DESIGN OF MACHINE MEMBERS-I (ME502PC)

COURSE PLANNER

I. **OBJECTIVE AND RELEVANCE:**

Design is a process that ends in creation of something which will satisfy some need of a person, group of persons or society. The homes and buildings in which we reside, the dams which store water for irrigation or generation of electricity, an engine which is used for pumping water or a hoist for lifting loads are the things that are designed before they are made. The design does not pertain to a single device, structure or product or even something which can be seen to exist. The process of design can achieve a system, which can be identified by its physical entity or by service, and learning to design simple elements is the objective of this course.

Design plays an important role in all three of the major phases of a product lifecycle:

- Invention—identification of a need, development of requirements, concept generation, prototype development, manufacturing, and verification testing.
- Performance engineering—enhancing manufacturing efficiency, reducing service and maintenance demands, adding features and improving effectiveness, and validation testing.
- Recycle—decommissioning and disposal, recovery and reuse of materials and components.

II. **SCOPE OF COURSE:**

Scope of this course is to learn the design process for elements like the Fasteners, Welded joints, Keys, Cotter and Knuckle joints, Shafts and different types of Shaft couplings. At the end of the course, student would be able to design different types of machine elements.

III. **Pre-requisites**:

Engineering mechanics, mechanics of solids, manufacturing processes, metallurgy and material science.

IV. **Course Objectives**:

1	To understand the general design procedures and principles in the design of machine elements
2	To study different materials of construction and their properties and factors determining the selection of material for various applications.
3	To determine stresses under different loading conditions.
4	To learn the design procedure of different fasteners, joints, shafts and couplings

V. **COURSE OUTCOME**

Sl No	Description	Blooms Taxonomy levels
1	The student acquires the knowledge about the principles of design, material selection, component behavior subjected to loads, and criteria of failure	Knowledge(L1),Understand(L2), Application(L3)
2	Understands the concepts of principal stresses, stress concentration in machine members and fatigue loading	Knowledge(L1),Understand(L2),

3	Design on the basis of strength and rigidity and analyze the stresses and strains induced in a machine element.	Design (L6)

VI. **HOW PROGRAM OUTCOMES ARE ASSESSED:**

Program Outcomes (PO)		Level	Proficiency assessed by
PO1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems related to Computer Science and Engineering.	3	Assignments
PO2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems related to Computer Science and Engineering and reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	3	Assignments
PO3	**Design/development of solutions**: Design solutions for complex engineering problems related to Computer Science and Engineering and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	2	Assignments
PO4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	2.5	Assignments
PO5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	--	--
PO6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the Computer Science and Engineering professional engineering practice.	---	Assignments
PO7	**Environment and sustainability**: Understand the impact of the		

	Computer Science and Engineering professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	-	--
PO8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	-	--
PO9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	**3**	**--**
PO10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	**2**	**--**
PO11	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	-	--
PO12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	**3**	Research

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) - : None

VII. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES: CO-PSO MAPPING

COURSE OOTCOME (CO'SS)	Program Outcomes (PO's)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO 1	3	3	2	--	--	--	--	--	3	2	--	3
CO 2	3	3	2	2	--	--	--	--	3	2	--	3
CO 3	3	3	3	3	--	--	--	--	3	2	--	3
Average	3	3	2	2.5	--	--	--	--	3	2	--	3

HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED

COURSE OOTCOME (CO'SS)	PSO ATTAINMENT		
	PSO 1	PSO 2	PSO 3
CO 1	3	3	1
CO 2	3	2	1
CO 3	3	3	1
Average	3	3	1

VII. JNTU SYLLABUS

UNIT – I Introduction: General considerations in the design of Engineering Materials and their properties – selection –Manufacturing consideration in design. Tolerances and fits –BIS codes of steels. Design for Static Strength: Simple stresses – Combined stresses – Torsional and Bending stresses – Impact stresses – Stress strain relation – Various theories of failure – Factor of safety – Design for strength and rigidity – preferred numbers. The concept of stiffness in tension, bending, torsion and combined situations.

UNIT – II Design for Fatigue Strength: Stress concentration–Theoretical stress Concentration factor– Fatigue stress concentration factor- Notch Sensitivity – Design for fluctuating stresses – Endurance limit – Estimation of Endurance strength – Gerber's curve– Modified Goodman's line– Soderberg's line

UNIT – III Riveted, Welded and Bolted Joints: Riveted joints- methods of failure of riveted jointsstrength equations-efficiency of riveted joints-eccentrically loaded riveted joints. Welded joints-Design of fillet welds-axial loads-circular fillet welds under bending, torsion. Welded joints under eccentric loading. Bolted joints – Design of bolts with pre-stresses – Design of joints under eccentric loading – locking devices – bolts of uniform strength

. UNIT – IV Keys, Cotters and Knuckle Joints: Design of keys-stresses in keys-cottered joints-spigot and socket, sleeve and cotter, jib and cotter joints-Knuckle joints.

UNIT – V
Shafts: Design of solid and hollow shafts for strength and rigidity – Design of shafts for combined bending and axial loads – Shaft sizes – BIS code. Use of internal and external circlips, Gaskets and seals (stationary & rotary) Shaft Couplings: Rigid couplings – Muff, Split muff and Flange couplings. Flexible couplings – Flange coupling (Modified).

TEXT BOOKS:
1. Design of Machine Elements / V. Bhandari / Mc Graw Hill
2. Machine Design / Jindal / Pearson

REFERENCE BOOKS:
1. Design of Machine Elements / V. M. Faires / Macmillan
2. Design of Machine Elements-I / Annaiah, M.H / New Agel

IX. COURSE PLAN (WEEK – WISE)

Lecture. No.	UNIT No.	Weeks	Topics to be covered	Content to be covered under each topic	links for PDF	links for ppt	Link for Small Projects/ Numericals(if any)	Course Learning Outcomes	Teaching Methodology	References
1	1	1	Introduction & Considerations in the design of Engineering Materials and their properties	● Introduction ● Considerations points ● Material Properties	https://drive.google.com/drive/folders/1A71xQhQP62b_2jvbI0-sYHIIMUGkswav?usp=sharing	https://drive.google.com/drive/folders/10qSLZUCqbhHmvpoKPBG6gPGUKgvWB2DS?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	Understand	Chalk and Talk	R1,R2
2	1		Material properties and selection of materials	● selection of materials	https://drive.google.com/drive/folders/1A71xQhQP62b_2jvbI0-sYHIIMUGkswav?usp=sharing	https://drive.google.com/drive/folders/10qSLZUCqbhHmvpoKPBG6gPGUKgvWB2DS?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	Understand	FLIPPED CLASS ROOM	R1,R2
3	1	2	Manufacturing considerations in Design	● Considerations points	https://drive.google.com/drive/folders/1A71xQhQP62b_2jvbI0-sYHIIMUGkswav?usp=sharing	https://drive.google.com/drive/folders/10qSLZUCqbhHmvpoKPBG6gPGUKgvWB2DS?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	Understand	FLIPPED CLASS ROOM	R1,R2

4	1		Tolerances	● Types	https://drive.google.com/drive/folders/1A71xQhQP62b_2jvbI0-sYHIIMUGkswav?usp=sharing	https://drive.google.com/drive/folders/10qSLZUCqbhHmvpoKPBG6gPGUKgvWB2DS?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	Understand	FLIPPE	R1,R2
5	1		Theories of failure-Factor of safety	● Types of Theories of failure ● FOS	https://drive.google.com/drive/folders/1A71xQhQP62b_2jvbI0-sYHIIMUGkswav?usp=sharing	https://drive.google.com/drive/folders/10qSLZUCqbhHmvpoKPBG6gPGUKgvWB2DS?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	Understand	FLIPPED CLASS ROOM	R1,R2
6	1	3	Design for strength and rigidity	● concept & numericals based on strength & rigidity	https://drive.google.com/drive/folders/1A71xQhQP62b_2jvbI0-sYHIIMUGkswav?usp=sharing	https://drive.google.com/drive/folders/10qSLZUCqbhHmvpoKPBG6gPGUKgvWB2DS?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	Understand	FLIPPED CLASS ROOM	R1,R2
7	1		Preferred numbers, Theoretical stress Concentration factor	● Preferred numbers concept ● Theoretical stress Concentration factor concept	https://drive.google.com/drive/folders/1A71xQhQP62b_2jvbI0-sYHIIMUGkswav?usp=sharing	https://drive.google.com/drive/folders/10qSLZUCqbhHmvpoKPBG6gPGUKgvWB2DS?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	Understand	FLIPPED CLASS ROOM	R1,R2

8	1		Simple stresses , combined stresses and fits, BIS codes of steels.	• Simple stresses & combined stresses concept & Formula	https://drive.google.com/drive/folders/1A71xQhQP62b_2jvbI0-sYHIIMUGkswav?usp=sharing	https://drive.google.com/drive/folders/10qSLZUCqbhHmvpoKPBG6gPGUKgvWB2DS?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	Unders Unders tand	FLIPPED CLASS ROOM	R1,R2
9	1	4	Torsional and bending stresses	• Torsional and bending stresses concept & Formula	https://drive.google.com/drive/folders/1A71xQhQP62b_2jvbI0-sYHIIMUGkswav?usp=sharing	https://drive.google.com/drive/folders/10qSLZUCqbhHmvpoKPBG6gPGUKgvWB2DS?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	Understand	FLIPPED CLASS ROOM	R1,R2
10	1		Impact stresses,	• Derivation & concept	https://drive.google.com/drive/folders/1A71xQhQP62b_2jvbI0-sYHIIMUGkswav?usp=sharing	https://drive.google.com/drive/folders/10qSLZUCqbhHmvpoKPBG6gPGUKgvWB2DS?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	Understand	FLIPPED CLASS ROOM	R1,R2
11	2		Stress and strain relations	• Formula	https://drive.google.com/drive/folders/1tklPWYLQyxP5W1oRE48dyLdoCIKk6Tcw?usp=sharing	https://drive.google.com/drive/folders/1iYvBAMZbr7sZPQR7Ipg0jc6vPQ6oS4Pj?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	Understand	THINK-PAIR-SHARE	R1,R2

12	2		Stiffness in tension	• Concept & Numericals	https://drive.google.com/drive/folders/1tklPWYLQyxP5W1oRE48dyLdoCIKk6Tcw?usp=sharing	https://drive.google.com/drive/folders/1iYvBAMZbr7sZPQR7Ipg0jc6vPQ6oS4Pj?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	Study	Chalk and Talk	1,2
13	2	5	Bending	• Defination & Concept & Numericals on Bending Stress	https://drive.google.com/drive/folders/1tklPWYLQyxP5W1oRE48dyLdoCIKk6Tcw?usp=sharing	https://drive.google.com/drive/folders/1iYvBAMZbr7sZPQR7Ipg0jc6vPQ6oS4Pj?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing			
14	2		Combined stresses	• Defination & Concept & Numericals on Combined Stress	https://drive.google.com/drive/folders/1tklPWYLQyxP5W1oRE48dyLdoCIKk6Tcw?usp=sharing	https://drive.google.com/drive/folders/1iYvBAMZbr7sZPQR7Ipg0jc6vPQ6oS4Pj?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	Understand	FLIPPED CLASS ROOM	T1,T2
15	2	6	Stress concentration, stress concentration factor	• Definition, Formula	https://drive.google.com/drive/folders/1tklPWYLQyxP5W1oRE48dyLdoCIKk6Tcw?usp=sharing	https://drive.google.com/drive/folders/1iYvBAMZbr7sZPQR7Ipg0jc6vPQ6oS4Pj?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	Understand	FLIPPED CLASS ROOM	**T1,T2**

16	2		Fatigue stress concentration factor	• Concept, Formula	https://drive.google.com/drive/folders/1tklPWYLQyxP5W1oRE48dyLdoCIKk6Tcw?usp=sharing	https://drive.google.com/drive/folders/1iYvBAMZbr7sZPQR7Ipg0jc6vPQ6oS4Pj?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	Understand	FLIPPED CLASS ROOM	T1,T2
17	2		Notch sensitivity	• Concept, Formula	https://drive.google.com/drive/folders/1tklPWYLQyxP5W1oRE48dyLdoCIKk6Tcw?usp=sharing	https://drive.google.com/drive/folders/1iYvBAMZbr7sZPQR7Ipg0jc6vPQ6oS4Pj?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	Understand	NOTE CHECK	**T1,T2**
18	2	7	Design for fluctuating stresses , Endurance limit	• Concept, Formula	https://drive.google.com/drive/folders/1tklPWYLQyxP5W1oRE48dyLdoCIKk6Tcw?usp=sharing	https://drive.google.com/drive/folders/1iYvBAMZbr7sZPQR7Ipg0jc6vPQ6oS4Pj?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	Understand	FLIPPED CLASS ROOM	T1,T2
19	2		Endurance strength	• Concept, Formula	https://drive.google.com/drive/folders/1tklPWYLQyxP5W1oRE48dyLdoCIKk6Tcw?usp=sharing	https://drive.google.com/drive/folders/1iYvBAMZbr7sZPQR7Ipg0jc6vPQ6oS4Pj?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	Understand	FLIPPED CLASS ROOM	**T1,T2**

20	2		Gerbers curve, soderbergs line.	• Curve Graph, Concept, Formula	https://drive.google.com/drive/folders/1tklPWYLQyxP5W1oRE48dyLdoCIKk6Tcw?usp=sharing	https://drive.google.com/drive/folders/1iYvBAMZbr7sZPQR7Ipg0jc6vPQ6oS4Pj?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	Understand	FLIPPED CLASS ROOM	T1,T2
21	2		Modified goodmans line	• Curve Graph, Concept, Formula	https://drive.google.com/drive/folders/1tklPWYLQyxP5W1oRE48dyLdoCIKk6Tcw?usp=sharing	https://drive.google.com/drive/folders/1iYvBAMZbr7sZPQR7Ipg0jc6vPQ6oS4Pj?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	Understand	FLIPPED CLASS ROOM	**T1,T2**
22	2	8	Methods of failure of riveted joints	• Concept, Formula	https://drive.google.com/drive/folders/1tklPWYLQyxP5W1oRE48dyLdoCIKk6Tcw?usp=sharing	https://drive.google.com/drive/folders/1iYvBAMZbr7sZPQR7Ipg0jc6vPQ6oS4Pj?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	COMPARE	THINK-PAIR-SHARE	T1,T2
23	2		Strength equations	• Concept, Formula	https://drive.google.com/drive/folders/1tklPWYLQyxP5W1oRE48dyLdoCIKk6Tcw?usp=sharing	https://drive.google.com/drive/folders/1iYvBAMZbr7sZPQR7Ipg0jc6vPQ6oS4Pj?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	COMPARE	FLIPPED CLASS ROOM	**T1,T2**

24	2		Efficiency of riveted joints	• Concept, Formula	https://drive.google.com/drive/folders/1tklPWYLQyxP5W1oRE48dyLdoCIKk6Tcw?usp=sharing	https://drive.google.com/drive/folders/1iYvBAMZbr7sZPQR7Ipg0jc6vPQ6oS4Pj?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	ANALYZE	FLIPPED CLASS ROOM	T1,T2
25	3	9	Eccentrically loaded riveted joints	• Concept, Formula & Numericals on Eccentric Loading	https://drive.google.com/drive/folders/10ScWOAhFW7LpPhc963cCHIJ5swvsVIC1?usp=sharing	https://drive.google.com/drive/folders/1AgHGdgeumxvkQOHyb__ZsixckCiOfNoc?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	Understand	FLIPPED CLASS ROOM	**T1,T2**
26	3		Design of fillet and axially loaded welded joints	• Concept, Formula & Numericals on Fillet welded Joint	https://drive.google.com/drive/folders/10ScWOAhFW7LpPhc963cCHIJ5swvsVIC1?usp=sharing	https://drive.google.com/drive/folders/1AgHGdgeumxvkQOHyb__ZsixckCiOfNoc?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	Study	Chalk and Talk	1,2
27	3	10	Eccentrically loaded welded joints	• Concept, Formula & Numericals on Eccentric Welded Joint	https://drive.google.com/drive/folders/10ScWOAhFW7LpPhc963cCHIJ5swvsVIC1?usp=sharing	https://drive.google.com/drive/folders/1AgHGdgeumxvkQOHyb__ZsixckCiOfNoc?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	Understand	FLIPPED CLASS ROOM	T1,T2

28	3		Design of bolted joints , eccentric loading , locking	• Concept, Formula & Numericals on Eccentric bolted Joint	https://drive.google.com/drive/folders/10ScWOAhFW7LpPhc963cCHIJ5swvsVIC1?usp=sharing	https://drive.google.com/drive/folders/1AgHGdgeumxvkQOHyb__ZsixckCiOfNoc?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	Application	FLIPPED CLASS ROOM	T1,T2
29	3	11	Bolts of uniform strength	• Concept, Formula	https://drive.google.com/drive/folders/10ScWOAhFW7LpPhc963cCHIJ5swvsVIC1?usp=sharing	https://drive.google.com/drive/folders/1AgHGdgeumxvkQOHyb__ZsixckCiOfNoc?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	Application	FLIPPED CLASS ROOM	T1,T2
30	3		Numericals	• Numericals on Bolted Joint	https://drive.google.com/drive/folders/10ScWOAhFW7LpPhc963cCHIJ5swvsVIC1?usp=sharing	https://drive.google.com/drive/folders/1AgHGdgeumxvkQOHyb__ZsixckCiOfNoc?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	Application	FLIPPED CLASS ROOM	T1,T2
31	3	12	Introduction to keys	• Introduction , Defination	https://drive.google.com/drive/folders/10ScWOAhFW7LpPhc963cCHIJ5swvsVIC1?usp=sharing	https://drive.google.com/drive/folders/1AgHGdgeumxvkQOHyb__ZsixckCiOfNoc?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	Application	FLIPPED CLASS ROOM	T1,T2

32	3		Design of keys	• Design of keys & Types	https://drive.google.com/drive/folders/10ScWOAhFW7LpPhc963cCHIJ5swvsVIC1?usp=sharing	https://drive.google.com/drive/folders/1AgHGdgeumxvkQOHyb__ZsixckCiOfNoc?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	Application	FLIPPED CLASS ROOM	T1,T2
33	3		Stresses in keys	• Concept, Formula	https://drive.google.com/drive/folders/10ScWOAhFW7LpPhc963cCHIJ5swvsVIC1?usp=sharing	https://drive.google.com/drive/folders/1AgHGdgeumxvkQOHyb__ZsixckCiOfNoc?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	Understand	FLIPPED CLASS ROOM	T1,T2
34	3	13	Cotter joint design	• Concept, Design Procedure, Formula	https://drive.google.com/drive/folders/10ScWOAhFW7LpPhc963cCHIJ5swvsVIC1?usp=sharing	https://drive.google.com/drive/folders/1AgHGdgeumxvkQOHyb__ZsixckCiOfNoc?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	Understand	JIG SAW	T1,T2
35	4		Spigot and socket joint design	• Concept, Design Procedure, Formula	https://drive.google.com/drive/folders/1O081uV9GMNjk-jOadRGQHViPu75KT5i-?usp=sharing	https://drive.google.com/drive/folders/13h3VPFpFq6Mb-15qI_-22ES_toubnXW?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	Explain	FLIPPED CLASS ROOM	T1,T2

36	4	14	Sleeve and cotter joints	• Concept, Design Procedure , Formula	https://drive.google.com/drive/folders/1O081uV9GMNjk-jOadRGQHViPu75KT5i-?usp=sharing	https://drive.google.com/drive/folders/13h3VPFpFq6Mb-15qI_-22ES_touvbnXW?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	Understand	Chalk and Talk	T1,T2
37	4		Jib and cotter joint deign	• Concept, Design Procedure , Formula	https://drive.google.com/drive/folders/1O081uV9GMNjk-jOadRGQHViPu75KT5i-?usp=sharing	https://drive.google.com/drive/folders/13h3VPFpFq6Mb-15qI_-22ES_touvbnXW?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	Application	FLIPPED CLASS ROOM	T1,T2
38	4		Numerical	• Numericals on Cotter Joint	https://drive.google.com/drive/folders/1O081uV9GMNjk-jOadRGQHViPu75KT5i-?usp=sharing	https://drive.google.com/drive/folders/13h3VPFpFq6Mb-15qI_-22ES_touvbnXW?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	Study	NOTE CHECK	T1,T2
39	4	15	Design of knuckle joint	• Concept, Design Procedure , Formula	https://drive.google.com/drive/folders/1O081uV9GMNjk-jOadRGQHViPu75KT5i-?usp=sharing	https://drive.google.com/drive/folders/13h3VPFpFq6Mb-15qI_-22ES_touvbnXW?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	Explain	FLIPPED CLASS ROOM	T1,T2

40	4		Design procedure for shafts	• Concept, Design Procedure , Formula	https://drive.google.com/drive/folders/1O081uV9GMNjk-jOadRGQHViPu75KT5i-?usp=sharing	https://drive.google.com/drive/folders/13h3VPFpFq6Mb-15qI_-22ES_touvbnXW?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	Explain	FLIPPED CLASS ROOM	T1,T2
41	4		Design of shafts based on strength and rigidity	• Numericals on Strength & Rigidity	https://drive.google.com/drive/folders/1O081uV9GMNjk-jOadRGQHViPu75KT5i-?usp=sharing	https://drive.google.com/drive/folders/13h3VPFpFq6Mb-15qI_-22ES_touvbnXW?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	Application	JIG SAW	T1,T2
42	4	16	Numerical	• Numericals on Shafts	https://drive.google.com/drive/folders/1O081uV9GMNjk-jOadRGQHViPu75KT5i-?usp=sharing	https://drive.google.com/drive/folders/13h3VPFpFq6Mb-15qI_-22ES_touvbnXW?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	Study	FLIPPED CLASS ROOM	T1,T2
43	4		Shafts subjected to combined bending and axial loads	• Numericals on Shafts on combined loading	https://drive.google.com/drive/folders/1O081uV9GMNjk-jOadRGQHViPu75KT5i-?usp=sharing	https://drive.google.com/drive/folders/13h3VPFpFq6Mb-15qI_-22ES_touvbnXW?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	Understand	FLIPPED CLASS ROOM	T1,T2

44	4		Shaft sizes ,Numerical	• Numericals on Shafts	https://drive.google.com/drive/folders/1O081uV9GMNjk-jOadRGQHViPu75KT5i-?usp=sharing	https://drive.google.com/drive/folders/13h3VPFpFq6Mb-15qI_-22ES_touvbnXW?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing			
45	4		Numerical	• Numericals on Shafts	https://drive.google.com/drive/folders/1O081uV9GMNjk-jOadRGQHViPu75KT5i-?usp=sharing	https://drive.google.com/drive/folders/13h3VPFpFq6Mb-15qI_-22ES_touvbnXW?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	APPLY	FLIPPED CLASS ROOM	R1,R2
46	4	17	Numerical	• Numericals on Shafts	https://drive.google.com/drive/folders/1O081uV9GMNjk-jOadRGQHViPu75KT5i-?usp=sharing	https://drive.google.com/drive/folders/13h3VPFpFq6Mb-15qI_-22ES_touvbnXW?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	APPLY	FLIPPED CLASS ROOM	R1,R2
47	5		Rigid coupling design, Muff and split couplings, Flange couplings	• Concept, Design Procedure , Formula	https://drive.google.com/drive/folders/1rHWkeK6q1D-t066MS80U_Xa4Zk46PS7a?usp=sharing	https://drive.google.com/drive/folders/1moS2tLLWglXMLI0fHS-zHWrRfz7xFouw?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	APPLY	FLIPPED CLASS ROOM	R1,R2

48	5		Flexible couplings, Modified flange couplings	• Concept, Design Procedure , Formula	https://drive.google.com/drive/folders/1rHWkeK6q1D-t066MS80U_Xa4Zk46PS7a?usp=sharing	https://drive.google.com/drive/folders/1moS2tLLWglXMLI0fHS-zHWrRfz7xFouw?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	APPLY	FLIPPED CLASS ROOM	R1,R2
49	5	18	Revision	• Practice of Different problems	https://drive.google.com/drive/folders/1rHWkeK6q1D-t066MS80U_Xa4Zk46PS7a?usp=sharing	https://drive.google.com/drive/folders/1moS2tLLWglXMLI0fHS-zHWrRfz7xFouw?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	Understand	FLIPPED CLASS ROOM	R1,R2
50	5		Revision	• Practice of Different problems	https://drive.google.com/drive/folders/1rHWkeK6q1D-t066MS80U_Xa4Zk46PS7a?usp=sharing	https://drive.google.com/drive/folders/1moS2tLLWglXMLI0fHS-zHWrRfz7xFouw?usp=sharing	https://drive.google.com/drive/folders/1lpF2V52KbxR6lzijo_i19zKfQbm9xm-r?usp=sharing	APPLY	FLIPPED CLASS ROOM	R1,R2

Long Answer Questions:

Sl No	Question	Blooms Taxonomy Level	Course Outcome
1	Enumerate the various manufacturing methods of machine parts which a designer should know	L2	CO 1
2	Explain briefly the different casting processes	L2	CO 1
3	Write a brief note on the design of castings	L2	CO 1
4	State and illustrate two principal design rules for casting design.	L2	CO 1
5	List the main advantages of forged components	L2	CO 1
6	What are the salient features used in the design of forgings? Explain.	L2	CO 1
7	What do you understand by 'hot working' and 'cold working' processes? Explain with examples.	L2	CO 1
8	State the advantages and disadvantages of hot working of metals. Discuss any two hot working processes.	L2	CO 1
9	What do you understand by cold working of metals? Describe briefly the various cold working processes.	L2	CO 1
10	What are fits and tolerances? How are they designated?	L1,L2	CO 1
11	What do you understand by the nominal size and basic size?	L2	CO 1
12	A steel shaft ABCD having a total length of 3.5 m consists of three lengths having different sections as follows: AB is hollow having outside and inside diameters of 100 mm and 62.5 mm respectively, and BC and CD are solid. BC has a diameter of 100 mm and CD has a diameter of 87.5 mm. If the angle of twist is the same for each section, determine the length of each section. Find the value of the applied torque and the total angle of twist, if the maximum shear stress in the hollow portion is 47.5 MPa and shear modulus, C = 82.5GPa.	L2,L3	CO 1 CO 2
13	A hollow shaft is required to transmit 600 kW at 110 r.p.m., the maximum torque being 20% greater than the mean. The shear stress is not to exceed 63 MPa and twist in a length of 3 meters not to exceed 1.4 degrees. Find the external diameter of the shaft, if the internal diameter to the external diameter is 3/8. Take modulus of rigidity as 84GPa.	L2,L3	CO 1 CO 2
14	Write short notes on the following : Interchangeability; (b) Tolerance; (c) Allowance; and (d) Fits	L2	CO 1
15	What is the difference in the type of assembly generally used in running fits and interference fits?	L2	CO 1
16	State briefly unilateral system of tolerances covering the points of definition, application and advantages over the	L2	CO 1

	bilateral system.		
17	What is meant by ‘hole basis system’ and ‘shaft basis system’? Which one is preferred and why?	L2	CO 1
18	Discuss the Indian standard system of limits and fits.	L2	CO 1
19	What are the commonly used fits according to Indian standards?	L2	CO 1
20	What do you understand by preferred numbers? Explain fully.	L2	CO 1
21	A steel rod of 20 mm diameter passes centrally through a copper tube of external diameter 40 mm and internal diameter 20 mm. The tube is closed at each end with the help of rigid washers (of negligible thickness) which are screwed by the nuts. The nuts are tightened until the compressive load on the copper tube is 50kN. Determine the stresses in the rod and the tube, when the temperature of whole assembly falls by 50°C. Take Es=200GPa; Ec=100GPa . [Ans. 99.6 MPa; 19.8 MPa]	L2,L3	CO 1 CO 2
22	A bar of 2 m length, 20 mm breadth and 15 mm thickness is subjected to a tensile load of 30kN. Find the final volume of the bar, if the Poisson’s ratio is 0.25 and Young's modulus is 200 GN/m2. [Ans. 600 150 mm3]	L2,L3	CO 1 CO 2
23	A bar of 12 mm diameter gets stretched by 3 mm under a steady load of 8kN. What stress would be produced in the bar by a weight of 800 N, which falls through 80 mm before commencing the stretching of the rod, which is initially unstressed? Take E = 200kN/mm2.	L2,L3	CO 1 CO 2
24	A steel shaft 50 mm diameter and 500 mm long is subjected to a twisting moment of 1100 N-m, the total angle of twist being 0.6°. Find the maximum shearing stress developed in the shaft and modulus of rigidity. [Ans. 44.8MPa; 85.6kN/m2]	L2,L3	CO 1 CO 2
25	A shaft is transmitting 100 kW at 180r.p.m. If the allowable stress in the material is 60 MPa, find the suitable diameter for the shaft. The shaft is not to twist more than 1° in a length of 3 meters. Take C = 80GPa. [Ans. 105 mm]	L2,L3	CO 1 CO 2
26	Design a suitable diameter for a circular shaft required to transmit 90 kW at 180r.p.m. The shear stress in the shaft is not to exceed 70MPa and the maximum torque exceeds the mean by 40%. Also find the angle of twist in a length of 2 meters. Take C= 90GPa. [Ans. 80 mm; 2.116°]	L2,L3	CO 1 CO 2
27	Design a hollow shaft required to transmit 11.2 MW at a speed of 300r.p.m. The maximum shear stress allowed in the shaft is 80 MPa and the ratio of the inner diameter to outer diameter is 3/4. [Ans. 240 mm; 320 mm]	L2,L3	CO 1 CO 2
28	Compare the weights of equal lengths of hollow shaft and solid shaft to transmit a given torque for the same	L2,L3	CO 1 CO 2

	maximum shear stress. The material for both the shafts is same and inside diameter is 2/3 of outside diameter in case of hollow shaft.		
29	A rotating shaft of 16 mm diameter is made of plain carbon steel. It is subjected to axial load of 5000N, a steady torque of 50 N-m and maximum bending moment of 75 N-m. Calculate the factor of safety available based on 1. Maximum normal stress theory; and 2. Maximum shear stress theory. Assume yield strength as 400 MPa for plain carbon steel. If all other data remaining same, what maximum yield strength of shaft material would be necessary using factor of safety of 1.686 and maximum distortion energy theory of failure. Comment on the result you get. [Ans. 1.752; 400 MPa]	L2,L3	CO 1 CO 2
30	A hand cranking lever, as shown in Fig. 5.37, is used to start a truck engine by applying a force F = 400 N. The material of the cranking lever is 30C8 for which yield strength = 320 MPa; Ultimate tensile strength = 500MPa; Young's modulus = 205GPa; Modulus of rigidity = 84GPa and poisson's ratio = 0.3.	L2,L3	CO 1 CO 2
31	A rectangular plate 50 mm × 10 mm with a hole 10 mm diameter is subjected to an axial load of 10kN. Taking stress concentration into account, find the maximum stress induced. [Ans. 50 MPa]	L2,L3	CO 1 CO 2
32	A stepped shaft has maximum diameter 45 mm and minimum diameter 30 mm. The fillet radius is 6 mm. If the shaft is subjected to an axial load of 10kN, find the maximum stress induced, taking stress concentration into account. [Ans. 22 MPa]	L2,L3	CO 1, CO 2

Short Answer questions

Sl No	Question	Blooms Taxonomy Level	Course Outcome
1	How do you classify materials for engineering use?	L1	CO1
2	What are the factors to be considered for the selection of materials for the design of machine elements? Discuss.	L2	CO1
3	Enumerate the most commonly used engineering materials and state at least one important property and one application of each.	L2	CO1
4	Why are metals in their pure form unsuitable for industrial use?	L2	CO1
5	Define 'mechanical property' of an engineering material. State any six mechanical properties, give their definitions and one example of the material possessing the properties.	L2	CO1

6	Define the following properties ofDuctility, (ii) Toughness, (iii) Hardness, and (iv) Creep.	L2	CO1
7	Distinguish clearly amongst cast iron, wrought iron and steel regarding their constituents and properties.	L2	CO1
8	How cast iron is obtained? Classify and explain different types of cast irons.	L2	CO1
9	How is grey cast iron designated in Indian standards?	L2	CO1
10	Discuss the effect of silicon, manganese, sulphur and phosphorus on cast iron.	L2	CO1
11	Define plain carbon steel. How it is designated according to Indian standards?	L2	CO1
12	Define alloy steel. Discuss the effects of nickel, chromium and manganese on steel.	L2	CO1
13	What are the common materials used in Mechanical Engineering Design? How can the properties of steel be improved?	L2	CO1
14	State the alloying elements added to steel to get alloy steels and the effect they produce. Give at least one example of each.	L2	CO1
15	Give the composition of 35Mn2Mo45 steel. List its main uses		
16	Write short notes on free cutting steel, and stainless steel.	L2	CO1
17	Select suitable material for the following cases, indicating the reason;		
18	a) A shaft subjected to variable torsional and bending load; b) Spring used in a spring loaded safety valve; c) Nut of a heavy duty screw jack; and d) Low speed line-shaft coupling.	L2	CO1
19	Select suitable materials for the following parts stating the special property which makes it most suitable for use in manufacturing:	L2	CO1
20	a) Turbine blade, b) Bush bearing, c) Dies, d) Carburettor body, e) Keys (used for fastening), f) Cams, g) Heavy duty machine tool beds, h) Ball bearing, i) Automobile cylinder block, j) Helical springs.	L2	CO1
21	Suggest suitable materials for the following parts stating the special property which makes it more suitable for use in manufacturing:	L2	CO1
22	a) Diesel engine crankshaft; b) Automobile tyres; c) Roller bearings; d) High pressure steam pipes; e) Stay bar of boilers; f) Worm and worm gear; g) Dies; h) Tramway axle ; i) Cam follower ; j) Hydraulic brake piston.	L2	CO1
23	Write short notes on high speed tool steel and spring steel.	L2	CO1
24	Explain the following heat treatment processes:		CO1
25	a) Normalising; b) Hardening; and c) Tempering.	L2	CO1
26	Write short note on the type of bearing metals.		
27	Discuss the important non-metallic materials of construction	L2	CO1

	used in engineering practice.		
28	Enumerate the various manufacturing methods of machine parts which a designer should know.	L2	CO1
29	Explain briefly the different casting processes.	L2	CO1
30	Write a brief note on the design of castings?	L2	CO1

Unit II

Long Answer Questions

Sl No	Question	Blooms Taxonomy Level	Course Outcome
1	A leaf spring in an automobile is subjected to cyclic stresses. The average stress = 150 MPa; variable stress = 500 MPa; ultimate stress = 630 MPa; yield point stress = 350 MPa and endurance limit = 150 MPa. Estimate, under what factor of safety the spring is working, by Goodman and Soderberg formulae. [Ans. 1.75, 1.3]	L2,L3	CO 1 CO 2
2	Determine the diameter of a tensile member of a circular cross-section. The following data is given : Maximum tensile load = 10kN; Maximum compressive load = 5kN; Ultimate tensile strength = 600 MPa; Yield point = 380 MPa; Endurance limit = 290 MPa; Factor of safety = 4; Stress concentration factor = 2.2 [Ans. 24 mm]	L2,L3	CO 1 CO 2
3	Determine the size of a piston rod subjected to a total load of having cyclic fluctuations from 15kN in compression to 25kN in tension. The endurance limit is 360 MPa and yield strength is 400 MPa. Take impact factor = 1.25, factor of safety = 1.5, surface finish factor = 0.88 and stress concentration factor = 2.25. [Ans. 35.3 mm]	L2,L3	CO 1 CO 2
4	A steel connecting rod is subjected to a completely reversed axial load of 160kN. Suggest the suitable diameter of the rod using a factor of safety 2. The ultimate tensile strength of the material is 1100MPa, and yield strength 930MPa. Neglect column action and the effect of stress concentration. [Ans. 30.4 mm]	L2,L3	CO 1 CO 2
5	Find the diameter of a shaft made of 37Mn 2 steel having the ultimate tensile strength as 600 MPa and yield stress as 440 MPa. The shaft is subjected to completely reversed axial load of 200kN. Neglect stress concentration factor and assume surface finish factor as 0.8. The factor of safety may be taken as 1.5.	L2,L3	CO 1 CO 2

Short Answer Questions

Sl No	Question	Blooms Taxonomy Level	Course Outcome
1	Explain endurance limit, size factor	L1	CO1
2	Explain surface finish factor, notch sensitivity	L1	CO1
3	Explain endurance strength	L1	CO1
4	Define stress concentration	L1	CO1
5	State application of soderbergs equation for different loadings	L1	CO1
6	State significance of soderberg diagram	L1	CO1

Unit III

Long Answer Questions

Sl No	Question	Blooms Taxonomy Level	Course Outcome
1	Two lengths of mild steel tie rod having width 200 mm are to be connected by means of Lozenge joint with two cover plates to withstand a tensile load of 180kN. Completely design the joint, if the permissible stresses are 80 MPa in tension; 65 MPa in shear and 160MPa in crushing. Draw a neat sketch of the joint. [Ans. t = 13 mm ; d = 22 mm ; n = 5]	L2,L3	CO 1 CO 3
2	A plate 100 mm wide and 10 mm thick is to be welded with another plate by means of transverse welds at the ends. If the plates are subjected to a load of 70kN, find the size of weld for static as well as fatigue load. The permissible tensile stress should not exceed 70MPa. [Ans. 83.2 mm; 118.5 mm]	L2,L3	CO 1 CO 3
3	If the plates in Ex. 1, are joined by double parallel fillets and the shear stress is not to exceed 56 MPa, find the length of weld for (a) Static loading, and (b) Dynamic loading. [Ans. 91 mm; 259 mm]	L2,L3	CO 1 CO 3
4	A 125 × 95 × 10 mm angle is joined to a frame by two parallel fillet welds along the edges of 150 mm leg. The angle is subjected to a tensile load of 180kN. Find the lengths of weld if the permissible static load per mm weld length is 430 N. [Ans. 137 mm and 307 mm]	L2,L3	CO 1 CO 3
5	A circular steel bar 50 mm diameter and 200 mm long is welded perpendicularly to a steel plate to form a cantilever to be loaded with 5kN at the free end. Determine the size of the weld, assuming the allowable stress in the weld as 100 MPa.	L2,L3	CO 1 CO 3
6	A steam engine cylinder of 300 mm diameter is supplied	L2,L3	CO 1 CO 3

	with steam at 1.5 N/mm2. The cylinder cover is fastened by means of 8 bolts of size M 20. The joint is made leak proof by means of suitable gaskets. Find the stress produced in the bolts. [Ans. 249 MPa]		
7	The effective diameter of the cylinder is 400 mm. The maximum pressure of steam acting on the cylinder cover is 1.12 N/mm2. Find the number and size of studs required to fix the cover. Draw a neat proportioned sketch for the elevation of the cylinder cover. [Ans. 14; M 24]	L2,L3	CO 1 CO 3
8	Specify the size and number of studs required to fasten the head of a 400 mm diameter cylinder containing steam at 2 N/mm2. A hard gasket (gasket constant = 0.3) is used in making the joint. Draw a neat sketch of the joint also. Other data may be assumed. [Ans. M 30; 12]	L2,L3	CO 1 CO 3
9	A steam engine cylinder has an effective diameter of 200 mm. It is subjected to a maximum steam pressure of 1.75 N/mm2. Calculate the number and size of studs required to fix the cylinder cover onto the cylinder flange assuming the permissible stress in the studs as 30 MPa. Take the pitch circle diameter of the studs as 320 mm and the total load on the studs as 20% higher than the external load on the joint. Also check the circumferential pitch of the studs so as to give a leak proof joint. [Ans. 16; M 16]	L2,L3	CO 1 CO 3
10	A steam engine cylinder of size 300 mm × 400 mm operates at 1.5 N/mm2 pressure. The cylinder head is connected by means of 8 bolts having yield point stress of 350 MPa and endurance limit of 240 MPa. The bolts are tightened with an initial preload of 1.8 times the steam lead. The joint is made leak-proof by using soft copper gasket which renders the effect of external load to be half. Determine the size of bolts, if factor of safety is 2 and stress concentration factor is 3. [Ans. M 20]	L2,L3	CO 1 CO 3
11	Find the diameter of screwed boiler stays; each stay supports an area equal to 200 mm × 150 mm. The steam pressure is 1 N/mm2. The permissible tensile stress for the stay material is 34 MPa. [Ans. M 36]	L2,L3	CO 1 CO 3
12	What size of hole must be drilled in a M 42 bolt so as to make the bolt of uniform strength?	L2,L3	CO 1 CO 3

Short Answer Questions

Sl No	Question	Blooms Taxonomy Level	Course Outcome
1	What do you understand by the term riveted joint? Explain the necessity of such a joint.	L1	CO1
2	What are the various permanent and detachable fastenings? Give a complete list with the different types of each	L1	CO1

	category.		
3	Classify the rivet heads according to Indian standard specifications.	L1	CO1
4	What is the material used for rivets?	L1	CO1
5	Enumerate the different types of riveted joints and rivets.	L1	CO1
6	What is an economical joint and where does it find applications?	L1	CO1
7	What is the difference between caulking and fullering? Explain with the help of neat sketches.	L1	CO1
8	Show by neat sketches the various ways in which a riveted joint may fail.	L1	CO1
9	What do you understand by the term 'efficiency of a riveted joint'? According to I.B.R., what is the highest efficiency required of a riveted joint?	L1	CO1
10	Explain the procedure for designing a longitudinal and circumferential joint for a boiler.	L1	CO1
11	Describe the procedure for designing a lozenge joint.	L1	CO1
12	What is an eccentric riveted joint? Explain the method adopted for designing such a joint?	L1	CO1
13	What do you understand by the term welded joint? How it differs from riveted joint?	L1	CO1
14	Sketch and discuss the various types of welded joints used in pressure vessels. What are the considerations involved?	L1	CO1
15	State the basic difference between manual welding, semi-automatic welding and automatic welding.	L1	CO1
16	What are the assumptions made in the design of welded joint?	L1	CO1
17	Explain joint preparation with particular reference to butt welding of plates by arc welding.	L1	CO1
18	Discuss the standard location of elements of a welding symbol.	L1	CO1
19	Explain the procedure for designing an axially loaded unsymmetrical welded section.	L1	CO1
20	What is an eccentric loaded welded joint? Discuss the procedure for designing such a joint.	L1	CO1
21	What do you understand by the single start and double start threads?	L1	CO1
22	Define the following terms : Major diameter, (b) Minor diameter, (c) Pitch, and (d) Lead.	L1	CO1
23	Write short note on nut locking devices covering the necessity and various types. Your answer should be illustrated with neat sketches.	L1	CO1
24	Discuss the significance of the initial tightening load and the applied load so far as bolts are concerned. Explain which of	L1	CO1

	the above loads must be greater for a properly designed bolted joint and show how each affects the total load on the bolt.		
25	Discuss on bolts of uniform strength giving examples of practical applications of such bolts.	L1	CO1
26	Bolts less than M 16 should normally be used in pre loaded joints. Comment.	L1	CO1
27	How the core diameter of the bolt is determined when a bracket having a rectangular base is bolted to a wall by four bolts and carries an eccentric load parallel to the axis of the bolt?	L1	CO1
28	Derive an expression for the maximum load in a bolt when a bracket with circular base is bolted to a wall by means of four bolts.	L1	CO1
29	Explain the method of determining the size of the bolt when the bracket carries an eccentric load perpendicular to the axis of the bolt.	L1	CO1

Unit IV

Long Answer Questions

Sl No	Question	Blooms Taxonomy Level	Course Outcome
1	Design a cotter joint to connect two mild steel rods for a pull of 30kN. The maximum permissible stresses are 55 MPa in tension; 40 MPa in shear and 70 MPa in crushing. Draw a neat sketch of the joint designed. [Ans. d = 22 mm; d2 = 32 mm ; t = 14 mm ; d1 = 44 mm ; b = 30 mm ; a = 12 mm ; d4 = 65 mm ; c = 12 mm ; d3 = 40 mm ; t1 = 8 mm]	L2,L3	CO 1 CO 3
2	Two rod ends of a pump are joined by means of a cotter and spigot and socket at the ends. Design the joint for an axial load of 100kN which alternately changes from tensile to compressive. The allowable stresses for the material used are 50 MPa in tension, 40 MPa in shear and 100 MPa in crushing. [Ans. d = 51 mm ; d2 = 62 mm ; t = 16 mm ; d1 = 72 mm ; b = 78 mm ; a = 20 mm ; d3 = 83 mm ; d4 = 125 mm ; c = 16 mm ; t1 = 13 mm]	L2,L3	CO 1 CO 3
3	Two mild steel rods 40 mm diameter are to be connected by a	L2,L3	CO 1 CO
4	The big end of a connecting rod is subjected to a load of 40 kN. The diameter of the circular part adjacent to the strap is 50 mm. Design the joint assuming the permissible tensile stress in the strap as 30 MPa and permissible shear stress in the cotter and gib as 20 MPa. **[Ans. B1 = 50 mm ; t = 15 mm ; t1 = 15 mm ; t3 = 22 mm ; B = 70 mm]**	L2,L3	CO 1 CO 3
5	Design a cotter joint to connect a piston rod to the crosshead. The maximum steam pressure on the piston rod is 35kN.	L2,L3	CO 1 CO 3

	Assuming that all the parts are made of the same material having the following permissible stresses : σ1 = 50 MPa ; τ = 60 MPa and		
6	σc= 90 MPa.[Ans. d2 = 40 mm ; t = 12 mm ; d3 = 75 mm ; L = 88 mm ; d = 44 mm; d1 = 38 mm]	L2,L3	CO 1 CO 3
7	Design and draw a cotter foundation bolt to take a load of	L2,L3	CO 1 CO
8	Design a knuckle joint to connect two mild steel bars under a tensile load of 25kN. The allowable stresses are 65 MPa in tension, 50 MPa in shear and 83 MPa in crushing.[Ans. d = d1 = 23 mm ; d2 = 46 mm ; d3 = 35 mm ; t = 29 mm ; t1 = 18 mm]	L2,L3	CO 1 CO 3
9	Two mild steel rods 40 mm diameter are to be connected by a cotter joint. The thickness of the cotter is 12 mm. Calculate the dimensions of the joint, if the maximum permissible stresses are: 46 MPa in tension; 35 MPa in shear and 70 MPa in crushing. [Ans. d2 = 30 mm ; d1 = 48 mm ; b = 70 mm ; a = 27.5 mm ; d4 = 100 mm ; c = 12 mm ; d3 = 44.2 mm ; t = 35 mm ; t1 = 13.5 mm]	L2,L3	CO 1 CO 3
10	The big end of a connecting rod is subjected to a load of 40 kN. The diameter of the circular part adjacent to the strap is 50 mm. Design the joint assuming the permissible tensile stress in the strap as 30 MPa and permissible shear stress in the cotter and gib as 20 MPa. [Ans. B1 = 50 mm ; t = 15 mm ; t1 = 15 mm ; t3 = 22 mm ; B = 70 mm]	L2,L3	CO 1 CO 3

Short Answer Questions

Sl No	Question	Blooms Taxonomy Level	Course Outcome
1	What is a key? State its function.	L1	CO1
2	How are the keys classified? Draw neat sketches of different types of keys and state their applications.	L1	CO1
3	What are the considerations in the design of dimensions of formed and parallel key having rectangular cross-section?	L1	CO1
4	Write short note on the splined shaft covering the points of application, different types and method of manufacture.	L1	CO1
5	What is the effect of keyway cut into the shaft?	L1	CO1
6	Discuss the function of a coupling. Give at least three practical applications.	L1	CO1
7	Describe, with the help of neat sketches, the types of various shaft couplings mentioning the uses of each type.	L1	CO1
8	How does the working of a clamp coupling differ from that of a muff coupling? Explain.	L1	CO1
9	What is a cotter joint? Explain with the help of a neat sketch,	L1	CO1

	how a cotter joint is made?		
10	What are the applications of a cottered joint?	L1	CO1
11	Discuss the design procedure of spigot and socket cotter joint.	L1	CO1
12	Why gibs are used in a cotter joint? Explain with the help of a neat sketch the use of single and double gib.	L1	CO1
13	Describe the design procedure of a gib and cotter joint.	L1	CO1
14	Distinguish between cotter joint and knuckle joint.	L1	CO1
15	Sketch two views of a knuckle joint and write the equations showing the strength of joint for the most probable modes of failure.	L1	CO1

Unit V

Long answer questions

Sl No	Question	Blooms Taxonomy Level	Course Outcome
1	A shaft running at 400r.p.m. transmits 10 kW. Assuming allowable shear stress in shaft as 40 MPa, find the diameter of the shaft. [Ans. 35 mm]	L2,L3	CO 1 CO 3
2	A hollow steel shaft transmits 600 kW at 500r.p.m. The maximum shear stress is 62.4 MPa. Find the outside and inside diameter of the shaft, if the outer diameter is twice of inside diameter, assuming that the maximum torque is 20% greater than the mean torque. [Ans. 100 mm ; 50 mm]	L2,L3	CO 1 CO 3
3	A hollow shaft for a rotary compressor is to be designed to transmit a maximum torque of 4750 N-m. The shear stress in the shaft is limited to 50 MPa. Determine the inside and outside diameters of the shaft, if the ratio of the inside to the outside diameter is 0.4. [Ans. 35 mm ; 90 mm]	L2,L3	CO 1 CO 3
4	A motor car shaft consists of a steel tube 30 mm internal diameter and 4 mm thick. The engine develops 10 kW at 2000r.p.m. Find the maximum shear stress in the tube when the power is transmitted through a 4: 1 gearing. [Ans. 30 MPa]	L2,L3	CO 1 CO 3
5	A cylindrical shaft made of steel of yield strength 700 MPa is subjected to static loads consisting of a bending moment of 10kN-m and a Torsional moment of 30kN-m. Determine the diameter of the shaft using two different theories of failure and assuming a factor of safety of 2. [Ans. 100 mm]	L2,L3	CO 1 CO 3
6	A line shaft rotating at 200r.p.m. is to transmit 20 kW. The allowable shear stress for the material of the shaft is 42 MPa. If the shaft carries a central load of 900 N and is simply supported between bearings 3m apart, determine the diameter of the shaft. The maximum tensile or compressive stress is not to exceed 56 MPa. [Ans. 50 mm]	L2,L3	CO 1 CO 3
7	Two 400 mm diameter pulleys are keyed to a simply supported	L2,L3	CO 1 CO

	shaft 500 mm apart. Each pulley is 100 mm from its support and has horizontal belts, tension ratio being 2.5. If the shear stress is to be limited to 80 MPa while transmitting 45 kW at 900r.p.m. find the shaft diameter if it is to be used for the input-output belts being on the same or opposite sides. [Ans. 40 mm]		3
8	A cast gear wheel is driven by a pinion and transmits 100 kW at 375 r.p.m. The gear has 200 machine cut teeth having 20° pressure angle and is mounted at the centre of a 0.4 m long shaft. The gear weighs 2000 N and its pitch circle diameter is 1.2 m. Design the gear shaft. Assume that the axes of the gear and pinion lie in the same horizontal plane. [Ans. 80 mm]	L2,L3	CO 1 CO 3
9	Fig. 14.17 shows a shaft from a hand-operated machine. The frictional torque in the journal bearings at A and B is 15 N-m each. Find the diameter (d) of the shaft (on which the pulley is mounted) using maximum distortion energy criterion. The shaft material is 40 C 8 steel for which the yield stress in tension is 380 MPa and the factor of safety is 1.5. [Ans. 20 mm]	L2,L3	CO 1 CO 3
10	A shaft 80 mm diameter transmits power at maximum shear stress of 63 MPa. Find the length of a 20 mm wide key required to mount a pulley on the shaft so that the stress in the key does not exceed 42 MPa. [Ans. 152 mm]	L2,L3	CO 1 CO 3
11	A shaft 30 mm diameter is transmitting power at a maximum shear stress of 80 MPa. If a pulley is connected to the shaft by means of a key, find the dimensions of the key so that the stress in the key is not to exceed 50 MPa and length of the key is 4 times the width. [Ans. l = 126 mm]	L2,L3	CO 1 CO 3
12	A steel shaft has a diameter of 25 mm. The shaft rotates at a speed of 600r.p.m. and transmits 30 kW through a gear. The tensile and yield strength of the material of shaft are 650 MPa and 353 MPa respectively. Taking a factor of safety 3, select a suitable key for the gear. Assume that the key and shaft are made of the same material. [Ans. l = 102 mm]	L2,L3	CO 1 CO 3
13	Design a muff coupling to connect two shafts transmitting 40 kW at 120r.p.m. The permissible shear and crushing stress for the shaft and key material (mild steel) are 30 MPa and 80 MPa respectively. The material of muff is cast iron with permissible shear stress of 15 MPa. Assume that the maximum torque transmitted is 25 per cent greater than the mean torque. [Ans. d = 90 mm ; w = 28 mm, t = 16 mm, l = 157.5 mm ; D = 195 mm, L = 315 mm]	L2,L3	CO 1 CO 3
14	Design a compression coupling for a shaft to transmit 1300 N-m. The allowable shear stress for the shaft and key is 40 MPa and the number of bolts connecting the two halves are 4. The permissible tensile stress for the bolts material is 70 MPa. The coefficient of friction between the muff and the shaft surface may be taken as 0.3. [Ans. d = 55 mm ; D = 125 mm ; L = 192.5 mm ; db = 24 mm]	L2,L3	CO 1 CO 3

15	Design a cast iron protective flange coupling to connect two shafts in order to transmit 7.5 kW at 720r.p.m. The following permissible stresses may be used : Permissible shear stress for shaft, bolt and key material = 33 MPa Permissible crushing stress for bolt and key material = 60 MPa Permissible shear stress for the cast iron = 15 MPa [Ans. d = 25 mm; D = 50 mm]	L2,L3	CO 1 CO 3

Short answer questions

Sl No	Question	Blooms Taxonomy Level	Course Outcome
1	Distinguish clearly, giving examples between pin, axle and shaft.	L1	CO1
2	How the shafts are formed?	L1	CO1
3	Discuss the various types of shafts and the standard sizes of transmissions shafts.	L1	CO1
4	What types of stresses are induced in shafts?	L1	CO1
5	How the shaft is designed when it is subjected to twisting moment only?	L1	CO1
6	Define equivalent twisting moment and equivalent bending moment. State when these two terms are used in design of shafts.	L1	CO1
7	When the shaft is subjected to fluctuating loads, what will be the equivalent twisting moment and equivalent bending moment?	L1	CO1
8	What do you understand by Torsional rigidity and lateral rigidity?	L1	CO1
9	A hollow shaft has greater strength and stiffness than solid shaft of equal weight. Explain.	L1	CO1
10	Under what circumstances are hollow shafts preferred over solid shafts? Give	L1	CO1

Knowledge(L1) ,Understand(L2), Application(L3)

OBJECTIVE QUESTIONS

UNIT 1

1. Hooke's law holds good up to ___________
2. The ratio of linear stress to linear strain is called _________
3. The modulus of elasticity for mild steel is approximately equal to ___________
4. When the material is loaded within elastic limit, then the stress is _____ to strain.
5. When a hole of diameter 'd' is punched in a metal of thickness `t', then the force required to punch a hole is equal to:________
6. The ratio of the ultimate stress to the design stress is known as

(a) Elastic limit (b) strain (c) Factor of safety (d) bulk modulus
7. The factor of safety for steel and for steady load is
(a) 2 (b) 4 (c) 6 (d) 8
8. An aluminum member is designed based on
(a) yield stress (b) elastic limit stress (c) proof stress (d) ultimate stress
9. In a body, a thermal stress is one which arises because of the existence of
(a) Latent heat (b) temperature gradient
(c) Total heat (d) specific heat
10. A localized compressive stress at the area of contact between two members is known as
(a) Tensile stress (b) bending stress (c) Bearing stress (d) shear stress

UNIT-II

1. A rivet is specified by ________
(2. The diameter of the rivet hole is usually ______ the nominal diameter of the rivet ________.
3. The rivet head used for boiler plate riveting is usually__________
4. According to Unwin's formula, the relation between diameter of rivet hole (d) and thickness of plate (t) is given by________
5. A line joining the centres of rivets and parallel to the edge of the plate is known as ___________
6. The centre to centre distance between two consecutive rivets in a row, is called
(a) margin (b) pitch (c) back pitch (d) diagonal pitch
7. The objective of caulking in a riveted joint is to make the joint
(a) Free from corrosion (b) stronger in tension
(c) free from stresses (d) leak-proof
8. A lap joint is always in _______shear.
(a) Single (b) double (c) triple (d) None
9. A double strap butt joint (with equal straps) is
(a) Always in single shear (b) always in double shear
(c) Either in single shear or double shear (d) any one of these
10. Which of the following riveted butt joints with double straps should have the highest efficiency as per Indian Boiler Regulations?
(a) Single riveted (b) Double riveted
(c) Triple riveted (d) quadruple riveted

UNIT-III

1. A cotter joint is used to transmit _______
2. The taper on cotter varies from ________
3. Which of the following cotter joint is used to connect strap end of a connecting rod (a) Socket and spigot cotter joint (b) Sleeve and cotter joint ______
4. In designing a sleeve and cotter joint, the outside diameter of the sleeve is taken as _________

5. The length of cotter, in a sleeve and cotter joint, is taken as ______
6. In a gib and cotter joint, the thickness of gib is _____thickness of cotter.

(a) more than (b) less than (c) equal to 9d0 None

7. When one gib is used in a gib and cotter joint, then the width of gib should be taken as

(a) 0.45 B (b) 0.55 B (c) 0.65 B (d) 0.75 B

Where B = Total width of gib and cotter.

8. In a steam engine, the piston rod is usually connected to the crosshead by means of a

(a) knuckle joint (b) universal joint (c) flange coupling (d) cotter joint

9. In a steam engine, the valve rod is connected to an eccentric by means of a

(a) Knuckle joint (b) universal joint (c) Flange coupling (d) cotter joint

10. In a turn buckle, if one of the rods has left hand threads, then the other rod will have

(a) right hand threads (b) left hand threads

(c) Pointed threads (d) multiple threads

UNIT-IV

1. The standard length of the shaft is _______

2. Two shafts A and B are made of the same material. The diameter of the shaft A is twice as that of shaft B. The power transmitted by the shaft A will be ________ of shaft B.

3. Two shafts A and B of solid circular cross-section are identical except for their diameters dA and dB. The ratio of power transmitted by the shaft A to that of shaft B is _________

4. Two shafts will have equal strength, if _____

5. A transmission shaft subjected to bending loads must be designed on the basis of ________

6. Which of the following loading is considered for the design of axles?

(a) Bending moment only

(b) Twisting moment only

(c) Combined bending moment and torsion

(d) Combined action of bending moment, twisting moment and axial thrust

7. When a shaft is subjected to a bending moment M and a twisting moment T, then the equivalent twisting moment is equal to

(a) M + T (b) $M^2 + T^2$ (c) $\sqrt{M^2 + T^2}$ (d) $\sqrt{M^2 - T^2}$

8. The maximum shear stress theory is used for

(a) Brittle materials (b) ductile materials

(c) Plastic materials (d) non-ferrous materials

9. The maximum normal stress theory is used for

(a) Brittle materials (b) Ductile materials (c) Plastic materials (d) Non-ferrous materials

10. The design of shafts made of brittle materials is based on

(a) Guest's theory (b) Rankine's theory (c) St. Venant's theory (d) Von Mises Theory

UNIT-V

1. A spring used to absorb shocks and vibrations is ________

2. The spring mostly used in gramophones is __________

3. Which of the following spring is used in a mechanical wrist watch _________

4. When a helical compression spring is subjected to an axial compressive load, the stress induced in the wire is ______

5. In a close coiled helical spring, the spring index is given by D/d where D and d are the mean coil diameter and wire diameter respectively. For considering the effect of curvature, the Wahl's stress factor K is given by ____

(6. When helical compression spring is cut into halves, the stiffness of the resulting spring will be

(a) Same (b) double (c) one-half (d) one-fourth

7. Two close coiled helical springs with stiffness k1 and k2 respectively are connected in series. The stiffness of an equivalent spring is given by

(a) $\frac{k1*k2}{k1+k2}$ (b) $\frac{k1-k2}{k1+k2}$ (c) $\frac{k1+k2}{k1*k2}$ (d) $\frac{k1-k2}{k1*k2}$

8. When two concentric coil springs made of the same material, having same length and compressed equally by an axial load, the load shared by the two springs will be ________ to the square of the diameters of the wires of the two springs.

(a) Directly proportional (b) inversely proportional (c) Equal to

9. A leaf spring in automobiles is used

(a) To apply forces (b) to measure forces (c) To absorb shocks (d) to store strain energy

10. In leaf springs, the longest leaf is known as

(a) Lower leaf (b) master leaf (c) upper leaf (d) none of these

JOURNALS:

1. International Journal of Mechanical Engineering & Technology (IJMET).
2. International Journal of Design Engineering.
3. International Journal of Mechanics and Design.
4. Mechanical structural analysis of dry contacts slipping in disc brake systems.
5. Determination of the most favorable friction moment for screw tightening
6. Design of a modular rollover carwash machine structure.
7. Simple clutches with multiple functions.
8. Static and dynamic characteristics of direct operated pressure relief valves.

WEBSITES:

1. www.nptel.iitm.ac.in/courses.php
2. booksformech.blogspot.com/2015/11/made-easy-handwritten-notes-in-pdf.html
3. http://nptel.ac.in/courses/112106137/
4. http://www.nptel.ac.in/downloads/112105125/
5. http://nptel.ac.in/courses/Webcourse-contents/IIT%20Kharagpur/Machine%20design1/New_index1.html
6. http://nptel.ac.in/courses/112105124/

SUBJECT EXPERTS:

1. Dr. Vinayak Eswaran, Professor, I.I.T, Hyderabad
2. Dr. Suresh Kumar, Professor, JNTU, Hyderabad
3. Dr. YVD Rao, Professor & HOD, Dept. of Mechanical Engineering, BITS-Pilani, Hyderabad Campus,
4. Dr. Jeevan Jaidi, Associate Professor, Dept. of Mechanical Engineering, BITS-Pilani, Hyderabad Campus
5. Dr. P. Laxminarayana, Professor, Dept. of Mechanical Engineering, Osmania University College of Engineering, Hyderabad

LIST OF TOPICS FOR STUDENT SEMINARS:

1. Cotter Joints, Keys
2. Couplings

3. Shafts
4. Springs
5. Riveted Joints
6. Welded Joints
7. Bolted Joints

CASE STUDIES/SMALL PROJECTS:

1. Prepare and find the strength of a triple riveted but joint
2. Prepare and find the strength of a Double strap Lap Joint
3. Prepare and find the strength of a welded joint