THE PAPUA NEW GUINEA UNIVERSITY OF TECHNOLOGY

Papua New Guinea University of Technology
Department of Mechanical Engineering
Machine Design ME 312
Semester 1 Examination Questions

Thursday 2nd June 2022 · 08 :20 PM

TIME ALLOWED: 2 HOURS

INFORMATION FOR CANDIDATES

1. You have 10 minutes to read the paper. You must not begin writing during this time.

2. **Answer all four questions**

3. Use only blue or black ink. Do not use pencil for writing except for drawings and sketches.

4.Start each question on a new page and show all your calculations in the answer book provided. No other written material will be accepted.

5. **Write your NAME and NUMBER clearly** on the front page. Do it now.

6. Calculators are permitted in the examination room. Notes and textbooks are not allowed.

MARKING SCHEME:
Marking scheme for each question is shown.

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Question One (10 Marks)

A hollow steel shaft has an outside diameter of 120 mm and an inside diameter of80 mm. The shaft is subjected to a torque of 28 kN - rn. The modulus of rigidity (shear modulus) for the steel is 80 GPa. Determine;

a. The shearing stress on a transverse cross section at the outside surface of the shalt.
b. The shearing stress on a transverse cross section at the inside surface of the shalt.
c. The magnitude of the angle of twist in a 2.0-m length of the shaft.
d. The magnitude of the angle of twist in a 2.0-m-long solid shaft that has the same weight as the hollow shaft.

Question Two (10 Marks)

A line shaft rotating at 200 r.p.m. is to transmit 20 kW. The shaft may be assumed to be made of mild steel with an allowable shear stress of 42 MPa. Determine the diameter of the shaft, neglecting the bending moment on the shaft.

Question Three (10 Marks)

A 20° full-depth steel spur pinion has 20 teeth and a module of 2 mm and is to transmit 0.5 kW at a speed of 200 rev/min. Find an appropriate face width if the bending stress is not to exceed 75 MPa. Take Y=0.322

Question Four (10 Marks)

1. As an engineer concerned with the design and development of machine and structural components subjected to dynamic load, what are some basic principles of fatigue strengthening surface treatment to consider?

2. The generally recognized Wear Equation, which emerged in the 1940s, can be written as:

$$W_r = \frac{\delta}{t} = \frac{K}{H} pv$$

write the meaning of each of the parameters involved in the equation.

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Equation Sheet

$$\gamma_\rho = \rho\frac{\theta}{L} \qquad \text{or} \qquad \gamma_\rho = \rho\frac{d\theta}{dL}$$

$$\theta = \frac{T_r L}{GJ}$$

$$G = \frac{\tau}{\gamma}$$

$$J = \int \rho^2 dA = \int_0^c \rho^2 (2\pi\, \rho\, d\rho) = \frac{\pi c^4}{2}$$

$$J = \int \rho^2 dA = \int_b^c \rho^2 (2\pi\, \rho\, d\rho) = \frac{\pi c^4}{2} - \frac{\pi b^4}{2} = \frac{\pi}{2}\left(r_o^4 - r_i^4\right)$$

$$T_r = \frac{\tau_c J}{c} = \frac{\tau_\rho J}{\rho}$$

$$\upsilon = \frac{\mu}{\rho}$$

$$T_f = \frac{4\pi^2 \mu n L R^3}{c}$$

$$f = 2\pi^2 \frac{\mu n}{P} \cdot \frac{R}{c}$$

$$H = T\omega = (W_t d/2)\omega$$

$$V = (d/2)\omega.\ V = \pi dn/12$$

$$\sigma = \frac{M}{I/c} = \frac{6W^t l}{Ft^2}$$

$$\sigma = \frac{W^t}{Fpy}$$

$$Y = \frac{2xP}{3}$$

$$\sigma = \frac{K_v W^t}{FmY} \quad \sigma = \frac{K_v W^t P}{FY}$$

$$K_v = \frac{3.05 + V}{3.05} \qquad \text{(cast iron, cast profile)}$$

$$K_v = \frac{6.1 + V}{6.1} \qquad \text{(cut or milled profile)}$$

$$K_v = \frac{3.56 + \sqrt{V}}{3.56} \qquad \text{(hobbed or shaped profile)}$$

$$K_v = \sqrt{\frac{5.56 + \sqrt{V}}{5.56}} \qquad \text{(shaved or ground profile)}$$

$$T = \frac{P \times 60}{2\pi N}$$