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PRESIDENCY UNIVERSITY BENGALURU

SCHOOL OF ENGINEERING

MAKE UP EXAMINATION - JULY 2024

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| **Semester : V** | **Date : 05-07-2024,** |
| **Course Code : MEC3090** | **Time : 09.30am to 12.30pm** |
| **Course Name : Design of Machine Elements-I** | **Max Marks : 100** |
| **Program : B.TECH** | **Weightage : 50%** |

**Instructions:**

1. *Read all questions carefully and answer accordingly.*
2. *Question paper consists of 3 parts.*
3. *Scientific and non-programmable calculator are permitted.*
4. *Do not write any information on the question paper other than Roll Number.*

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| **PART A** | | | |
| **ANSWER ANY 4 QUESTIONS 4Q X 5M=20M** | | | |
| 1 | Explain Maximum Principal stress theory and Von Mises theory of failure along with a neat diagram of Region of Safety. | (CO 1) | [Knowledge] |
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| 2 | Illustrate the stress-strain diagrams for Cast Iron, Mild Steel, Rubber band, Glass, and ABS plastic. | (CO 1) | [Knowledge] |
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| 3 | Explain the distinctions between alternating stresses, repeated stresses, and reversed stresses in the context of fatigue analysis, draw the S-N curve. | (CO 2) | [Knowledge] |
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| 4 | Explain endurance limit and fatigue life. | (CO 2) | [Knowledge] |
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| 5 | Provide an overview of keys, including their classification, and elaborate on one specific type. | (CO 4) | [Knowledge] |
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| 6 | Define the term "Transmission shaft" and distinguish between a shaft, axle, and spindle. | (CO 3) | [Knowledge] |
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| **PART B** | | | |
| **ANSWER ANY 5 QUESTIONS 5Q X 10M=50M** | | | |
| 7 | Create a design for a double riveted butt joint, incorporating two cover plates, to secure the longitudinal seam of a boiler shell with a 1.5 m diameter. The boiler is exposed to a steam pressure of 0.95 N/mm². Consider a joint efficiency of 75%, and set allowable stresses as follows: 90 MPa for tensile stress in the plate, 140 MPa for compressive stress, and 56 MPa for shear stress in the rivet. | (CO 5) | [Comprehension] |
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| 8 | Devise a design for a triple riveted longitudinal butt joint with cover plates of equal width for a boiler with a diameter of 1200 mm, exposed to an internal pressure of 0.9 MPa. Consider a joint efficiency of 75%. For practical considerations, where d represents the rivet diameter. Specify material constraints with allowable tensile stress at 120 MPa, shear stress at 80 MPa, and compressive stress at 160 MPa. | (CO 5) | [Comprehension] |
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| 9 | Apply coupling design principles to determine the specific type and essential parameters required for efficiently transmitting 30 kW of power from the hydraulic pump's shaft to the excavator's slew drive. Consider factors such as a shaft yield strength of 350 MPa, a Factor of Safety of 2.8, and a rotational speed of 1800 RPM. Identify the coupling configuration that is recommended for this application? | (CO 5) | [Comprehension] |
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| 10 | Determine the diameter of a machine shaft operating at 600 rpm, supported on bearings spaced 750 mm apart. The shaft receives 15 kW of power through a 450 mm pulley located 250 mm to the right of the right bearing, and the power is transmitted through a 200 mm gear situated 250 mm to the left of the left bearing. In this vertical belt drive system, the 450 mm pulley carries an 800 N weight to provide flywheel effect. The belt has an angle of contact of 157 degrees with a coefficient of friction of 0.4. Additionally, the steel 45C8 shaft (with Sut = 600 and Syt = 380 N/mm²) is subject to gradually applied loads, considering shock and fatigue. The gear is meshed with another gear directly above the shaft. Calculate the required shaft diameter, taking a pressure angle of 20 degrees into account according to the ASME code. Take bending moment as 250 N-m. | (CO 3) | [Comprehension] |
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| 11 | To assess the welded connection depicted in Figure under an eccentric force of 7.5 kN, the task is to determine the required size of welds, considering a permissible shear stress for the weld material of 100 N/mm². Assuming static conditions, what is the appropriate size for the welds to meet the specified shear stress criterion? | (CO 5) | [Comprehension] |
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| 12 | Design a key to transmit 475 N·m of torque from a shaft to a hub. The key and shaft are both constructed from commercial steel with a yield strength (Syt = Syc = 230 N/mm²). Aim for a factor of safety of 3 in the design. The shaft diameter is 40 mm. Determine the key dimensions to ensure the desired safety factor while accommodating the specified torque transmission. | (CO 4) | [Comprehension] |
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| 13 | For connecting two trolleys under a 50 kN axial load, a forked joint is essential. Design parameters must adhere to permissible stresses: 100 MPa (tension), 100 MPa (compression), and 50 MPa (shear). Design and name this forked joint. | (CO 5) | [Comprehension] |
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| **PART C** | | | |
| **ANSWER ANY 2 QUESTIONS 2Q X 15M=30M** | | | |
| 14 | Apply the principles of coupling design to determine the specific type and key parameters required for efficiently transmitting 50 kW of power from the BeLAZ 75710's transmission shaft to the differential, considering a shaft yield strength of 400 MPa, a Factor of Safety of 2.5, and a rotational speed of 1350 RPM. | (CO 3) | [Application] |
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| 15 | Identify an axial joint, connect a locomotive's drive shaft and wheel assembly for synchronized movement. With a 100 kN load, design the joint to meet permissible stresses of 120 MPa (tension), 160 MPa (compression), and 80 MPa (shear), ensuring efficient axial load transmission and easy assembly. | (CO 4) | [Application] |
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| 16 | A cantilever beam made of cold drawn steel 4OC8 (\sigmaut = 500 N/mm^{2} and \sigmayt = 380 N/mm^{2}) is shown in Fig. The force P acting at the free end varies from –50 N to +150 N. The expected reliability is 90% and the factor of safety is 2. The notch sensitivity factor at the fillet is 0.9. Solve for the diameter ‘d’ of the beam at the fillet cross-section. | (CO 3) | [Application] |
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