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Machine Design
(1030)

P. Pages : 2

Time : Three Hours **Max. Marks : 100**

Instructions to Candidates :
1. Do not write anything on question paper except Seat No.
2. Answer sheet should be written with blue ink only. Graph or diagram should be drawn with the same pen being used for writing paper or black HB pencil.
3. Students should note, no supplement will be provided.
4. Answer **all** questions.
5. Neat diagrams must be drawn wherever necessary.
6. Figures to the right indicate full marks.
7. Use of non programmable electronic pocket calculator is allowed.
8. Assume suitable data wherever necessary.

1. a) The load on a bolt consists of an axial pull of 10 kN together with a transverse shear force of 5 kN. Find the diameter of bolt required according to 1. Maximum principal stress theory; 2. Maximum shear stress theory; 3. Maximum principal strain theory; 4. Maximum strain energy theory; and 5. Maximum distortion energy theory. **8**

b) Explain how the Hertz theory is applicable in contact stress analysis of gears. **8**

2. a) Laminate of composite material has a fracture toughness of $K_{IC} = 30 MPa$ & tensile strength of 500 MPa. A 25mm width structural element made from this material has an edge crack of length 3mm. Find the critical tensile stress that would cause unstable propagation of the crack. For the geometry of the specimen stress intensity factor. **8**

$K_{IC} = \sigma\sqrt{\pi a}\ f(a/b)$

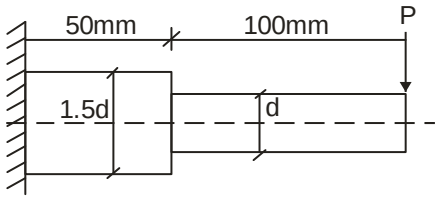
where $f(a/b) = 1.12 - 0.231(a/b) + 10.55(a/b)^2$

b) Explain in brief : **8**

i) Fracture mechanics concept of fatigue design.

ii) Fracture toughness of material.

3. a) A cantilever beam made of cold drawn steel 40 C8 **10**
$\left(S_{ut} = 600\ N/mm^2 \text{ and } S_{yt} = 380\ N/mm^2\right)$ is shown in fig. the force placing at free end varies from -50N to + 150N. The expected reliability is 90% and the factor safety is 2. The notch sensitivity factor at the fillet is 0.9. Determine the diameter of the beam at the fillet cross section using Gerber curve as failure criterion. (Assume $K_b = 0.85, K_a = 0.77,$ $K_t = 1.44, K_c = 0.897,\ K_d = 0.716,\ S_e = 0.5 S_{ut}$)



b) A chemical reaction chamber working at temperature at temperature 500ºC uses steel bolts to tighten the two parts. The test on the bolt material at this temperature resulted in to strain rates of $3\times10^{-18}/hr$ and $2\times10^{-18}/hr$ at 30 MPa & 25 MPa stress levels respectively. If the bolts are tightened to a stress level 68 MPa initially, calculate in what time the stress will be reduced to half of this value. Assume chamber is made of same material & flanges are very rigid. Take E at 500ºC = 1.7×10^5MPa. **8**

4. a) Relationship between factor of safety and reliability. Explain the method to predict reliability of parallel systems in design. **8**

b) A machine has a failure rate of 1×10^{-5} failure/hour. What is its reliability for a period of 500 hours. If there are 5000 items in the test, how many failure are expected in 400 hours. Assume a constant failure rate. **8**

5. a) Show that the material whose properties satisfy the following relations is Isotropic $E_1 = E_2$ **8**

$$G_{12} = \frac{E_1}{2(1+\mu_{12})}$$

b) Determine stiffness matrices for Quasi-isotropic [-60|0|60] laminate with the following material properties – **8**

$E1 = 140\ GPa \quad E2 = 10GPa \quad E6 = 6GPa \quad \mu_{12} = 0.3$

The thickness of Lamina is 0.2 mm.

6. Explain with suitable practical examples. **18**

a) Robust design
b) Design for assembly
c) Design for reliability.

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