BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI
I Semester 2023-2024
MID SEMESTER EXAMINATION
Materials Technology & Testing (DE G631)
CLOSED BOOK EXAMINATION

Date: 11/10/2023 **Time: 90 min** **Max Marks:30**

Q1) Answer the following question in brief with proper justification.

a) For a bronze alloy, the stress at which plastic deformation begins is 275 MPa and the modulus of elasticity is 115 GPa **[2M]**

i. What is the maximum load that may be applied to a specimen with a cross-sectional area of 325 mm^2 without plastic deformation?

ii. If the original specimen length is 115 mm what is the maximum length to which it may be stretched without causing plastic deformation?

b) What *frequency ultrasonic probe* would you recommend for an application where defects equal to or larger than 2mm are to be detected in a material for which the velocity of sound is 5000m/sec. **[1M]**

c) The ultrasonic pulse echo method is employed to detect possible defects in a steel bar of thickness 40cm. if the pulse arrival times are 30micro seconds and 80micro seconds. Find the distance of the defect from the front end of the bar, where the ultrasonic pulse enters the bar. **[2M]**

d) Mention the factors which results in embrittlement (ductile to brittle transition) of the materials during its service. Which NDT technique is capable of predicting this transition ? Justify your answer **[2M]**

e) The following true stresses produce the corresponding true plastic strains for a brass alloy: **[3M]**

True stress (MPa)	True strain
350	0.10
450	0.20

What true stress is necessary to produce a true plastic strain of 0.25?

Q2) A steel tensile specimen with an initial diameter of 20mm and gage length of 120mm is subjected to a load of 125 kN and a gage length of 135mm is observed. Assuming uniform deformation at this point, calculate the followings:

a) calculate the true stress, strain and the instantaneous diameter

b) suppose the plastic behavior of the specimen material is expressed as $950\varepsilon^{0.15}$MPa, estimate the yield strength of the deformed specimen. **[3M]**

Q3) A test specimen in a tensile test has a gage length of 50 mm and a cross- sectional area of 316 mm^2. During the test the specimen yields (0.2% offset) under a load of 140kN.The corresponding gage length is 50.2mm. The maximum load of 200 kN is reached at a gage length of 58mm. Determine the followings: **[6M]**

a. Yield strength in MPa
b. Modulus of elasticity in GPa
c. Tensile strength in MPa
d. Percentage elongation if fracture occurs at a gage length of 66mm
e. Percentage area reduction (ductility) if the specimen necked to an area of 156 mm2
f. Strain hardening exponent n and strength coefficient Kin MPa
g. New yield strength and tensile strength in MPa and the ductility for the specimen with a 20% cold work

Q4) A cylindrical rod 120 mm long and having a diameter of 15.0 mm is to be deformed using a tensile load of 35,000 N. It must not experience either plastic deformation and neither a diameter reduction of more than 1.2x10^{-2} mm. Of the materials listed below, which are possible candidates? Justify your choice(s). **[5M]**

Material	Modulus of Elasticity (GPa)	Yield Strength (MPa)	Poisson's Ratio
A	70	250	0.3
B	205	550	0.27
C	45	200	0.35

Q5 a) Draw Typical SN curves for Mild steel and Aluminum and explain the differences. **[2M]**

b) A large plate of thickness 't' contains an edge crack of length 0.005m. Determine the no. of cycles to failure of the plate if the load varies between σ to 2σ. Also comment whether the crack will propagate or not. The material follows Paris law of crack propagation. **[4M]**

Given: $Yield\ strength\ of\ material\ (\sigma o) = 1200MPa$, K_{IC} (Fracture toughness) $=50MN/m^{3/2}$, $\sigma = 400MPa$, $Y = 0.826$, $C\ and\ n\ (constants\ of\ Paris\ law\ eq.) = 1.1487 \times 10^{-12}$ and 3 respectively, $\Delta K_{threshold} = 4MN/m^{3/2}$,