

Faculty of Engineering

End Semester Examination May 2025

RA3CO43 Design of Machine Elements & Transmission Systems

Programme	:	B.Tech.	Branch/Specialisation	:	RA
Duration	:	3 hours	Maximum Marks	:	60

Note: All questions are compulsory. Internal choices, if any, are indicated. Assume suitable data if necessary.
Notations and symbols have their usual meaning.

Section 1 (Answer all question(s))				Marks CO BL
Q1. The endurance or fatigue limit is defined as the maximum value of the stress which a polished standard specimen can withstand without failure, for infinite number of cycles, when subjected to-				1 1 1
<input type="radio"/> Static load				
<input checked="" type="radio"/> Completely reversed load				
<input type="radio"/> Dynamic load				
<input type="radio"/> Static as well as dynamic load				
Q2. When a material is subjected to fatigue loading, the ratio of the endurance limit to the ultimate tensile strength is-				1 1 1
<input type="radio"/> 0.20				
<input checked="" type="radio"/> 0.35				
<input type="radio"/> 0.50				
<input type="radio"/> 0.65				
Q3. Which of the following riveted butt joints with double straps should have the highest efficiency as per Indian Boiler Regulations?				1 2 1
<input type="radio"/> Single riveted				
<input checked="" type="radio"/> Double riveted				
<input type="radio"/> Triple riveted				
<input checked="" type="radio"/> Quadruple riveted				
Q4. The parallel fillet welded joint is designed for-				1 2 1
<input type="radio"/> Tensile strength				
<input checked="" type="radio"/> Compressive strength				
<input type="radio"/> Bending strength				
<input checked="" type="radio"/> Shear strength				
Q5. A key made from a cylindrical disc having segmental cross-section, is known as-				1 3 1
<input type="radio"/> Feather key				
<input checked="" type="radio"/> Gib head key				
<input type="radio"/> Woodruff key				
<input type="radio"/> Flat saddle key				
Q6. A transmission shaft subjected to bending loads must be designed on the basis of-				1 3 1
<input checked="" type="radio"/> Maximum normal stress theory				
<input type="radio"/> Maximum normal stress and maximum shear stress theories				
<input type="radio"/> Maximum shear stress theory				
<input type="radio"/> Fatigue strength				
Q7. Lewis equation in spur gears is used to find the-				1 4 1
<input type="radio"/> Tensile stress in bending				
<input checked="" type="radio"/> Compressive stress in bending				
<input type="radio"/> Shear stress				
<input type="radio"/> Fatigue stress				
Q8. When a belt drive is transmitting maximum power-				1 4 1
<input type="radio"/> Effective tension is equal to the centrifugal tension				
<input type="radio"/> Driving tension in slack side is equal to the centrifugal tension				
<input checked="" type="radio"/> Effective tension is half of the centrifugal tension				
<input checked="" type="radio"/> Driving tension in tight side is twice the centrifugal tension				
Q9. In leaf springs, the longest leaf is known as-				1 5 1
<input type="radio"/> Lower leaf				
<input checked="" type="radio"/> Master leaf				
<input type="radio"/> Upper leaf				
<input type="radio"/> None of these				

Q10. A sliding bearing which can support steady loads without any relative motion between the journal and the bearing is called- 1 5 1

- Zero film bearing
- Boundary lubricated bearing
- Hydrodynamic lubricated bearing
- Hydrostatic lubricated bearing

Section 2 (Answer all question(s))

Marks CO BL

Q11. Explain the following terms in connection with design of machine members subjected to variable loads: 2 1 1

- Endurance limit
- Surface finish factor
- Size factor
- Notch sensitivity

Rubric	Marks
0.5 Marks for each	2

Q12. What is meant by 'stress concentration'? How do you take it into consideration in case of a component subjected to dynamic loading? 3 1 2

Rubric	Marks
What is meant by 'stress concentration' - 1 mark take it into consideration in case of a component subjected to dynamic loading - 2 marks	3

Q13. (a) A simply supported beam has a concentrated load at the centre which fluctuates from a value of P to 4 P. 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 value of P. Take a size factor of 0.85 and a surface finish factor of 0.9. 5 1 3

Rubric	Marks
Given data with notation and formula used - 1 mark Complete solution with correct answer - 4 marks	5

(OR)

(b) A machine component is subjected to a flexural stress which fluctuates between + 300 MN/m² and - 150 MN/m². Determine the value of minimum ultimate strength according to (a) Gerber relation (b) Modified Goodman relation and (c) Soderberg relation. Take yield strength = 0.55 Ultimate strength; Endurance strength = 0.5 Ultimate strength; and factor of safety = 2.

Rubric	Marks
Given data with notation and formula used - 1 mark Complete solution with correct answer - 4	5

Section 3 (Answer all question(s))

Marks CO BL

Q14. Define the following terms: 4 2 1

- Major diameter
- Minor diameter
- Pitch
- Lead

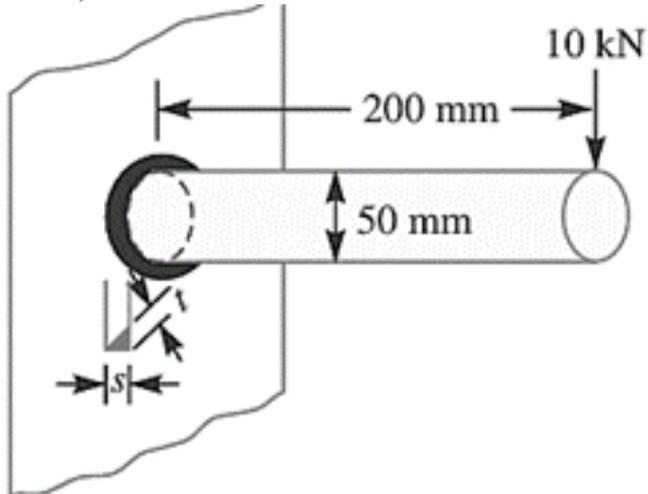
Rubric	Marks
One marks for each definition	4

- Q15.(a)** Two lengths of mild steel tie rod having width 200 mm and thickness 12.5 mm are to be connected by means of a butt joint with double cover plates. Design the joint if the permissible stresses are 80 MPa in tension, 65 MPa in shear and 160 MPa in crushing. Make a sketch of the joint.

Rubric	Marks
Given data with notation and formula used - 2 marks	6
Complete solution with correct answer - 4 marks	

(OR)

- (b)** A 50 mm diameter solid shaft is welded to a flat plate as shown in Fig. If the size of the weld is 15 mm, find the maximum normal and shear stress in the weld.



Rubric	Marks
Given data with notation and formula used - 2marks	6
Complete solution with correct answer - 4 marks	

Section 4 (Answer all question(s))

Marks CO BL

- Q16.** Design the rectangular key for a shaft of 50 mm diameter. The shearing and crushing stresses for the key material are 42 MPa and 70 MPa. 3 3 2

Rubric	Marks
Given data with notation and formula used - 1 mark	3
Complete solution with correct answer - 2 marks	

- Q17. (a)** A solid circular shaft is subjected to a bending moment of 3000 N-m and a torque of 10 000 N-m. The shaft is made of 45 C 8 steel having ultimate tensile stress of 700 MPa and a ultimate shear stress of 500 MPa. Assuming a factor of safety as 6, determine the diameter of the shaft

7 3 3

Rubric	Marks
Given data with notation and formula used - 2 marks	7
Complete solution with correct answer - 5 marks	

(OR)

- (b)** A shaft is supported by two bearings placed 1 m apart. A 600 mm diameter pulley is mounted at a distance of 300 mm to the right of left hand bearing and this drives a pulley directly below it with the help of belt having maximum tension of 2.25 kN. Another pulley 400 mm diameter is placed 200 mm to the left of right hand bearing and is driven with the help of electric motor and belt, which is placed horizontally to the right. The angle of contact for both the pulleys is 180° and $\mu = 0.24$.

Determine the suitable diameter for a solid shaft, allowing working stress of 63 MPa in tension and 42 MPa in shear for the material of shaft. Assume that the torque on one pulley is equal to that on the other pulley.

Rubric	Marks
Given data with notation and formula used - 2 marks	7
Complete solution with correct answer - 5 marks	

Section 5 (Answer all question(s))

Marks CO BL

- Q18.** Explain the different causes of gear tooth failures and suggest possible remedies to avoid such failures.

3 4 2

Rubric	Marks
different causes of gear tooth failures - 2 marks	3
possible remedies to avoid such failures - 1 mark	

- Q19. (a)** A reciprocating compressor is to be connected to an electric motor with the help of spur gears. The distance between the shafts is to be 500 mm. The speed of the electric motor is 900 r.p.m. and the speed of the compressor shaft is desired to be 200 r.p.m. The torque, to be transmitted is 5000 N-m. Taking starting torque as 25% more than the normal torque, determine : (a) Module and face width of the gears using 20 degrees stub teeth and (b) Number of teeth and pitch circle diameter of each gear. Assume suitable values of velocity factor and Lewis factor.

7 4 3

Rubric	Marks
Given data with notation and formula used - 2 marks	7
Complete solution with correct answer - 5 marks	

(OR)

- (b)** Design a belt drive to transmit 110 kW for a system consisting of two pulleys of diameters 0.9 m and 1.2 m, centre distance of 3.6 m, a belt speed 20 m / s, coefficient of friction 0.3, a slip of 1.2% at each pulley and 5% friction loss at each shaft, 20% over load.

Rubric	Marks
Given data with notation and formula used - 2 marks	7
Complete solution with correct answer - 5 marks	

Section 6 (Answer any 2 question(s))

Marks CO BL

Q20. Design a helical compression spring for a maximum load of 1000 N for a deflection of 25 mm using the value of spring index as 5. The maximum permissible shear stress for spring wire is 420 MPa and modulus of rigidity is 84 kN/mm². 5 5 3

Rubric	Marks
Given data with notation and formula used - 2 marks	5
Complete solution with correct answer - 3 marks	

Q21. Design a journal bearing for a centrifugal pump from the following data : Load on the journal = 20 000 N; Speed of the journal = 900 r.p.m.; Type of oil is SAE 10, for which the absolute viscosity at 55°C = 0.017 kg / m-s; Ambient temperature of oil = 15.5°C ; Maximum bearing pressure for the pump = 1.5 N / mm². Calculate also mass of the lubricating oil required for artificial cooling, if rise of temperature of oil be limited to 10°C. Heat dissipation coefficient = 1232 W/m²/°C. 5 5 3

Rubric	Marks
Given data with notation and formula used - 2 marks	5
Complete solution with correct answer - 3 marks	

Q22. What are rolling contact bearings? Discuss their advantages over sliding contact bearings. Write short note on classifications and different types of antifriction bearings. 5 5 2

Rubric	Marks
rolling contact bearings - 1 mark	5
advantages over sliding contact bearing - 1 mark	
classifications and different types of antifriction bearings - 3 marks	
