Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/M.Tech (ME)/SEM-2/MME-201/2013

2013
ADVANCE MACHINE DESIGN

Time Allotted : 3 Hours *Full Marks* : 70

The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.

GROUP – A
(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following :

$10 \times 1 = 10$

i) In fatigue diagram showing various criteria of failure the Gerber line is of the form of

a) Straight line b) elliptical

c) parabolic d) Exponential.

ii) The notch sensitivity factor q is related with fatigue stress concentration factor and theoretical stress concentration factor by the term

a) $\frac{K_f + 1}{K_t + 1}$ b) $\frac{K_f - 1}{K_t - 1}$

c) $\frac{K_t + 1}{K_f - 1}$ d) $\frac{K_f + 1}{K_t - 1}$.

iii) The value of shear stress at a corner of non circular section due to torsion is

a) Maximum b) Minimum

c) Zero d) Exponential.

iv) The maximum shear stress in a rectangular section is

a) $\frac{T}{48ab^2}$ b) $\frac{T}{\alpha\ ab^2}$

c) $\frac{T}{\alpha\ a^2b}$ d) $\frac{T}{\alpha\ ab^3}$.

v) The maximum shear stress in a rectangular section occurs at ..... of the largest edge due to torsion.

a) Each corner b) Midpoint

c) perpendicular d) surface.

vi) In hydrodynamic lubrication of journal bearing the Pressure within the fluid mass increases as the film thickness ..... due to load

a) decreases b) increases

c) not changed d) fluctuates.

vii) The angle of twist in rectangular section due to torsion is

a) $\frac{TL}{\alpha\ a^2b^2G}$ b) $\frac{TL}{\alpha\ a^2bG^2}$

c) $\frac{TL}{\beta\ ab^3G}$ d) $\frac{TL}{\beta\ ab^2G}$.

viii) The speed of rotation, ω, of disc for plastic collapse is

a) $\frac{1}{R}\sqrt{\frac{9\sigma_y}{\rho}}$ b) $\frac{1}{\rho}\sqrt{\frac{\sigma_y}{R}}$

c) $\frac{1}{R}\sqrt{\frac{3\sigma_y}{\rho}}$ d) $\frac{1}{\sigma_y}\sqrt{\frac{9R}{\rho}}$.

ix) The radius at which maximum radial stress occurs for a rotating solid disc with a central hole having inner radius r_i and outer radius r_0 *is*

a) $\sqrt{\frac{r_i}{r_0}}$ b) $\sqrt{3 r_i r_0}$

c) $\sqrt{\pi r_i r_0}$ d) $\sqrt{r_i r_0}$.

x) The equation defined as $\frac{S_a}{S_e} + \frac{S_m}{S_{ut}} = 1$ is known as

a) Sodeberg line criterion Equation

b) Modified Goodman criterion Equation

c) Gerber criterion Equation

d) Langer equation.

xi) The interference I is defined as ..... the times the shrink fittings allowance, Δr

a) 1 / 2 b) 2

c) 4 d) 1.

xii) The torque in a bar of non circular cross section can be measured as ..... times the volume bounded by the Prandl's stress function Φ and the section or *x-y* plane

a) 3 b) 2

c) 4 d) 2 π.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. Define theoretical and fatigue stress concentration factor and how they are related with notch sensitivity factor. State Soderberg, modified Goodman and Gerberg equation along with fatigue diagram showing various criteria of failure.

3. State the general expression for the circumferential and radial stress of a thick cylinder subjected to internal pressure and also state the expression of the maximum stress in the thick cylinder subjected to internal pressure only for the both inner surface and outer surface.

4. State the generalized Reynolds equation of hydrodynamic lubrication with different terms involved in it and what are the assumption made by Reynolds for his hydrodynamic lubrication theory.

5. Define Conformal, non-conformal surfaces with example and also define thick, thin, mixed, boundary lubrication and elasto-hydrodynamic lubrication.

6. State the expression of maximum circumferential and radial stress for rotating solid disc with central hole and at what radius the maximum radial stress occurs. Explain what is the condition of plastic collapse of rotating disc.

7. State Prandl's stress function and torsion equation and also Elastic membrane equation for torsion of non circular section and the expression of maximum shear stress and angle of twist for the torsion of Equilateral triangle and elliptical cross section.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

8. a) A thick cylinder of internal radius 150 mm and outer radius 200 mm is subjected to pressure on both inner and outer surfaces. The outer surcface is at 15 MPa pressure. To what extent there could be pressure at inner surface so that maximum stress could be permitted up to 45 MPa (tensile) ?

   b) Calculate the maximum shear stress and angle of twist for a square shaft of 50 mm side and 2 metre long when it transmits a torque of 3000 Nm. The modulus of rigidity is 83 GPa. 8 + 7

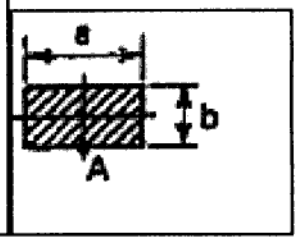
9. A disc 300 mm diameter has central hole of 50 mm is shrunk fitted on a shaft. The pressure between the disc and the shaft is 80 MPa. The assembly is rotated. At what speed of rotation will the disc loosen up as a result of rotation ? Compute the maximum hoop stress at above speed.

   Assume ρ = 7900 kg/m^3, υ = 0.33 and E =200 GPa.

10. A journal of a stationary oil engine is 80 mm in dia. and 40 mm long. The radial clearance is 0.060 mm. It supports a load of 9 kN when the shaft is rotating at 3600 rpm. The bearing is lubricated with SAE 40 oil supplied at atmospheric pressure and average operating temperature is about 65°C. Analyze the bearing assuming that it is working under steady state condition. μ = 30 cP at 65°C for SAE 40 oil.

11. a) A cantilever rectangular shaft of an alloy steel is subjected to torsion by the torque T = 700 N.m. Determine the maximum shearing stress and the angle of twist at the free end. Assume G = 220 GPa, length of the shaft, L = 2.0 metre, a = 120 mm and b = 60 mm. Refer the following table for required data.

a/b	β	α
1.0	0.141	0.208
1.5	0.196	0.231
2.0	0.229	0.246
2.5	0.249	0.256
3.0	0.263	0.267
4.0	0.281	0.282
5.0	0.291	0.292
10.0	0.312	0.312
∞	0.333	0.333



b) Derive the expression of maximum shear stress for an elliptical cross section having major axis $2a$ and minor axis $2b$ subjected by a torque T with the help of Prandtl's Stress function. 8 + 7

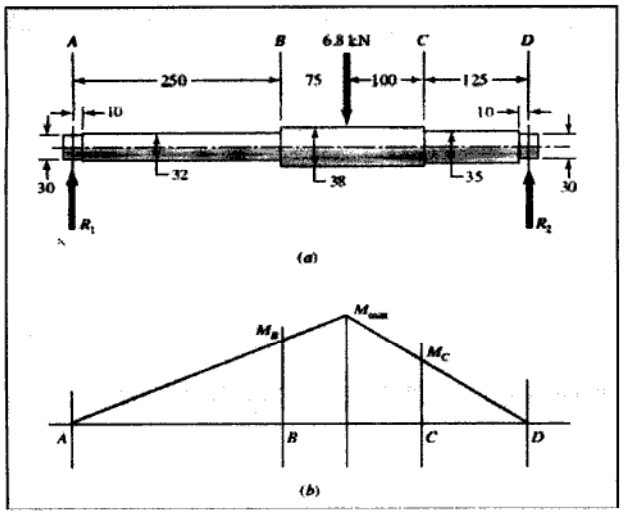
12. The figure on Page-7 shows a rotating shaft simply supported in ball bearings at A and D and loaded by a non-rotating force F of 6.8 kN. Estimate the life of the part.

For D/d = 38/32 = 1.1875 and r/d = 3/32 = 0.09375, the K_t = 1.65.

For S_{ut} = 690 MPa = 100 kpsi. The value of f = 0.844,

Use the relation $\sqrt{a}$ = 0.245799 – 0.307794 (10^{-2}) S_{ut} + 0.150874 (10^{-4}) S^{2}_{ut} – 0.266978 (10^{-7}) S^{3}_{ut} in $\sqrt{}$inch,

and $K_f = 1 + (K_t - 1)/(1 + \sqrt{a}/r)$ and $N = \left(\sigma_a / a\right)^{1/b}$



a) Shaft drawing showing all dimensions in millimetres; all fillets 3-mm radius. The shaft rotates and the load is stationary; material is machined from AISI 1050 cold-drawn steel.

b) Bending moment diagram

13. a) A machine journal bearing has a journal diameter of 150 mm and length of 120 mm. The bearing diameter is 150.24 mm. It is operating with SAE 40 oil at 65°C. The shaft is carrying a load of 8 kN and rotates at 960 rpm. Estimate the bearing coefficient of friction and power loss using Petroff's equation. μ = 30 cP at 65°C for SAE 40 oil.

b) A shaft with 120 mm diameter is supported by a bearing of 100 mm length with a diametral clearance of 0.2 mm and is lubricated by oil having a viscosity of 60 MPas. The shaft rotates at 720 rpm. The radial load is 6000 N. Find the bearing coefficient of friction, Sommerfeld number and power loss. 7 + 8