

Roll No: _____

BTECH
(SEM V) THEORY EXAMINATION 2025-26
MACHINE DESIGN

TIME: 3 HRS

M.MARKS: 70

Note: Attempt all Sections. In case of any missing data, choose suitably.

SECTION A

1. Attempt all questions in brief.

02 x 7 = 14

Q no.	Question	CO	Level
a.	What is meant by endurance limit? How does it differ from fatigue strength? ✓	3	K3
b.	What are the advantages of welded joints compared with riveted joints? ✓	2	K2
c.	Define contact ratio in spur gears and state its significance.	2	K2
d.	What is the significance of interference in involute gears?	1	K2
e.	What is the difference between hydrostatic bearing and hydrodynamic bearing.	4	K4
f.	Write any two functions of piston rings in an IC engine. How are the compression rings different from the oil rings?	5	K5
g.	State the Goodman criterion used in design against fluctuating loads.	2	K2

SECTION B

2. Attempt any three of the following:

07 x 3 = 21

a.	A steel rod is subjected to an axial tensile load of 30 kN. If the permissible tensile stress is 100 MPa, determine the required diameter of the rod.	2	K2
b.	A single riveted lap joint has a rivet diameter of 20 mm and a plate thickness of 10 mm. Calculate the shearing strength of one rivet, given the allowable shear stress as 80 MPa.	3	K3
c.	Explain the factors affecting the life of rolling contact bearings, with reference to load and reliability.	4	K4
d.	A rolling contact bearing is required to operate for 10,000 hours at 600 rpm. Calculate the total number of revolutions the bearing will complete during its life.	4	K4
e.	Discuss the failure of riveted joints under eccentric loading and state the design precautions to prevent such failures.	5	K5

SECTION C

3. Attempt any one part of the following:

07 x 1 = 07

a.	Design a single riveted lap joint to transmit a tensile force of 60 kN. The allowable stresses are: i. Tensile stress = 80 MPa ii. Shear stress = 60 MPa iii. Crushing stress = 120 MPa Determine the rivet diameter, pitch, and efficiency of the joint.	2	K2
b.	Explain the design considerations of a single plate friction clutch and derive the expression for torque transmitting capacity under uniform wear theory.	3	K3

4. Attempt any one part of the following:

07 x 1 = 07

a.	A rotating shaft is subjected to a bending moment varying from -500 N-m to +1500 N-m and a steady torsional moment of 800 N-m. The shaft material has $S_{ut} = 600 \text{ MPa}$, $S_y = 420 \text{ MPa}$, and endurance limit $S_e = 280 \text{ MPa}$. Considering stress concentration factor = 1.5 and using the Modified Goodman criterion, determine the safe diameter of the shaft.	4	K4
b.	Design an eccentrically loaded riveted joint to transmit a load of 80 kN acting at an eccentricity of 150 mm. The joint consists of 4 rivets placed symmetrically. Allowable shear stress is 70 MPa. Determine the maximum load on the most heavily loaded rivet and comment on joint safety.	3	K3



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5. Attempt any one part of the following:

07 x 1 = 07

a.	Design a spur gear pair to transmit 15 kW at 900 rpm with a velocity ratio of 3:1. The allowable bending stress is 100 MPa, and the gear material has a wear load factor $k = 1.2 \text{ N/mm}^2$. Determine the module, number of teeth, and face width, considering both beam strength and wear strength.	4	K4
b.	A pair of parallel helical gears consists of a 20 teeth pinion meshing with a 100 teeth gear. The pinion rotates at 720 rpm. The normal pressure angle is 20° , while the helix angle is 25° . The face width is 40 mm and the normal module is 4 mm. The pinion as well as the gear is made of steel 40C8 ($S_{ut} = 600 \text{ N/mm}^2$) and heat treated to a surface hardness of 300 BHN. The service factor and the factor of safety are 1.5 and 2 respectively. Assume that the velocity factor accounts for the dynamic load and calculate the power transmitting capacity of gears. CO5	3	K3

6. Attempt any one part of the following:

07 x 1 = 07

a.	A hydrodynamic journal bearing supports a radial load of 20 kN. The journal diameter is 100 mm, and the speed is 1200 rpm. The bearing operates with SAE 30 oil. Estimate the bearing pressure, heat generated, and heat dissipated, and comment on the thermal stability of the bearing.	4	K4
b.	A single-row deep groove ball bearing is subjected to a pure radial force of 3 kN from a shaft that rotates at 600 rpm. The expected life L _{10h} of the bearing is 30 000 h. The minimum acceptable diameter of the shaft is 40 mm. Select a suitable ball bearing for this application.	5	K5

7. Attempt any one part of the following:

07 x 1 = 07

a.	The following data is given for a four-stroke diesel engine: Cylinder bore = 250 mm Length of stroke = 300 mm Speed = 600 rpm Indicated mean effective pressure = 0.6 MPa Mechanical efficiency = 80% Maximum gas pressure = 4 MPa Fuel consumption = 0.25 kg per BP per h Higher calorific value of fuel = 44 000 kJ/kg Assume that 5% of the total heat developed in the cylinder is transmitted by the piston. The piston is made of grey cast iron FG 200 ($S_{ut} = 200 \text{ N/mm}^2$ and $k = 46.6 \text{ W/m}^2\text{C}$) and the factor of safety is 5. The temperature difference between the centre and the edge of the piston head is 220°C. (i) Calculate the thickness of piston head by strength consideration. (ii) Calculate the thickness of piston head by thermal consideration. (iii) Which criterion decides the thickness of piston head?		K2
b.	A single-cylinder, four-stroke IC engine develops 12 kW at 2800 rpm. The maximum cylinder pressure is 4 MPa. The allowable stresses are: i. Allowable bending stress for piston material = 35 MPa ii. Allowable bearing pressure on gudgeon pin = 12 MPa Design the piston diameter and determine the diameter and length of the gudgeon pin. Assume suitable proportions for piston dimensions and clearly state all assumptions used in the design.	5	K5