**Q. Code:809529**

**Reg. No.** | | | | | | | | | | | | | |

# B.E./ B.TECH. DEGREE EXAMINATIONS, MAY 2024

Fourth Semester

## MN22401 – DESIGN OF MACHINE ELEMENTS

*(Mechanical Engineering)*

**(Regulation 2022)**

**TIME:3 HOURS** **MAX. MARKS: 100**

| COURSE OUTCOMES | STATEMENT | RBT LEVEL |
|---|---|---|
| **CO 1** | Analyze the stresses induced in simple machine elements and shafts subjected to static and fatigue loading | **3** |
| **CO 2** | Select and design the required rolling contact bearing to support the given application | **3** |
| **CO 3** | Design the permanent and temporary joints subjected to direct and eccentric loading conditions. | **3** |
| **CO 4** | Apply procedures to design the transmission elements like belt and chain drives. | **3** |
| **CO 5** | Apply the design procedure for helical, bevel and worm gear drives to transmit power. | **3** |

### PART- A(20x2=40Marks)

(Answer all Questions)

| | | CO | RBT LEVEL |
|---|---|---|---|
| **1.** | What are the methods used to improve fatigue strength? | **1** | **2** |
| **2.** | Give some methods of reducing the stress concentration. | **1** | **2** |
| **3.** | Under what circumstances the hollow shaft preferred over solid shafts? | **1** | **2** |
| **4.** | List out the types of stresses are induced in shafts. | **1** | **2** |
| **5.** | List the important physical characteristics of a good bearing material. | **2** | **2** |
| **6.** | Describe bearing characteristic number. | **2** | **2** |
| **7.** | Differentiate between rigid and flexible couplings | **2** | **2** |
| **8.** | What are possible modes of failure of the bolt in a flexible coupling? | **2** | **2** |
| **9.** | Differentiate with a neat sketch the fillet welds subjected to parallel loading | **3** | **2** |
| **10.** | When will the weld deposit be weaker? | **3** | **2** |
| **11.** | How is a bolt designated? | **3** | **2** |
| **12.** | What are the different applications of screwed fasteners? | **3** | **2** |
| **13.** | Why tight side of the Flat belt should be at the bottom side of the pulley? | **4** | **2** |
| **14.** | State the law of belting. | **4** | **2** |
| **15.** | How the Chain can be designated? | **4** | **3** |
| **16.** | How chordal action can be reduced? | **4** | **3** |
| **17.** | Why is gear tooth subjected to dynamic load? | **5** | **2** |
| **18.** | Illustrate the materials for making gears. | **5** | **2** |
| **19.** | Differentiate a straight bevel gear and a spiral bevel gear. | **5** | **2** |

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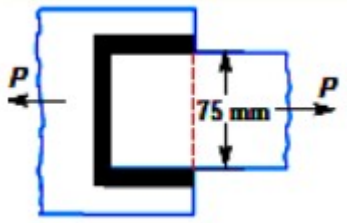
|---|---|---|---|---|
| **20.** | Usually worm is made of hard material and worm gear is made of softer material – justify. | **5** | **2** | |

**PART- B (5x 10=50Marks)**

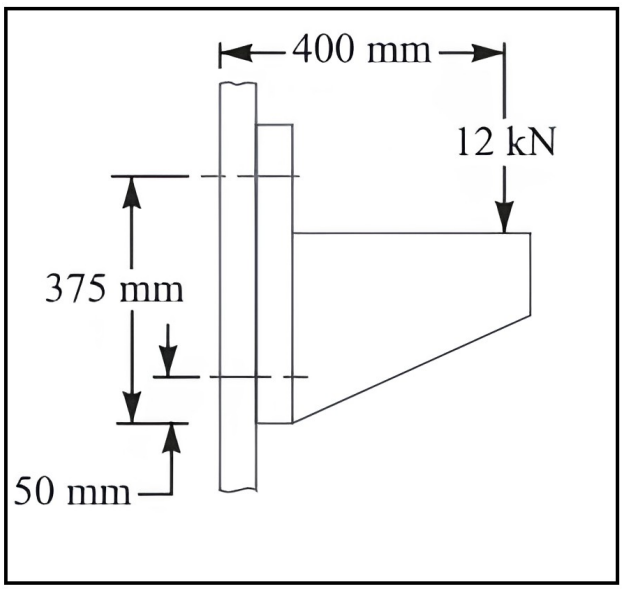
| | | Marks | CO | RBT LEVEL |
|---|---|---|---|---|
| **21. (a)** | A hollow shaft of 40 mm outer diameter and 25 mm inner diameter is subjected to a twisting moment of 120 N-m, simultaneously; it is subjected to an axial thrust of 10 kN and a bending moment of 80 N-m. Calculate the maximum compressive and shear stresses. | **(10)** | **1** | **2** |
| | **(OR)** | | | |
| **(b)** | A bar of circular cross-section is subjected to alternating tensile forces varying from a minimum of 200 kN to a maximum of 500 kN. It is to be manufactured of a material with an ultimate tensile strength of 900 MPa and an endurance limit of 700 MPa. Determine the diameter of bar using safety factors of 3.5 related to ultimate tensile strength and 4 related to endurance limit and a stress concentration factor of 1.65 for fatigue load. Use Goodman straight line as basis for design. | **(10)** | **1** | **2** |
| **22. (a)** | The rolling contact ball bearing are to be selected to support the overhung countershaft. The shaft speed is 720 r.p.m. The bearings are to have 99% reliability corresponding to a life of 24 000 hours. The bearing is subjected to an equivalent radial load of 1 kN. Consider life adjustment factors for operating condition and material as 0.9 and 0.85 respectively. Find the basic dynamic load rating of the bearing from manufacturer's catalogue, specified at 90% reliability. | **(10)** | **2** | **3** |
| | **(OR)** | | | |
| **(b)** | Design a rigid flange coupling to transmit a torque of 250 N-m between two coaxial shafts. The shaft is made of alloy steel, flanges out of cast iron and bolts out of steel. Four bolts are used to couple the flanges. The shafts are keyed to the flange hub. The permissible stresses are given below: Shear stress on shaft is 100 MPa Bearing or crushing stress on shaft is 250 MPa Shear stress on keys is 100 MPa Bearing stress on keys is 250 MPa Shearing stress on cast iron is 200 MPa Shear stress on bolts is 100 MPa. The stresses developed in the various members may be checked if thumb rules are used for fixing the dimensions. | **(10)** | **2** | **3** |

| | | | | |
|---|---|---|---|---|
| **23. (a)** | A plate 75 mm wide and 12.5 mm thick is joined with another plate by a single transverse weld and a double parallel fillet weld as shown in fig. The maximum tensile and shear stress are 70 MPa and 56 MPa respectively. Calculate the length of each parallel fillet weld if the joint is subjected to both static and fatigue loading | **(10)** | **3** | **2** |




**(OR)**

| | | | | |
|---|---|---|---|---|
| **(b)** | For supporting the travelling crane in a workshop, the brackets are fixed on steel columns as shown in Figure given below. The maximum load that comes on the bracket is 12 kN acting vertically at a distance of 400 mm from the face of the column. The vertical face of the bracket is secured to a column by four bolts, in two rows (two in each row) at a distance of 50 mm from the lower edge of the bracket. Determine the size of the bolts if the permissible value of the tensile stress for the bolt material is 84 MPa. Also find the cross-section of the arm of the bracket which is rectangular. | **(10)** | **3** | **2** |

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|---|---|---|---|---|
| **24. (a)** | Design a suitable V-belt for a centrifugal pump running at 340 rpm is to be driven by 100 KW motor at 1440 rpm. The drive is to work at least 20 hours every day. Centre distance is 1.2 m. | **(10)** | **4** | **3** |

**(OR)**

| | | | | |
|---|---|---|---|---|
| **(b)** | A truck equipped with 9.5 KW engine uses a roller chain of the final drive to | **(10)** | **4** | **3** |

the rear axle. The driving sprocket runs at 900 rpm and driven sprocket at 400 rpm with a center distance of approximately 600 mm. select a suitable the roller chain.

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|---|---|---|---|---|
| **25. (a)** | Design a pair of helical gears to transmit 37.5KW at 1750 rpm of the pinion. The drive is subjected to heavy shock loading. The speed reduction ratio is 4 and the helix angle is 15°. Select suitable material and design the gears. | **(10)** | **5** | **3** |
| | **(OR)** | | | |
| **(b)** | Design a worm gear drive to transmit 20 KW at a worm speed of 1440 rpm. Velocity ratio is 24:1. An efficiency of at least 82% is desired. The temperature raise should be restricted to 400°C. Determine the required cooling area. | **(10)** | **5** | **3** |

## PART- C (1x 10=10Marks)

(Q.No.26 is compulsory)

| | | Marks | CO | RBT LEVEL |
|---|---|---|---|---|
| **26.** | Design a shaft and flange for a Diesel engine in which protected type of flange coupling is to be adopted for power transmission. The following data is available for design: Power of engine is 75 kW; speed of engine is 200 r.p.m.; maximum permissible stress in shaft is 40 MPa; maximum permissible twist in shaft is 1° in length of shaft equal to 30 times the diameter of shaft; maximum torque is 1.25 × mean torque; pitch circle diameter of bolts is 3 × diameter of shaft; maximum permissible stress in bolts is 20 MPa. | **(10)** | **2** | **4** |

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