of 100 kN. The pin and the rods are made of same material. Assume the working stresses in the material as 80 MPa in tension, 40 MPa in shear and 120 Mpa in crushing.	5	CO6	L4
5		Design a bushed pin type flexible coupling to connect a motor shaft to a pump shaft transmitting 20 kW power at 1440 rpm. The allowable shear and crushing stress for steel shafts, keys and pins are 40 MPa and 80 MPa respectively. The allowable shear stress for the cast iron flange is 10 MPa and the allowable bearing pressure for rubber bush is 0.5 MPa.	5	CO6	L4
6		A power transmission shaft 1800 mm long, is supported at two points A and B. Whereas A is at a distance of 300 mm from the left extreme end of the shaft, B is at the right extreme end. A power of 50 kN is received at 500 rpm, through a gear drive located at the left extreme end of the shaft. The gear mounted on the shaft here, has a pitch diameter of 300 mm and weighs 700 N. The driver gear is located exactly behind. 30 kW of this power is given out through a belt drive located at a distance of 600 mm from the left support. The pulley mounted on the shaft has a diameter of 400 mm and weighs 1000N. The belt is directed towards the observer below the horizontal and inclined 45° to it. The ratio of belt tensions is 3. The remaining power is given out through a gear drive located at a distance of 400 mm from the right support. The driver gear has a pitch diameter of 200 mm and weighs 500 N. The driven gear is located exactly above. Selecting C40 steel (a y = 328.6 MPa) and assuming factor of safety 3, determine the diameter of a solid shaft for the purpose. Take kb = 1.75 ; kt = 1.5 & pressure angle = 20° for both the gears.	5	CO5	L4
7		Design a protected type cast iron flange coupling for a steel shaft transmitting 30 kW at 200 rpm. The allowable shear stress in the shaft and key material is 40 MPa. The maximum torque transmitted to be 20% greater than the full load torque. The allowable shear stress in the bolt is 60 MPa and allowable shear stress in the flange is 40 MPa.		CO6	L4
8		Design a sleeve type cotter joint, to connect two tie rods, subjected to an axial pull of 60 kN. The allowable stresses of C30 material used for the rods and cotters are at = 65 N/mm2 ; a, = 75 N/mm 2 ; t = 35 Nimm 2 ; cast steel used for the sleeve has the allowable stresses tensile = 70 N/mm2 ; Crushing = 110 N/mm 2 ; Shear = 45 Nimm2	5	CO6	L4
9		Design a Knuckle joint to transmit 150 kN. The design stresses may be taken as 75 N/mm 2 in tension, 60 N/mm2 in shear and 150 N/mm2 in compression.	5	CO6	L4
10		A horizontal piece of commercial shafting is supported by two bearings 1.5m apart. A keyed gear, 20° involute and 175 mm diameter, is located 400 mm to the left of the right bearing and is driven by a gear directly behind it. A 600 mm diameter pulley is keyed to the shaft 600 mm to the right of the left bearing and drives another pulley by means of a belt drive inclined at 45° to the horizontal below the shaft and in front of it. The tension ratio of the belt is 3:1. The drive transmits 45 kW at 330 rpm cw when viewed from right side. The allowable shear stress for shaft material is 40 Mpa. The combined shock and fatigue factors for torsion and bending are 1.5 and 2.0	5	CO5	L4

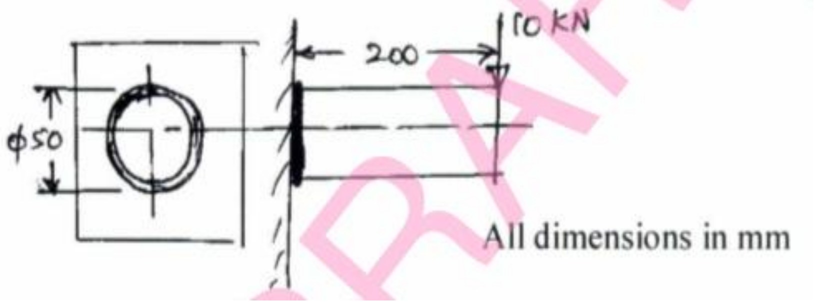
		respectively. Draw the moment diagrams and calculate the necessary shaft diameter.			
11		Design and sketch the assembly of a cotter joint to connect two rods, subjected to an axial pull of 120 kN. The material selected for the joint has the following permissible stresses : 300 MPa in tension, 220 MPa in shear and 450 MPa in crushing.	5	CO6	L4
12		A cast iron protective type flange coupling is used to connect two shafts of 80 mm diameter. The shaft runs at 250 rpm and transmits a torque of 4300 N-m. The permissible shear stress for shaft and bolt materials is 50 MPa and permissible shear stress for flange is 8 Mpa. Design the bolts, hub and flange for the coupling.	5	CO6	L4
13		A transmission shaft running at 500 rev/min is supported on bearings 800 mm apart. Twenty K.W power is supplied to the shaft through a 450 mm dia pulley which is located 400 mm to the right of right bearing and receives power from a motor placed directly below the shaft. The shaft further transmits this power to a spur gear of 300 mm pitch circle diameter, which is located at 400 mm to the right of left bearing. The gear has 20° involute teeth and ratio of belt tensions is 3:1. The gear drives another gear which is placed directly above the shaft. The gear and pulley are keyed to the shaft. Selecting the material as steel having ultimate tensile stress = 700 MPa and Yield stress = 460 MPa as per ASME code, determine the diameter of shaft. Assume shock factors for bending and torsion as 1.5.	5	CO5	L4
14		The standard cross-section of a flat key, which is fitted on a 50 mm diameter shaft is 16 x10 mm. The key is transmitting 475 N-m torque from the shaft to the hub. The key is made of commercial steel for which yield strength in both tension and compression may be taken as 230 N/mm2. Determine the minimum length of key required if the factor of safety is 3.	5	CO6	L3
15		It is required to design a rigid type flange coupling to connect two shafts. The input shaft transmits 37.5 KW at 180 rev/min to the output shaft through the coupling. The starting torque is 50% higher then the rated torque. Select material for flanges as cast iron FG200 taut = 200 MPa) with a factor of safety 6, material for shafts as carbon steel with yield stress = 380 MPa, with a factor of safety 2.5, material for key and bolts may be taken as steel with yield normal stress = 400 MPa (in tension) and yield stress = 600 MPa (in compression) respectively and a factor of safety 2.5. Design the coupling and give major dimensions.	5	CO6	L4
16		A power transmission shaft 1300 mm long is supported in bearings at its extreme ends A & B. A power of 30kW is received at 500rpm through a gear drive located at 400mm to the right of the left extreme end of the shaft. The gear mounted on the shaft has a pitch diameter of 300mm and weights 800N. This gear receives power from a gear located exactly behind. The power is delivered through a belt drive located 500mm to the left of the right bearing. The pulley mounted on the shaft has a diameter of 400mm and weighs l kN. The belt is directed towards the observer below the horizontal and inclined at 45°. Ratio of belt tensions is 3. Material of the shaft is C40 steel. Assuming a factor of safety of 2.5 and loading to be with minor shocks, determine the diameter of the solid shaft.	5	CO6	L4
17		A mild steel shaft has to transmit 40kW power at 600rpm. The maximum torque to be transmitted is 30% greater than the average torque. Design a rigid flange coupling for this application.	5	CO6	L4
18		Design a Knuckle joint to connect two mild steel rods. The joint has to transmit a tensile load of 80kN. Material for the rods has following allow the stresses: Tensile = 80MPa, Crushing = 120MPa, shear = 40MPa.	5	CO6	L4

D3. TEACHING PLAN – 3

Module – 4

Title:	Riveted and Welded Joints	Appr Time:	13 Hrs
a	***Course Outcomes***	**CO**	**Blooms**
-	At the end of the topic the student should be able to . . .	-	**Level**

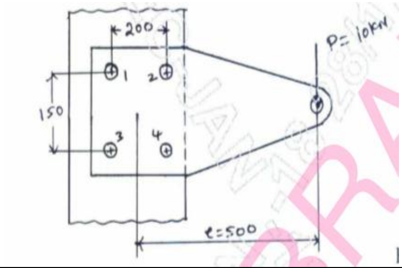
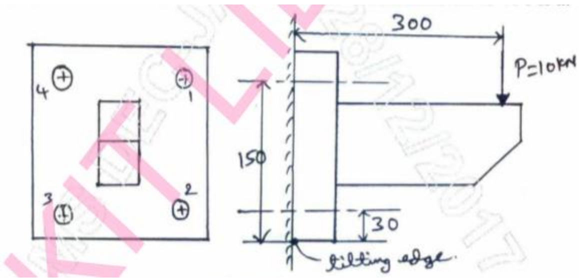
1	Analyse Boiler joints and design lap and butt riveted joints.	CO7	L4
2	Analyse welded joints and design parallel, transverse and eccentrically loaded welded joints.	CO8	L4
b	***Course Schedule***		
Class No	**Portion covered per hour**	**-**	**-**
40	Introduction to Module, course objectives and outcomes	CO7	L2
41	Riveted Joints, Rivets types, materials. Failure of riveted joints, joints efficiency. Boiler joints.	CO7	L2
42	Numerical examples on design of Boiler joints	CO7	L4
43	Numerical examples on design of Boiler joints	CO7	L4
44	Numerical examples on design of Lozenze joints	CO7	L4
45	Riveted Brackets, Design of Eccentrically loaded joints	CO7	L4
46	Design of Eccentrically loaded joints	CO7	L4
47	Welded joints, strength of butt and fillet welds	CO8	L2
48	Numerical examples on transverse and parallel fillet welds	CO8	L3
49	Design of Eccentrically loaded welded joints	CO8	L4
50	Design of Eccentrically loaded welded joints	CO8	L4
51	Design of Eccentrically loaded welded joints	CO8	L4
52	Design of Eccentrically loaded welded joints	CO8	L4
c	**Application Areas**	**-**	**-**
-	Students should be able employ / apply the Module learnings to . . .	-	-
1	Boilers, Storage tanks	CO7	L4
2	Frames, Brackets	CO8	L4
d	**Review Questions**	-	-
-		-	-
32	Explain in detail the various possible modes of failure of a riveted joint.	CO7	L2
33	Design a longitudinal double riveted strap butt joint with unequal straps for a pressure vessel. The internal diameter of the pressure vessel is 1m and is subjected to an internal pressure of 2.2MPa. The pitch of the rivet in the outer row is to be double the pitch in the inner row. The allowable tensile stress in the plate is 124MPa. The allowable shear & crushing of the rivets are 93MPa & 165MPa respectively.	CO7	L3
34	Design a double riveted lap joint with chain riveting for a mild steel plates of 20mm thick taking the allowable values of stress in shear, tension & compression as 60, 90 & 120MPa respectively	CO7	L4
35	Design a double riveted butt joint with two cover plates for the longitudinal seam of a boiler shell 1.5m in diameter subjected to a steam pressure of 1MPa. Assume joint efficiency of 75%, allowable tensile stress in the plate 83MPa, compressive stress 138MPa and shear stress in the rivet 55MPa.	CO7	L4
36	Design a double riveted lap joint with zig-zag riveting for 13mm thick plates. The working stresses to be used are allowable tensile stress = 80MPa, Allowable shear stress = 60MPa, allowable crushing stress = 120MPa. State how the joint will fail and find the efficiency of the joint.	CO7	L4
37	A mild steel plate of 15mm thickness is welded to another plate by two parallel welds to carry a load of 50KN. Determine the length of weld required if: i) load is static ii) load is dynamic.	C87	L4
38	A plate 80mm wide and 15mm thick is joined with another plate by a single transverse weld and a double parallel weld. Determine the length of parllel fillet weld if the joint is subjected to both static and fatigue loading. Take Allowable tensile stress and shear stress as 90MPa and 55MPa respectively. The stres concentration factor as 1.5 for transverse weld and 207 for parallel weld.	CO8	L4
39	A bracket carrying a load of 15KN is to be welded as shown in fig.1. Find the size of the weld required if the allowable shear stress is not exceed 80MPa.	CO8	L4
40	For the eccentrically loaded welded joint, determine the size of the weld required. Take permissible stress for the weld as 75MPa.	CO8	L4
41	A circular shaft 50 mm in diameter is welded to a support by means of a fillet weld and loaded as shown in Fig. Determine the size of weld if the permissible shear stress in the weld is limited to 100 Mpa.	CO8	L4



e	**Experiences**	-	-
1			
2			
3			
4			
5			

Module – 5

Title:	Threaded Fasteners and Power Screws	Appr Time:	10 Hrs
a	***Course Outcomes***	**CO**	**Blooms**
-	At the end of the topic the student should be able to . . .	-	**Level**
1	Design threaded fasteners and eccentrically loaded bolted joints	CO9	L4
2	Analyse power screws and design Screw Jack (Complete Design)	CO10	L4
b	***Course Schedule***	-	-
Class No	**Portion covered per hour**	**-**	**-**
53	Introduction to Module, course objectives and outcomes	CO9	L2
54	Stresses in threaded fasteners, Effect of initial tension. Design of threaded fasteners under static loads. Design of eccentrically loaded bolted joints.	CO9	L4
55	Design of threaded fasteners under static loads. Design of eccentrically loaded bolted joints.	CO9	L4
56	Design of threaded fasteners under static loads. Design of eccentrically loaded bolted joints.	CO9	L4
57	Design of threaded fasteners under static loads. Design of eccentrically loaded bolted joints.	CO9	L4
58	Types of power screws, Efficiency & Self locking	CO10	L2
59	Design of power screws.	CO10	L4
60	Design of power screws.	CO10	L4
61	Numericals on Power Screws	CO10	L4
62	Numericals on Power Screws	CO10	L4
63	Numericals on Power Screws	CO10	L4
64	Design of Screw Jack. (Complete Design)	CO10	L4
65	Design of Screw Jack. (Complete Design)	CO10	L4
c	**Application Areas**	**-**	**-**
-	Students should be able employ / apply the Module learnings to . . .	-	-
1	Bolts & Nuts	CO9	L4
2	Screw Jack	CO10	L4
d	**Review Questions**	-	-
-		-	-
1	Distinguish between temporary and permanent fasteners.	CO9	L2
2	What is the difference between pitch and lead,	CO9	L2
3	Explain the stresses induced in a screw fastening subjected to static, dynamic and impact loading.	CO9	L2
4	A bolt subjected to initial loading of 5kN and final tensile load of 9kN. Determine the size of bolt, if the allowable stress is 80MPa and k=0.05.	CO9	L2
5	Explain self locking and overhaul of screw jack.	CO10	L2
6	Design a screw jack for a capacity of 10kn to lift 200mm height. Select suitable materials and factor of safety.	CO10	L4
7	A triple threaded power screw is used in a screw jack, has a nominal diameter of 50mm and a	CO9	L4

	pitch of 8mm. The threads are square shape and the length of the nut is 48mm. The screw jack is used to lift a load of 7.5kN. The coefficient of friction at the threads is 0.12 and the collar friction is negligible. Calculate I) The principle shear stresses in the screw rod. ii) The transverse shear stress in the screw and nut. Iii) The bearing pressure for threads and iv) State whether the screw is self locking.		
8	A single start square threaded power screw is used to raise a load of 120kN. The screw has mean diameter of 24mm and 4 threads per 24mm length. The mean collar diameter is 40mm. The coefficient of friction is estimated as 0.1 for both thread and the collar (I) Determine the major diameter of the screw. (ii) Estimate the screw torque required to raise the load (iii) Estimate overall efficiency (iv) If friction is estimated, what minimum value of thread coefficient is needed to prevent the screw from overhauling?	CO10	L4
9	Derive expression for maximum efficiency of a square threaded screw	CO9	L2
10	A screw jack is to lift a load of 80kN through a height structure in Fig. is subjected to eccentric load P = 10 kN with eccentricity of 500 mm. All bolts are identical mode of carbon steel ha,ving yield strength in tension is 400 MPa and factor of safety is 2.5. Determine size of bolt. 	CO9	L2
11	A bracket is fixed to wall by 4 bolts and loaded as shown in Fig. Calculate the size of bolts if the load is 10 kN and allowable shear stress in bolt material is 40 Mpa 	CO9	L4
12	The lead screw of a lathe machine has a single start ISO trapezoidal threads of 30 mm outside diameter and 6 mm pitch. It drives a tool carriage against a cutting force of 6 kN at a speed of 720 mm/min. The end of the screw is carried on a thrust washer of outside and inside diameters of 50 mm and 30 mm. the coefficient of thread friction is 0.12 and that for collar is 0.15. Find: i) The torque required to drive the carriage. ii) Power of motor. iii) The efficiency. iv) Compressive stress induced in the screw. v) Length of bronze not required taking allowable bearing pressure in the threads as 1.5 MPa.	CO10	L4
e	**Experiences**	-	-
1			
2			
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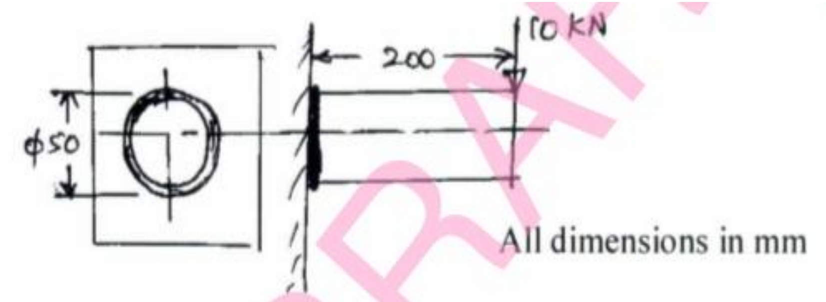
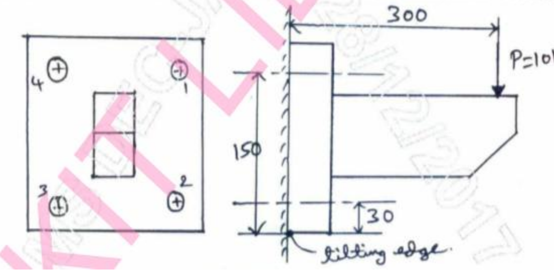
5			

E3. CIA EXAM – 3

a. Model Question Paper - 3

Crs Code:	17ME54	Sem:	5	Marks:	30	Time:	75 minutes
Course:	DESIGN OF MACHINE ELEMENTS -1						

-	-	Note: Answer all questions, each carry equal marks. Module : 4,5	Marks	CO	Level
1	a	Design a longitudinal double riveted strap butt joint with unequal straps for a	8	CO7	L4

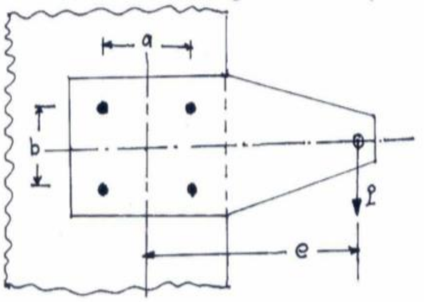
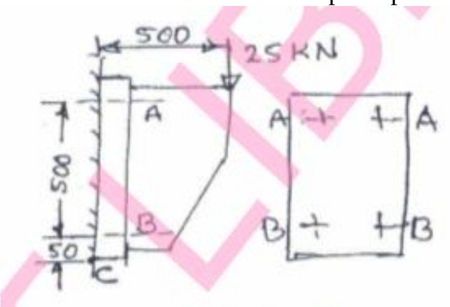
		pressure vessel. The internal diameter of the pressure vessel is 1m and is subjected to an internal pressure of 2.2MPa. The pitch of the rivet in the outer row is to be double the pitch in the inner row. The allowable tensile stress in the plate is 124MPa. The allowable shear & crushing of the rivets are 93MPa & 165MPa respectively.			
	b	For the eccentrically loaded welded joint, determine the size of the weld required. Take permissible stress for the weld as 75MPa.	7	CO8	L4
		OR			
1	a	A circular shaft 50 mm in diameter is welded to a support by means of a fillet weld and loaded as shown in Fig. Determine the size of weld if the permissible shear stress in the weld is limited to 100 Mpa. 	8	CO8	L4
	b		7	CO7	L4
2	a	A triple threaded power screw is used in a screw jack, has a nominal diameter of 50mm and a pitch of 8mm. The threads are square shape and the length of the nut is 48mm. The screw jack is used to lift a load of 7.5kN. The coefficient of friction at the threads is 0.12 and the collar friction is negligible. Calculate I) The principle shear stresses in the screw rod. ii) The transverse shear stress in the screw and nut. Iii) The bearing pressure for threads and iv) State whether the screw is self locking.	9	CO10	L4
	b	A bolt subjected to initial loading of 5kN and final tensile load of 9kN. Determine the size of bolt, if the allowable stress is 80MPa and k=0.05.	6	CO9	L4
		OR			
2	a	A bracket is fixed to wall by 4 bolts and loaded as shown in Fig. Calculate the size of bolts if the load is 10 kN and allowable shear stress in bolt material is 40 Mpa 	7	CO9	L4
	b	A single start square threaded power screw is used to raise a load of 120kN. The screw has mean diameter of 24mm and 4 threads per 24mm length. The mean collar diameter is 40mm. The coefficient of friction is estimated as 0.1 for both thread and the collar. (i) Determine the major diameter of the screw. (ii) Estimate the screw torque required to raise the load (iii) Estimate overall efficiency (iv) If friction is estimated, what minimum value of thread coefficient is needed to prevent the screw from overhauling?	8	CO10	L4

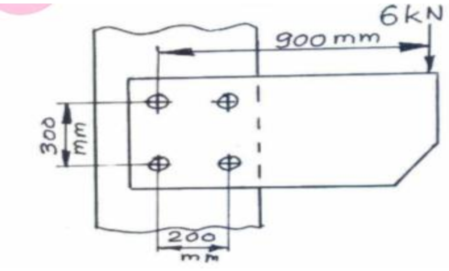
b. Assignment – 3

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

Model Assignment Questions							
Crs Code:	17ME54	Sem:	5	Marks:	10	Time:	90 – 120 minutes
Course:	DESIGN OF MACHINE ELEMENTS -1				Module : 5		
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.							

SNo	USN	Assignment Description	Marks	CO	Level
1		The lead screw of a lathe machine has a single start ISO trapezoidal threads of 30 mm outside diameter and 6 mm pitch. It drives a tool carriage against a cutting force of 6 kN at a speed of 720 mm/min. The end of the screw is carried on a thrust washer of outside and inside diameters of 50 mm and 30 mm. the coefficient of thread friction is 0.12 and that for collar is 0.15. Find: i) The torque required to drive the carriage. ii) Power of motor. iii) The efficiency. iv) Compressive stress induced in the screw. v) Length of bronze nut required taking allowable bearing pressure in the threads as 1.5 MPa.	5	CO10	L4
2		A square threaded power screw has nominal diameter of 30mm and a pitch of 6mm with Double start. Load on screw is 6kN and mean diameter of thrust collar is 40mm. The co- efficient of friction for screw is 0.1 and for collar is 0.09. Determine a) torque required to rotate the screw against the load. b) Torque required to rotate the screw with the load c) overall efficiency d) Is the screw self locking?	5	C10	L4
3		A machine slide weighing 20 kN is raised by a double start square threaded screw at the rate of 0.84 m/min. take p= 0.12 and pc = 0.14. The outside diameter of the screw is 44 mm and the pitch is 7 mm. The outside and inside diameter of the collar at the end of the screw are 58 mm and 32 mm respectively. Calculate the power required to drive slide. If the allowable shear stress in the screw is 30 MPa, is the screw strong enough to sustain load.	5	C10	L4
4		An electric motor driven power screw moves a nut in a horizontal plane against a force of 751(N at 300mm/min. The screw has a single thread of 6mm pitch on a major diameter of 40mm The friction coefficient at screw threads is 0.1. Estimate the power of the motor.	5	C10	L4
5		A screw jack is to lift a load of 80 kN through a height of 400 mm. Ultimate strength of screw material in tension and compression is 200 N/mm2 and in shear 120 N/mm2. The material for the nut is phosphor bronze for which the ultimate strength is 100 N/mm2 in tension and 90 N/mm2 in compression and 80 N/mm2 in shear. The bearing pressure between the nut and the screw is not to exceed 18 N/mm2. Design the screw and nut and check for stresses. Take FOS = 2, assume 25% overload for screw rod design.	5	CO10	L4
6		A single start square-threaded power screw is used to raise a load of 120 kN. The screw has a mean diameter of 24 mm and tour threads per 24 mm length. The mean collar diameter is 40 mm. The coefficient of friction is estimated as 0.1 for both the thread and the collar. (i) Determine the major diameter of the screw. (ii) Estimate the screw torque required to raise the load. (iii) Estimate overall efficiency. (iv) If collar friction is eliminated, what minimum value of thread coefficient is needed to prevent the screw from overhauling?	5	CO10	L4
7		A weight of 500 kN is raised at a speed of 6 m/min by a two screw rods with square threads of 50 x 8 cut on them. The two screw rods are driven through level gear drives by a motor. Determine (i) The torque required to raise the load (ii) The speed of rotation of the screw rod assuming the threads are double start (iii) The maximum stresses in ed in screw rod. (iv) The efficiency of screw drive. (v) The length of nuts for the purpose of supporting the load.	5	CO10	L4
8		An M20 x2 steel bolt of 100 mm long is subjected to impact load. The energy absorbed by the bolt is 2 N-m, i) Determine the stress in the shank of the bolt if there is no threaded portion between the nut and bolt head. ii) Determine the stress in the shank if the entire length of the	5	CO9	L4

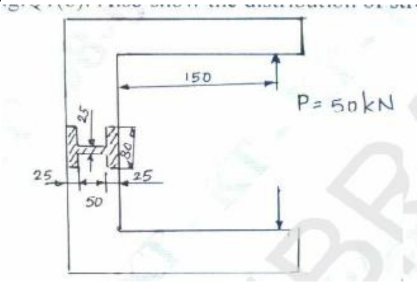
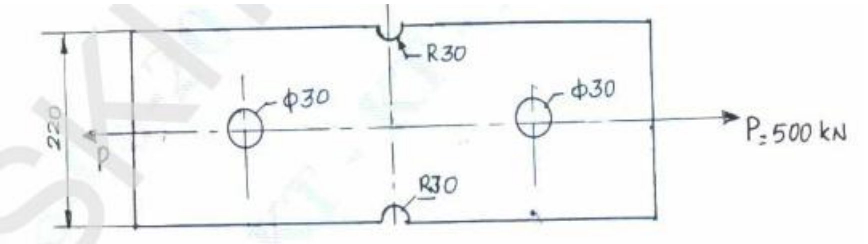
		bolt is threaded. Assume modulus of elasticity for steel as 206 GPa.			
9		A M10 steel bolt of 125 mm long is subjected to an impact load. The kinetic energy absorbed by the bolt is 2.5 Joules. Determine (i) Stres44he shank of the bolt if there is no threaded portion between the nut and the bolt head. (ii) §tress in the shank of the area of the shank is reduced to that of the root area of the threaded or the entire length of the bolt is threaded.	5	CO9	L4
10		A bolt is subjected to initial loading of 5 kN and final tensile load of 9 kN. Determine the size of the bolt. if the allowable stress is 80 MPa and K = 0.05.	5	CO9	L4
11		An M10 steel bolt of 125 mm long is subjected to an impact load. The kinetic energy absorbed by the bolt is 2.5 J. Determine: i) Stress in the shank of the bolt if there is no threaded position between the nut and the bolt head. ii) Stress in the shank if the area of the shank is reduced to that of the root area of the thread or the entire length of bolt is threaded.	5	CO9	L4
12		A flat circular plate is used to close the flanged end of a pressure vessel of internal diameter 300 mm. The vessel carries a fluid pressure of 0.7 N/mm2. A soft copper gasket is used to make the joint leak proof Twelve bolts are used to fasten the cover plate on the pressure vessel. Find the size of the bolt, so that the stress in the bolt not to exceed 100 N/mm2.	5	CO9	L4
13		The structural joint shown in Fig. is subjected to an eccentric load P of 10 kN with an eccentricity of 500 mm from the center of gravity of the bolts arrangement. Distance between the bolts is 200 mm and 150 mm perpendicular and parallel to the direction of the load acting. Bolts are identical and made of plain carbon steel having yield strength of 400 N/mm2. Determine the size of the bolts taking factor of safety as 2.5. 	5	CO9	L4
14		A wall bracket is attached by means of 4 identical bolts, two at 'A' and two at 'B' and loaded as shown in Fig. Assuming that the bracket is held against the wall firmly and prevented from tipping about the point C by all four bolts, determine the size of bolts taking an allowable tensile stress of 35 MPa and based on the maximum principal stress theory 	5	CO9	L4

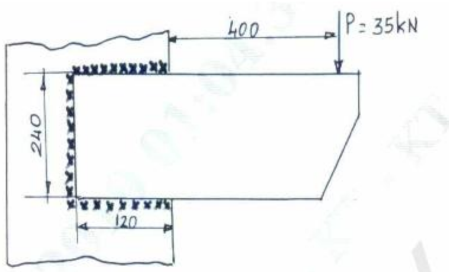
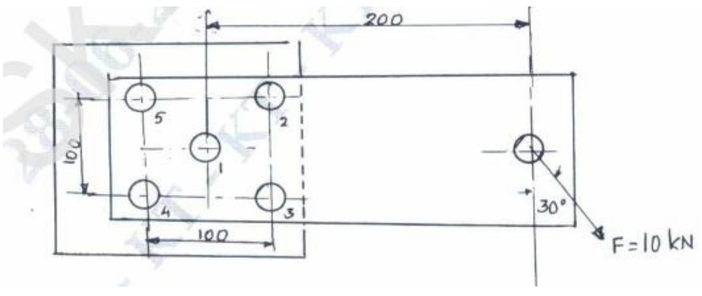
15		A bracket is, bolted as shown in Fig. All the bolts are identical and have allowable stress of 60 MPa. Determine the size of the bolt 	5	CO9	L4

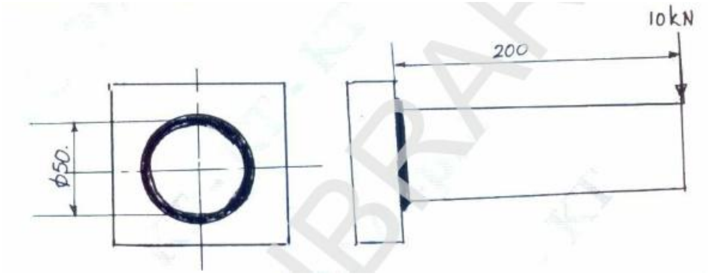
F. EXAM PREPARATION

1. University Model Question Paper

Course:	DESIGN OF MACHINE ELEMENTS -1					Month / Year	Dec /2019	
Crs Code:	17ME54	Sem:	5	Marks:	60	Time:	180 minutes	

Module	Note	Answer all FIVE full questions. All questions carry equal marks.	Marks	CO	Level
1	a	Determine the extreme fibre stresses at the critical section of the machine member loaded as shown in Fig. Also show the distribution of stresses at this section. 	12	CO1	L4
	b	Give any three examples of stress raisers and show how the stress concentration can be reduced in these cases.	8	CO2	L2
		OR			
2	a	A machine element loaded as show, n in Fig. Determine the safe value of thickness of the plate. Material selected for the machine element has an allowable stress of 200 MPa. 	12	CO2	L3
	b	Briefly discuss the factors influencing the selection of suitable material for machine elements.	8	CO1	L2
3	a	Derive an expression for impact stress in a axial bar of c/s A and length due to the impact load of 'W' falling from a height 'h' from the collar.	8	C03	L2
	b	hot rolled steel shaft is subjected to a torsional load varies from 330 Nm clockwise to 110 Nm counter, clockwise and an applied bending moment varies from +440 Nm to —220 Nm. Determine the required shaft diameter. The ultimate strength of the material is 550 MPa and yield stress is 410 MPa. Take factor of safety as 1.5, endurance limit as half the ultimate strength and size factor as 0.85. Neglect the effect of stress concentration	12	CO4	L4
		OR			

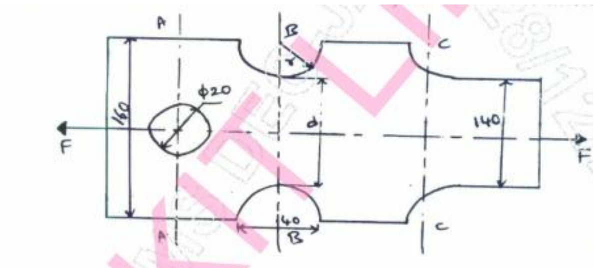
4	a	A steel cantilever beam of rectangular cross section is loaded 400 mm from the support. The width of the beam is 15 mm and depth is 20 mm. Determine the max bending stress in the beam, when a weight of 100 N is dropped on the beam through a height of 5 mm. Take F = 210 N/mm2.	10	CO3	L4
	b	Derive Soderberg's design equation for members subjected to variable stresses.	6	CO4	L2
	c	Explain with neat sketches, the different types of varying stresses.	4	CO3	L2
5		A steel shaft (C45) transmitting 15 kW at 210 rpm is supported between two bearings 1000 mm apart. On this, two spur gears are mounted. The gear having 80 teeth of module 6 mm is located 100 mm to the left of the right bearing and receives power from a driving gear such that the tangential force acts vertical. The pinion having 24 teeth and 6 mm module located 200 mm to the right of the left bearing and delivers power to a gear mounted behind it. Taking combined shock and fatigue factors 1.75 in bending and 1.25 in torsion, determine the diameter of the shaft.	20	CO5	L4
		OR			
6	a	Design a socket and spigot type of cotter joint for an axial load of 50 kN which alternately changes from tensile to compressive, assuming allowable stresses in the components under tension and compression as 52.5 MPa, bearing stress as 63 MPa and shearing stress as 35 MPa.	10	CO6	L4
	b	Design a protected type cast-iron flange coupling for a steel shaft transmitting 30 kW at 200 rpm. The allowable shear stress in the shaft and key material is 40 MPa. The maximum torque transmitted is 20% greater than the full load torque. The allowable shear stress in the bolt is 60 MPa and allowable shear stress in the flange is 40 MPa.	10	CO6	L4
7	a	esign a double riveted butt joint to connect two plates of 20 mm thick. The joint is zig-zag riveted and has equal width cover plates. The allowable tensile stress for the plate is 100 MPa. The allowable shear and crushing stresses for rivet material are 60 MPa and 120 MPa respectively. Calculate the efficiency of the joint so that the joint should be leak proof.	10	CO7	L4
	b	steel plate is welded by fillet weds to a structure and is loaded as shown in Fig. Calculate the size of the weld, if the load is 35 kN and allowable shear stress for the weld material is 90 MPa. 	10	C08	L4
		OR			
8	a	Determine the size of rivets required for the bracket shown in Fig. Take permissible shear stress for the rivet material as 100 MPa. 	10	CO7	L4
	b	A circular beam, 50 mm in diameter is welded to a support by means shown in Fig. Determine the size of the weld, if the permissible weld is limited to 100 N/mm2.	10	CO8	L4

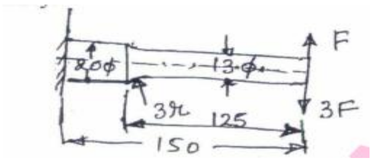


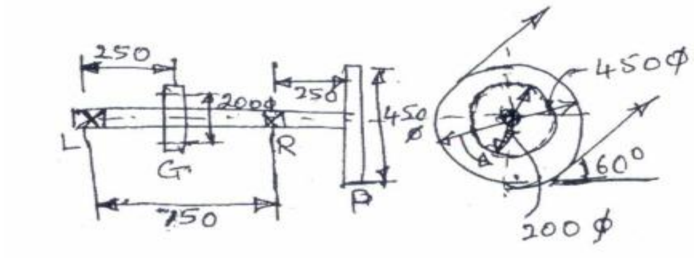
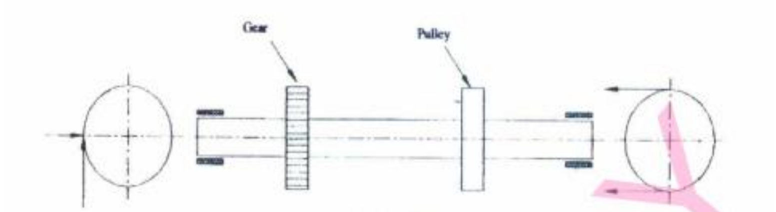
9	a	Explain various types of stresses in threaded fasteners.	6	CO9	L2
	b	A square threaded power screw has a nominal diameter of 30 mm and a pitch of 6 mm with double start. Load on the screw is 6 kN and the mean diameter of the thrust collar is 40 mm. The coefficient of friction for screw is 0.1 and for collar is 0.09. Determine: i) Torque required to rotate the screw against the load. ii) Torque required to rotate the screw with the load. iii) Overall efficiency. iv) Is the screw self-locking?	12	CO10	L4
		OR			
10	a	Derive an expression for torque required to lift the load on a square threaded screws.	8	CO9	L2
	b	A cylinder head is fastened to the cylinder of a compressor using 6 bolts of M20 size. Bolt material is C20 steel. The maximum fluid pressure is 3.5 MPa, cylinder diameter is 75 mm. A soft gasket is used. Assuming initial tension in each bolt is 40 kN, determine the factor of safety.	12	C010	L4

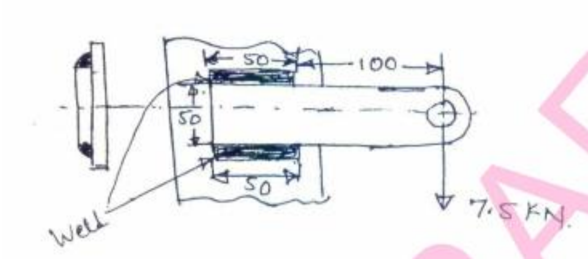
2. SEE Important Questions

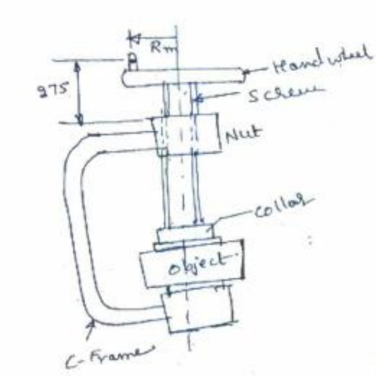
Course:	DESIGN OF MACHINE ELEMENTS - 1					Month / Year	May /2018
Crs Code:	17ME54	Sem:	5	Marks:	60	Time:	180 minutes

	Note	Answer all FIVE full questions. All questions carry equal marks.	-	-	
Module	Qno.	Important Question	**Marks**	**CO**	**Year**
1	1	What is Mechanical Engineering Design? Explain	4	CO1	2019
	2	Explain the importance of standards in design. List different types of standards in use.	4	CO1	2019
	3	State and explain following theories of failure: (i) Maximum normal stress theory. (ii) Maximum shearing stress theory.	6	CO2	2019
	4	mass of 15 kg falls from a height of 250 mm at the midpoint of a simply supported beam. It is made of steel, has a length of 1 m between the supports. Cross section of the beam is 60mm x 60mm square. Determine maximum deflection and bending stress induced in the beam due to falling mass.	8	CO2	2019
	5	A flat bar shown in Fig. is subjected to an axial load of 100 kN. Assuming that the stress in the bar is limited to 200 Nimm2, determine the thickness of bar. 	12	CO2	2018
2	1	A cantilever beam made of carbon steel of circular cross section shown in Fig. is subjected to a load which varies from (-F) to (+3F). Determine the maximum load that this member can withstand for an	14	CO3	2017

		infinite life using factor of safety '2'. Theoretical stress concentration factor of Kt = 1.42 and notch sensitivity of 0.9 may be used, with following stresses. (i) Ultimate strength au = 550 MPa, Yield strength ay = 470 MPa. Assume endurance strength as 0.5 times ultimate strength (a.) and other correction factors for endurance strength suitably. 			
	2	Derive the soderberg equation for members subjected to fluctuating stresses	6	CO3	2017
	3	Explain briefly the following : (i) High cycle and low cycle fatigue (ii) Endurance limit.	8	CO3	2016
	4	A simply supported beam has a concentrated load at the centre which fluctuates from a value of P to 4P. The span of the beam is 500 mm and its cross-section is circular with a diameter of 60 mm. Taking for the beam material an ultimate stress of 700 MPa, a yield stress of 500 MPa, endurance limit of 330 MPa for reversed bending, and a factor of safety of 1.3, calculate the maximum load of P. Take a size factor of 0.85, a surface finish factor of 0.9 and fatigue stress concentration factor of 1.	10	CO4	2015
	5	A flat circular plate is used to close the flanged end of a pressure vessel of internal diameter 300 mm. The vessel carries a fluid pressure of 0.7 N/mm2. A soft copper gasket is used to make the joint leak proof Twelve bolts are used to fasten the cover plate on the pressure vessel. Find the size of the bolt, so that the stress in the bolt not to exceed 100 N/mm2	10	CO4	2016
3	1	A machine shaft running at 600 rev/min is supported on bearings 750 mm apart as shown in Fig. Q5. Fifteen KW is supplied to the shaft through a 450 mm. Pulley (P) located 250 mm to the right of the right bearing (R). The power is given away from the shaft through a 200 mm spur gear (G) located 250 mm to the right of the left bearing (L). The belt drive is at angle of 60° above the horizontal. The pulley weighs 800 N to provide some flywheel effect. The ratio of belt tensions is 3 : 1. The gear has a 20° tooth form and mates another gear located directly above it. The shaft material has an ultimate strength of 500 MPa and a yield strength of 310 MPa. Determine the necessary diameter of shaft as per ASME standards. Take the load factors in bending and torsion as 1.5 and 1.0 respectively and also keyway effects due to mounting of gear and pulley. The shaft rotates CCW looking from left as shown.	20	CO5	2017

					
	2	Explain what do you understand by bolts of uniform strength.	4	CO5	2017
	3	Design a knuckle joint to transmit 120 kN. The design stresses may be taken as 75 MPa in tension, 60 MPa in shear and 150 MPa in compression	8	CO6	2017
	4	Design a cast iron flange coupling for a mild steel shaft transmitting 90 kW at 250 r.p.m. The allowable shear stress in the shaft is 40 MPa and the angle of twist is not to exceed 1° in a length of 20 diameters. The allowable shear stress in the coupling bolts is 30 MPa	9	CO6	2017
	5	A uniform circular carbon steel shaft made of SAE 1025 annealed is mounted on two bearings 850 mm apart as shown in the Fig.Q5. The shaft carries a gear 'A' at 200 mm to the right of the left bearing and a pulley 'B' at 250 mm to the left of the right bearing. The gear is subjected to horizontal pressure of 3500 N and a vertical upward pressure of 9600 N. The pulley is driven by a belt with a tension on tight side to be 6000 N and on the slack side to be 2000 N. The shock and fatigue factors for bending and torsion as Km = 2 and Kt = 1.5 respectively and weight of the pulley to be 1500 N. Design the diameter of the shaft for yield stress taking factor of safety as 3. Draw neatly the sketch with loading and bending moment diagrams. Gar 	20	CO6	2016
4	1	Design a knuckle joint to connect two circular rods subjected to an axial load of 50 KN. The rods are co-axial and a small angular movement between their axes is permissible. Assume the strength of the rods and pin same in tension and compression and equal to 400 MPa(ay) and shear strength is to be taken as 0.5 times yield strength. Factor of safety is 5. Also write a neat sketch of the assembly.	10	CO7	2017
	2	It is required to design a protected type rigid flange coupling to	10	CO7	2017

		connect two shafts. The shaft transmit 37.5 kW at 180 rev/min to the output shaft through the coupling. Starting torque is 1.5 times rated torque. The shafts and keys are made of steel with yield strength a= 380 N/mm2 with a factor of safety 2.5. Flanges are made by C.I. FG 200 with a factor yt of safety 6. Assume ultimate shear strength as one half of the ultimate tensile strength. Also draw a sketch of the coupling.			
	3	A welded connection as shown in Fig. is subjected to an eccentric force of 7.5 kN. Determine the size of weld if the permissible shear stress for the weld is limited to 100 MPa.  	10	CO8	2016
	4	Design a double riveted double strap longitudinal butt joint, for a cylindrical steam pressure vessel of 1 m diameter subjected to an internal pressure of 2.5 MPa. The straps are of equal width. The pitch of the rivets in the outer row should be twice of the pitch of the rivets in the inner row. The rivets spacing has to be zig zag, between inner and outer rows, permissible tensile stress for the plates of vessel is 80 MPa and permissible shear stress for the rivets is 60 MPa. Assuming joint do not fail by crushing, determine the major dimensions and efficiency of the joint, which should be at least 70%.	10	CO8	2017
	5	double riveted lap joint with zig-zag riveting is to be designed for 13 mm thick plates. Assume out = 80 MPa; t = 60 MPa ; = 80 MPa. State how the joint will fail and find the efficiency of the joint	10	CO8	2017
5	1	What is self locking screw? Show that efficiency of a square threaded self locking screw is less than ½ —50%	10	CO9	2017

	2	It is required to design a double start screw with square threads for the C-clamp shown in Fig. Q8 (b). The maximum force exerted by the clamp is 5 KN. It is assumed that, operator will exert a force of 250 N at the ball handle of the hand wheel. The screw has a nominal diameter of 22 mm, normal series square threads with 5 mm pitch and is made of 45C8 steel and the nut is made of FG200 cast iron. The mean diameter of collar friction is 12 mm and the bearing pressure between nut and screw may be assumed as 15 MPa. Check whether stress are safe and determine the radius of hand wheel. Assume a thread friction of 0.15 and collar friction as 0.17 	10	CO10	2017
	3	Explain self locking and overhauling in power screws.	16	CO9	2017
	4	A vertical two start square threaded screw of 100 mm mean diameter and 20 mm pitch supports a vertical load of 18 kN. The nut of the screw is fitted in the hub of a gear wheel having 80 teeth which meshes with a pinion of 20 teeth. The mechanical efficiency of the pinion and gear wheel drive is 90 percent. The axial thrust on the screw is taken by a collar bearing 250 mm outside diameter and 100 mm inside diameter. Assuming uniform pressure conditions, find minimum diameter of pinion shaft and height of nut, when coefficient of friction for vertical screw and nut is 0.15 and that for the collar bearing is 0.20. Take t = 56 MPa and Pb = 1.4 MPa.	14	CO10	2017
	5	A machine slide weighing 20 kN is raised by a double start square threaded screw at the rate of 0.84 m/min. take p. = 0.12 and pc = 0.14. The outside diameter of the screw is 44 mm and the pitch is 7 mm. The outside and inside diameter of the collar at the end of the screw are 58 mm and 32 mm respectively. Calculate the power required to drive slide. If the allowable shear stress in the screw is 30 MPa, is the screw strong enough to sustain load	10	CO10	2015

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	Fundamentals of Mechanical Engineering Design, Static stresses	7	- L2 - L4	L4	Compute	- Lecture -	- CIA -Assignment
1	Stress concentration & Stress concentration factor.	5	- L2 - L4	L4	-Compute -	- Lecture - Tutorial	-CIA Assignment
2	Design for Impact Loads	5	- L2 - L4	L4	-Analyse -	- Lecture -	-CIA Assignment
2	Design for Fatigue Loads	7	- L2 - L4	L4	-Analyse -	- Lecture -	- CIA Assignment
3	Design of Shafts	8	- L2 - L4	L4	-Analyse -	- Lecture -	- CIA Assignment
3	Design of Joints, Couplings and Keys	7	- L2 - L4	L4	-Compute -	- Lecture - Tutorial	-CIA Assignment
4	Riveted Joints	7	- L2 - L4	L4	-Compute -	- Lecture - Tutorial	-CIA Assignment
4	Weld Joints	6	- L2 - L4	L4	-Analyse -	- Lecture - Tutorial	-CIA Assignment
5	Threaded Fasteners	6	- L2 - L2	L2	-Analyse -	- Lecture -	-CIA Assignment
5	Power Screws	7	- L2 - L4	L4	-Analyse -	- Lecture -	-CIA Assignment

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*
1	Fundamentals of Mechanical Engineering Design, Static stresses	-Design Process & material selection - static combined combined	Design Process & Combined stresses	Process of Mech. Engg. Design	- Understand - Compare induced stresses with Allowable stress	Understand the steps in Mech. Engg. Design.
1	Stress concentration & Stress concentration factor.	-Stress Concentration & SCF -	Analysis of Stress concentration factor	Examine the members with discontinuities and change of cross section	- Analyze - Consider stress concentration -SCF	Analyze the elements with stress concentration and use SCF for design..
2	Design for Impact Loads	-Analysis of members under Impact loads	Impact Analysis	Understand Impact, effect of impact	- Analyze - members under axial & bending impact loads - -	Analyze the members under axial & bending impact loads.
2	Design for Fatigue Loads	-Analysis of elements under cyclic loads	Fatigue Analysis	Understand Fatigue, effect of fatigue loads	- Understand - Analyse members under simple and combined fatigue loads -	Understand fatigue loads & design members under combined loads.
3	Design of Shafts	-Analysis of Shafts -	Power transmission Shafting	Knowledge of power transmission by pulley, gear drives	- Understand - Types of power drives	Understand power drives and to design of power transmission shafts.
3	Design of Joints,	-Analysis of	Analysis of Coupling, keys	Understand Coupling, keys & joints	- Analyse - Design Couplings,	Design Coupling, keys & joints.

	Couplings and Keys	Coupling & joints	& joints		keys and joints -	
4	Riveted Joints	-Boiler joint analysis -	Riveted joint analysis	Understand boiler joints like longitudinal & circumferential joints	- Analyse Boiler joints & structural joints -	Design boiler joints and structural joints using rivets.
4	Weld Joints	-Welded joint analysis -	Analysis of welded joints	Analyse parallel, transverse and eccentrically loaded welded joints	- Analyze - Design welded joints	Analyze types of welded joints and to design them.
5	Threaded Fasteners	-Analysis of threaded fasteners	Threaded fasteners analysis	Understand Threaded fasteners	- Understand - design threaded fasteners	Understand the principle of threaded fasteners and design them.
5	Power Screws	Analysis of power screws	Analysis of Power screws	Understand the priciple of power screws	- Understand - design screws used in power transmission	Design the power screws, Screw Jack