Total No. of Questions : 10]

SEAT No. :

P2209

[Total No. of Pages : 3

[4460]-592
M.E. (Mechanical) (CADM&E)
ADVANCED MACHINE DESIGN
(2012 Pattern) (Semester - I)

Time : 3 Hours] *[Max. Marks : 100*

Instructions to the candidates:

1) ***Answers three questions from each section.***
2) ***Answers to the two sections should be written in separate books.***
3) ***Use of electronic pocket calculator is allowed.***
4) ***Assume suitable data, if necessary.***

SECTION - I

Q1) a) Derive the compatibility equation in polar co-ordinate system. **[8]**

b) Explain Airy's stress function with its significance in stress analysis. **[8]**

Q2) The stress function :

$$\phi = \left(Ar^3 + \frac{B}{r} + Cr + Dr\log r \right)\cos 2\theta$$

represents the stress distribution in semi circular ring with inner radius r_i = 75 mm and outer radius r_0 = 100 mm with 'd' as thickness. The constants A, B, C and D involved in the stress function ϕ are to be evaluated for the following boundary conditions.

a) The inner and outer surface of the ring is free from radial stresses as well as shear stresses.

b) At horizontal cross section total tangential force i.e. $d\int_{r_i}^{r_o} \sigma\theta.dr = p$ at $\theta = 0$ where r_i and r_o are inner and outer radius of the ring and p is vertical load supported by the ring. Also investigate the stress distribution along the cross - section of the ring. If the ring is used to support load p = 25 kN. Determine the maximum shear stress developed in the ring and its location. **[16]**

P.T.O.

Q3) a) What is true stress and true strain? Assuming exponential relation for true stress and true strain, derive the expression to estimate time of rupture. **[8]**

b) A cantilever beam has a rectangular cross - section 5 cm wide and 9 cm deep. The length of beam is 200 cms with a load of 12000 N on it at the end. The material is carbon steel with $\eta = 7$ and $B = 40 \times 10^{-39}$ $(cm^2/N)^{\eta}$ day. Find permanent deflection after 10 years. **[8]**

Q4) a) What is the cumulative fatigue damage? How the life of component subjected to different values of fluctuating stresses in cycle, is estimated by using Miner's equation. **[6]**

b) A solid circular shaft, 15 mm in diameter, is subjected to torsional shear stress, which varies from 0 to 35 N/mm^2 and at the same time, is subjected to an axial stress that varies from – 15 to + 30 N/mm^2. The frequency of variation of these stresses is equal to the shaft speed. The shaft is made of Fe E400 steel ($S_{ut} = 540$ N/mm^2 and $S_{yt} = 400$ N/mm^2) and the corrected endurance limit of the shaft is 200 N/mm^2. Determine the factor of safety. **[10]**

Q5) Write short note on the following (Any three) : **[18]**

a) Rayleigh - Ritz methods

b) Galerkin's methods

c) Theorem of virtual work

d) Castigliano's theorems.

SECTION - II

Q6) a) Derive an expression for maximum space efficiency of helical springs. **[8]**

b) A disc spring is made of 3 mm sheet with an outside diameter of 125 mm and an inside diameter of 50 mm. The spring is dished 4.5 mm. The maximum stress is to be 560 N/mm^2. Determine : **[8]**

i) The load that may be safely carried.

ii) The deflection at this load.

iii) Stress produced at outer edge.

Q7) a) Based on correction aspect how gearing is classified, explain S_o gearing and S gearing. **[6]**

b) Two 10 teeth gears are to mesh without undercutting. The gears are generated using standard nob with 20° pressure angle. Module is 4 mm, the clearance is 0.2 mm. Using extended centre distance method find out, **[10]**

i) Hob shift.

ii) Blank diameter & depth of cutter setting.

iii) Actual pressure angle.

Take usual notations

θ = in v ϕ

$$\phi = v - \frac{2}{15}v^3 + \frac{3}{175}v^5$$

where, $v = \sqrt[3]{3\theta}$

θ& ϕ are in radians.

Q8) Prove that according to the distortion energy theory, the yield strength in shear is 0.577 times the yield strength in tension. **[16]**

Q9) a) Explain the use of composite materials in mechanical engineering giving examples of such use, state reasons for a preference in favour of such materials. **[6]**

b) Consider a graphite - epoxy laminate, whose elastic constants along and perpendicular to the fibers are as follows, **[10]**

E_{xx} = 181 GPa; E_{yy} = 10.3 GPa; G_{xy} = 7.17 GPa:

$$\upsilon_{xx} = 0.28; \upsilon_{xy} = 0.01594$$

Obtain the compliance coefficients appropriate to $x'y'$ axes which are at

i) + 30° (counter - clockwise) to xy axes and

ii) +9° to xy axes.

Q10) Write short note on the following : **[18]**

a) Transverse shear effects in composite laminates

b) Surge in springs

c) Low cycle and high cycle fatigue

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