Total No. of Questions : 7] SEAT No. :

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[4760] - 1065

M.E. (Mechanical) (Design Engineering)

MATERIAL SCIENCE & MECHANICAL BEHAVIOUR OF MATERIALS

(2013 Pattern)

Time : 3 Hours] *[Max. Marks : 50*

Instructions to the candidates :

1) ***Answer any five questions.***
2) ***Neat diagrams must be drawn whenever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of logarithmic tables, slide rule, Mollier charts, electronic pocket calculator and steam tables is allowed.***
5) ***Assume suitable data, whenever necessary.***

Q1) It is proposed to improve the wear resistance of a steel gear by hardening its surface. This is to be accomplished by increasing the carbon content within an outer surface layer as a result of carbon diffusion into the steel; the carbon is to be supplied from an external carbon rich gaseous atmosphere at an elevated and constant temperature. The initial carbon content of steel is 0.15 wt%, whereas the surface concentration is to be maintained at 0.95 wt%. For this treatment to be effective, a carbon content of 0.55 wt% must be established at 0.75 mm below the surface. Specify the appropriate heat treatment in terms of temperature and time for temperature at **[10]**

i) 900^0C

ii) 950^0C

iii) 1000^0C and

iv) 1050^0C.

Given that D_0 and Q (for diffusion of carbon and α-iron) are $2.3 \times 10^{-5} m^2/s$ and 148000J/mole respectively.

P.T.O.

z	erf(z)
0.40	0.4284
0.45	0.4755
0.50	0.5205
0.55	0.5633

Q2) The state of stress at a point to an xyz coordinate system is given by the stress matrix **[10]**

$$[\sigma] = \begin{bmatrix} -8 & 6 & -2 \\ 6 & 4 & 2 \\ -2 & 2 & -5 \end{bmatrix} \text{MPa}$$

Determine state of stress on an element that is oriented by first rotating the xyz axes 45^0 about the z axis and then rotating axes 30^0 about the new x axis.

Q3) At a point of interest in an engineering component, the stresses with respect to a convenient coordiate system are **[10]**

σ_x = 100 MPa, σ_x=-60 MPa, σ_x=40 MPa, τ_{xy}=80 MPa, $\tau_{xy} = \tau_{zy}$= 0 MPa

By using Mohr's circle determine the

i) Principal stresses

ii) Octahedral stresses

iii) Maximum shearing stress

Q4) A specimen of an alloy is made into a cylindrical bar of 12.827mm diameter and 203.2 mm length. The bar is loaded in axial tension upto the proportional limit when the load is 42.85 kN. At this load the length was measured as 204.1 mm and diameter was measured as 12.808mm. Determine the following. **[10]**

i) Proportional limit

ii) Modulus of elasticity

iii) Poisson's ratio

Also find true stress and true strain corresponding to load of 42.85kN.

Q5) The strains measured on the surface of a piece of sheet metal after deformation are $\varepsilon_1 = 0.182$, $\varepsilon_2 = -0.035$. The stress-strain curve in tension can be approximated by $\sigma = 30 + 40\varepsilon$. Assume the von Mises criterion, and assume that the loading was such that the ratio of $\varepsilon_2/\varepsilon_1$ was constant. **[10]**

Calculate the levels of σ_1 and σ_2 reached before unloading.

Q6) Explain residual shear stresses in solid circular cylinder in torsion. **[10]**

Q7) What is viscoelasticity? Explain Kelvin model of viscoelasticity. **[10]**