Menofiya University Faculty of Engineering, Shebin El-kom Production Engineering and Mechanical Design Department Second Semester Examination, 2017-2018 Date of Exam: 30/ 5 /2018	جامعة المنوفية	1st year (Mechanical Power) Subject: Material Science Code: PRE 111 Time allowed: 3 Hours Total Mark: 70 marks

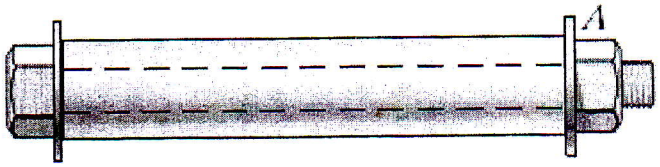
Answer all the following questions

QUESTION NO. 1

(20 MARK)

A) The steel bolt has a diameter of 7 mm and fits through an aluminum sleeve as shown in Fig. 1. The sleeve has an inner diameter of 8 mm and an outer diameter of 10 mm. The nut at A is adjusted so that it just presses up against the sleeve. If the assembly is originally at a temperature of T=20 °C and then is heated to a temperature of T2=100 °C, determine the average normal stress in the bolt and the sleeve. Take $\alpha_{st} = 14(10^{-6})/°C$, $\alpha_{al} = 23(10^{-6})/°C$. $E_{st} = 200$ GPa and $E_{al} = 70$ GPa, (10 marks)

Fig. 1



B) A square plate with 800 mm sides parallel to x and y-axes has a uniform thickness h = 10 mm and is made of isotropic steel (E = 200 GPa and $\nu = 0.29$). The plate is subjected to a uniform state of stress. If $\sigma_z = \tau_{zx} = \tau_{zy} = 0$ (plane stress), $\sigma_x = \sigma_1 = 500$ MPa and $\epsilon_y = 0$ for the plate. Determine $\sigma_y = \sigma_2$ and the final dimensions of the plate assuming linearly elastic conditions. (10 marks)

QUESTION NO. 2

(15 MARK)

A) A steel shaft 5 m long, having a diameter of 50 mm, is to be transmitted a power at a rotational speed of 600 rev/min, if maximum shear stress is limited to 60 MN/m^2. Determine the following: (8 marks)

i) The maximum power that can be transmitted. Take the modulus of rigidity = 80 GN/m^2.

ii) The corresponding angle of twist

) A 250 mm (depth) x 150 mm (width) rectangular beam is subjected to maximum bending moment of 750 kN/m. Determine:- (7 marks)

i) The maximum stress in the beam

ii) If the value of E for the beam material is 200 GN/m^2. Find out the radius of curvature for that portion of the beam where the bending is maximum.

QUESTION NO. 3

(17 MARK)

A) Write short notes about the following:- (3 marks)

- FGM - APF - CNT

B) Determine the packing efficiency and density of sodium chloride from the following data: (i) radius of the sodium ion = 0.98 Å, (ii) radius of chlorine ion = 1.81 Å (iii) atomic mass of sodium =22.99 amu and atomic mass of chlorine = 35.45 amu. (4 marks)

C) The glancing angle of 10° is observed in first order Bragg's reflection. Show that the angle for 3rd order reflection is 31.39 °.(4 marks)

D) The slow cooling of number of (BI) - (Sb) alloys of different composition gave the following results:

Antimony %	0	20	40	60	80	100
Temperature at whitch solidification begins ©	271	400	490	550	600	631
Temperature at which solidification end ©	-	285	320	370	450	-

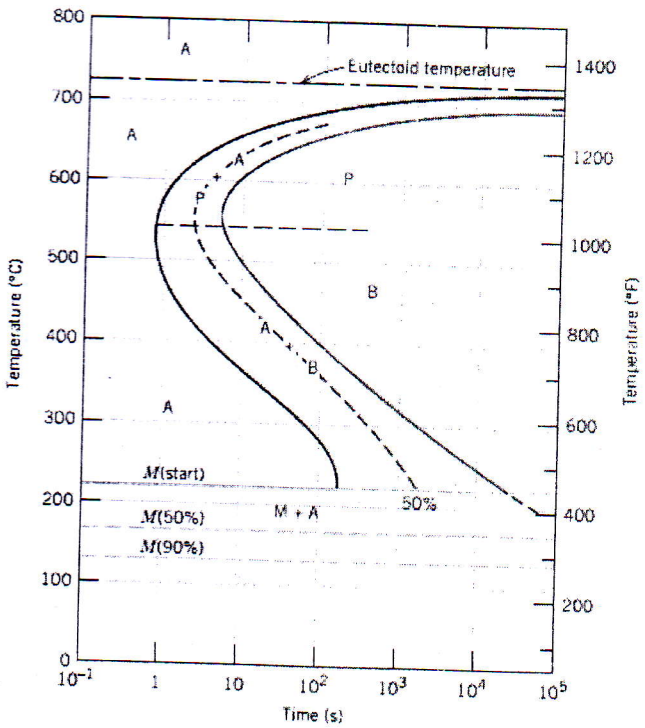
i) Draw and label the (Bi) -(Sb) equilibrium phase diagram
ii) Draw the cooling curves for alloys containing 80% and 100% (Sb)
iii) Determine the composition and the weight percentage of the phases present in an alloy containing 40% (Sb) at 510 ° C, 380 °C and RT. (6 marks)

QUESTION NO. 4

(18 MARK)

A) Cite two reasons why martensite is so hard and brittle. (4 marks)
B) Consider 1.5 kg of a 99.7% Fe and 0.3% C iron-carbon alloy that is cooled to a temperature below the eutectoid temperature. Construct the iron-carbon diagram, (8 marks)
i) Compute the amount of proeutectoid ferrite that forms.
ii) Determine the amount of eutectoid ferrite.
iii) Determine the amount of cementite that forms
C) Using the isothermal transformation diagram (TTT) for an iron–carbon alloy of eutectoid composition, Fig. 2, specify the nature of the final microstructure of a small specimen that has been subjected to the following time– temperature treatments (TTT). In each case assume that the specimen begins at 760°C (1400°F) and that it has been held at this temperature long enough to have achieved a complete and homogeneous austenitic structure. (6 marks)
i) Rapidly cool to 350°C, hold for 104s, quench to T_{room}
ii) Rapidly cool to 250°C, hold for 100s, quench to T_{room}
iii) Rapidly cool to 650°C, hold For 20s, rapidly cool to 400 °C, hold for 103s, quench to T_{room}

Fig (2)



********** GOOD LUCK************

	This exam measures the following ILOs							
Question Number	Q1a	Q2a	Q3b	**Q1b**	**Q3c**	**Q4d**	Q3b	Q4c
Skills	a1-1	a3-1	a19-1	**b2-1**	**b5-1**	**b11-1**	c7-1	c15-1
	Knowledge &Understanding Skills			**Intellectual Skills**			Professional Skills	

Prof. Dr / Soad Mohamed Serag & Dr. / Mahmoud Samir El-wazery