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CONFIDENTIAL

SET B

UNIVERSITI KUALA LUMPUR
Malaysia France Institute

FINAL EXAMINATION
JULY 2010 SESSION

SUBJECT CODE	:	FTD 11202
SUBJECT TITLE	:	MATERIAL SCIENCE 2
LEVEL	:	DIPLOMA
DURATION	:	12.30pm – 2.30pm (2 HOURS)
DATE / TIME	:	10 NOVEMBER 2010

INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper CAREFULLY.
2. This question paper is printed on both sides of the paper.
3. Please write your answers on the answer booklet provided.
4. Answer should be written in blue or black ink except for sketching, graphic and illustration.
5. This question paper consists of TWO (2) sections. Section A and B. Answer ALL questions in Section A and THREE (3) questions only in Section B.
6. Answer all questions in English.
7. Graph paper is appended.

THERE ARE 8 PRINTED PAGES OF QUESTIONS AND 2 PAGE OF FORMULAE, EXCLUDING THIS PAGE.

SECTION A (Total: 25 marks)

INSTRUCTION: Answer ALL questions.
Please use objective answer sheet provided.

1. Stress measures the _____________ required to deform or break a material.
   A. Strain B. Hardness
   C. Force D. Elongation

2. Which of the following is referred to proportional limit?
   A. The maximum stress which produces permanent plastic deformation.
   B. The minimum stress which produces permanent plastic deformation.
   C. The maximum stress at which stress is directly proportional to strain.
   D. The minimum stress at which stress is directly proportional to strain.

3. _____________ tells how much energy is needed to break a sample.
   A. Toughness B. Elongation
   C. Force D. Strength

4. _____________ is the property of a material that makes it break easily without bending.
   A. Brittleness B. Malleability
   C. Ductility D. Strength

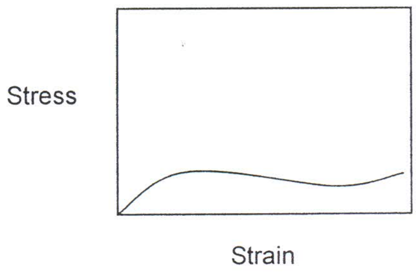
5. The following statement is **TRUE** about ductility:
   A. The metal must either break or be scraped off during these processes.
   B. It may be expressed quantitatively as either percent elongation or percent increase in area.
   C. It is an ability of a metal to elastically deform without breaking or fracturing.
   D. It is important in wire drawing and sheet stamping.

6. Which of the following is the **MOST** brittle metal:
   A. Manganese B. White cast iron
   C. Copper D. Brass

7. Modulus of elasticity is also called as

A.	Yan's Modulus	B.	Young's Modulus
C.	Yong's Modulus	D.	Yung's Modulus

8. Which of the following properties is referred to the stress-strain curve below?



A.	High toughness	B.	High ductility
C.	High strength	D.	High modulus

9. What is the definition of notch toughness?

A. It is a progressive localized damage due to fluctuating stresses and strains on the material.

B. It is the largest value of fluctuating stress that will not cause failure for essentially an infinite no. of cycle.

C. It is the ability that a material possesses to absorb energy in the presence of a flaw.

D. It is the time-dependent plastic deformation of materials subjected to a constant load and temperature greater than $0.4T_m$.

10. How many ways of applying a force to enable a crack to propagate?

A.	1	B.	3
C.	2	D.	4

11. Which of the following is **NOT** true about brittle fracture?

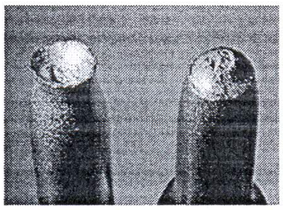
A. It is characterized by rapid crack propagation with low energy release and without significant plastic deformation.

B. The fracture may have a bright granular appearance.

C. The fractures are generally of the flat type and chevron patterns may be present.

D. The fracture may have a gray, fibrous appearance.

12. Which of the following is represented the fracture below?



A. Brittle fracture
B. Ductile fracture
C. Crystalline fracture
D. None of the above

13. Heat can be transferred by three methods. Which of the following is **NOT** the method of heat transfer?

A. Convention
B. Conduction
C. Radiation
D. Convection

14. __________________ is the fracture of a body resulting from thermal stresses induced by rapid temperature changes.

A. Thermal shock resistance
B. Thermal shock
C. Thermal expansion
D. Thermal stress

15. The ________________ that surrounds a magnet exerts magnetic force.

A. Magnetic strength
B. Magnetic flux density
C. Magnetic field
D. Magnetization

16. What would be happened to antiferromagnetic materials if they are sufficiently heated to Neel temperature?

A. Materials will lose magnetic character and become paramagnetic.
B. Materials will gain magnetic character and become paramagnetic.
C. Materials will lose magnetic character and become diamagnetic.
D. Materials will gain magnetic character and become diamagnetic.

17. Magnetic character of materials is typically analyzed relative to its _________________.

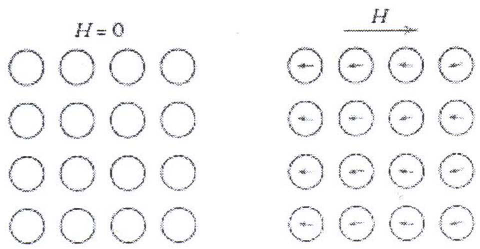
A. Magnetic force
B. Magnetic susceptibility
C. Magnetic flux density
D. Magnetization

18. Which of the following is an example of paramagnetic material?

A. Silver
B. Copper
C. Sodium
D. Zinc

19. Figure below shows the effect of magnetic field on one type of magnetism. Which of the following is referred to the figure below?

No Applied Magnetic Field Applied Magnetic Field



A. Diamagnetism B. Ferromagnetism
C. Paramagnetism D. Antiferromagnetism

20. Which of the following is **TRUE** about the electrical resistance?

A. It depends on the specific sample geometry
B. It decreases with the sample length
C. It increases with the sample area
D. Its unit is Ohm-meter (Ω.m)

21. The conduction of electricity in materials is due to charge carriers. These charge carriers are referred to ___________.

A. Proton B. Electron
C. Neutron D. Hole

22. Electrical conduction applies _______________ which defines the relationships between (V) voltage, (I) current, and (R) resistance.

A. Faraday's Law B. Newton's Law
C. Ohm's Law D. Boyle's Law

23. Which of the following is a factor of increasing the electrical conductivity in metal?

A. Increasing deformation B. Decrease temperature
C. Increasing imperfection D. Doping process

24. Which of the following are the main things to be considered in material selection?

A. Function of the product B. Cost
C. Design / Appearance D. All of the above

25. What is the importance of product analysis?

A. Enables us to identify the best classes of materials.

B. Enables us to understand the important materials, processing, economic and aesthetic decisions which are required before any product can be manufactured.

C. Enables us to understand the important materials and processing.

D. Enables us to use the material selection charts to eliminate materials which will definitely *not* be good enough.

SECTION B (Total: 75 marks)

INSTRUCTION: Answer THREE (3) questions only.

Please use answer booklet provided.

Question 1

a) A cylindrical specimen of aluminum having a diameter of 12.8 mm and a gauge length of 50.800 mm is pulled in tension. Use the tabulated data in table 1 below and answer the following problem;

Table 1: Data for Aluminium

Stress (MPa)	Strain
0	0.0000
57	0.0010
117	0.0020
179	0.0030
236	0.0040
267	0.0050
298	0.0100
321	0.0200
348	0.0400
359	0.0600
368	0.0800
369	0.1000
358	0.1200
348	0.1350
331	0.1500
283	0.1650
Fracture	

(i) Plot the data as engineering stress versus engineering strain.

(7 marks)

(ii) Determine the tensile strength of this alloy

(2 marks)

(iii) Compute the modulus of elasticity

(3 marks)

(iv) Determine the 0.2% proof stress.

(4 marks)

(v) What is the approximate ductility, in percent elongation?

(2 marks)

b) A 10-mm-diameter Brinell hardness indenter produced an indentation 1.62 mm in diameter in a steel alloy when a load of 500 kg was used.

i. Compute the HB of this material.

(3 marks)

ii. What will be the diameter of an indentation to yield a hardness of 450 HB when a 500 kg load is used?

(4 marks)

Question 2

(a) Describe **THREE (3)** differences between brittle fracture and ductile fracture.

(6 marks)

(b) The fatigue data for a brass alloy are given in Table 2:

Table 2: Data for brass alloy.

Stress Amplitude (MPa)	Cycles to Failure
310	2×10^5
223	1×10^6
191	3×10^6
168	1×10^7
153	3×10^7
143	1×10^8
134	3×10^8
127	1×10^9

(i) Using these data, plot stress amplitude versus log cycles to failure, *S* -*N* curve.

(13 marks)

(ii) Using the plot in b(i), determine the fatigue strength at 5×10^5 cycles.

(3 marks)

(iii) Using the plot in b(i), determine the fatigue life for 200 MPa.

(3 marks)

Question 3

(a) (i) About 3.5 Ampere of electric current is conducted through a 150 m copper wire. Calculate the minimum diameter of the wire. Assume that the voltage drop, $\Delta V < 3.5V$. Conductivity of copper is $6.07 \times 10^7 \ \Omega^{-1}m^{-1}$.

(10 marks)

(ii) Describe the mechanism of heat conduction in solid material. Explain why heat conduction in metal is faster than non metal.

(10 marks)

(b) A coil of wire of 0.45 m long and having 300 turns carries a current of 10 Ampere. Calculate the magnitude of the magnetic field strength.

(5 marks)

Question 4

a) State the factors that affecting resistivity in metal.

(5 marks)

b) A coil of wire 0.45 m long and having 300 turns carries a current of 10 A.

i. What is the magnitude of the magnetic field strength H?

(3 marks)

ii. Compute the flux density B if the coil is in a vacuum.

(5 marks)

iii. Compute the flux density inside a bar of titanium that is positioned within the coil. The susceptibility for titanium is 1.81×10^{-4}

(7 marks)

iv. Compute the magnitude of the magnetization M.

(5marks)

END OF QUESTION

Table 1.1 **Tabulation of the Thermal Properties for a Variety of Materials**

Material	c_p $(J/kg\text{-}K)^a$	α_l $[(°C)^{-1} \times 10^{-6}]^b$	k $(W/m\text{-}K)^c$	L $[\Omega\text{-}W/(K)^2 \times 10^{-8}]$
		Metals		
Aluminum	900	23.6	247	2.20
Copper	386	17.0	398	2.25
Gold	128	14.2	315	2.50
Iron	448	11.8	80	2.71
Nickel	443	13.3	90	2.08
Silver	235	19.7	428	2.13
Tungsten	138	4.5	178	3.20
1025 Steel	486	12.0	51.9	—
316 Stainless steel	502	16.0	15.9	—
Brass (70Cu-30Zn)	375	20.0	120	—
Kovar (54Fe-29Ni-17Co)	460	5.1	17	2.80
Invar (64Fe-36Ni)	500	1.6	10	2.75
Super Invar (63Fe-32Ni-5Co)	500	0.72	10	2.68
		Ceramics		
Alumina (Al_2O_3)	775	7.6	39	—
Magnesia (MgO)	940	13.5^d	37.7	—
Spinel ($MgAl_2O_4$)	790	7.6^d	15.0^e	—
Fused silica (SiO_2)	740	0.4	1.4	—
Soda–lime glass	840	9.0	1.7	—
Borosilicate (Pyrex) glass	850	3.3	1.4	—
		Polymers		
Polyethylene (high density)	1850	106–198	0.46–0.50	—
Polypropylene	1925	145–180	0.12	—
Polystyrene	1170	90–150	0.13	—
Polytetrafluoroethylene (Teflon)	1050	126–216	0.25	—
Phenol-formaldehyde, phenolic (Bakelite)	1590–1760	122	0.15	—
Nylon 6,6	1670	144	0.24	—
Polyisoprene	—	220	0.14	—

[a] To convert to cal/g-K, multiply by 2.39×10^{-4}; to convert to Btu/lb_m-°F, multiply by 2.39×10^{-4}.

[b] To convert to $(°F)^{-1}$, multiply by 0.56.

[c] To convert to cal/s-cm-K, multiply by 2.39×10^{-3}; to convert to Btu/ft-h-°F, multiply by 0.578.

[d] Value measured at 100°C.

[e] Mean value taken over the temperature range 0–1000°C.

Table 1.2 **Room-Temperature Electrical Conductivities for Nine Common Metals and Alloys**

Metal	*Electrical Conductivity* $[(\Omega\text{-}m)^{-1}]$
Silver	6.8×10^7
Copper	6.0×10^7
Gold	4.3×10^7
Aluminum	3.8×10^7
Iron	1.0×10^7
Brass (70 Cu–30 Zn)	1.6×10^7
Platinum	0.94×10^7
Plain carbon steel	0.6×10^7
Stainless steel	0.2×10^7

FORMULAE SHEET

$$\sigma = \frac{F}{A_o}$$

$$\varepsilon = \frac{\Delta l}{l_o}$$

$$E = \frac{\sigma}{\varepsilon}$$

$$U_r = \frac{(\sigma_y)^2}{2E}$$

$$\%elongation = \frac{\Delta l}{l_o} x100\%$$

$$\%\ area\ reduction = \frac{\Delta A}{A_o} x100\%$$

$$BHN = \frac{F}{\frac{\pi D}{2}(D - \sqrt{D^2 - d^2})}$$

$$DPH = \frac{1.85F}{d^2}$$

$$Q = mC\theta$$

$$C = \frac{dQ}{dT}$$

$$q = -k\frac{\Delta T}{\Delta x}$$

$$H = qA$$

$$Q = Ht$$

$$\Delta L = L_o \alpha_l \Delta T$$

$$\Delta V = 3V_o \alpha_l \Delta T$$

$$\sigma = E\alpha_l \Delta T$$

$$TSR \cong \frac{\sigma_f k}{E\alpha_l}$$

$$\sigma_c = \sqrt{\frac{2E\gamma}{\pi a}}$$

$$K_{Ic} \cong Y\sigma\sqrt{\pi a}, \text{ Y} = 0.7, 1 \text{ or } 1.12$$

$$B \geq \left[\frac{2.5K_{Ic}}{\sigma_y}\right]$$

$$\Delta V = IR$$

$$R = \frac{\rho L}{A}$$

$$\sigma = \frac{1}{\rho}$$

$$H = \frac{NI}{l}$$

$$M_s = 0.60\mu_B N$$

$$B_s = \mu_o M_s$$

$$R_{total} = R_A + R_B$$

$$P = \frac{V^2}{R}$$

$$U = Pt$$