Program: BSc. in IPE (3rd Semester)

Date: 05 March, 2024
Time: 02:30 PM to 4.00 PM

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANIZATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

Mid Semester Examination
Course Number: ME 4225
Course Title: Materials Engineering

Summer Semester: 2022-2023
Full Marks: 75
Time: 1.5 hours

There are 03 (Three) questions. Answer 3 (Three) questions. The symbols have their usual meanings. Marks of each Question and the corresponding CO and PO are written in the brackets.

1.	(a)	Build the layers of atoms to compare the stacking sequences of atoms in FCC and HCP packing structures. Draw an FCC unit cell and apply the concept of space-filling to calculate the atomic packing factor.	(10) (CO-1) (PO-1) K1,K3/P1
	(b)	Utilize atomic packing illustration to calculate the planar density for the following scenarios: (a) The FCC crystal structure on the (100) plane, and (b) The BCC crystal structure on the (111) plane.	(12) (CO-1) (PO-1) K1,K3/P1
	(c)	Niobium has an atomic radius of 0.1430 nm and a theoretical density of 8.57 g/cm^3. Solve whether it has an FCC or BCC crystal structure.	(08) (CO-1) (PO-1) K1,K3/P1
2.	(a)	Provided a 6.0 kg austenite sample with 0.45 wt.% carbon, cooled below 727 °C, respond to the following inquiries: (a) Determine the proeutectoid phase. (b) Compute the masses of ferrite and cementite formed. (c) Assess the masses of pearlite and the proeutectoid phase formed.	(10) (CO-2) (PO-2) K3,K4/P1
	(b)	Analyze thoroughly the microstructural changes that take place during the slow cooling of a 0.45 wt.% carbon steel from the austenite range.	(10) (CO-2) (PO-2) K3,K4/P1
3.	(a)	Investigate the underlying objectives of the annealing process. Upon analyzing an iron-carbon alloy characterized by 20% ferrite and 80% pearlite, deduce the overall carbon percentage within the steel, categorize the specific type of steel, and provide an educated estimation of its approximate tensile strength.	(10) (CO-2) (PO-2) K3,K4/P1
	(b)	Examine the impact of drastic cooling rate on (a) the formation of martensite and (b) the tempering of steel.	(10) (CO-2) (PO-2) K3,K4/P1
	(c)	Can the approximate carbon content of normalized steel be deduced through microscopic analysis? Provide a detailed explanation.	(05) (CO-2) (PO-2) K3,K4/P1

(d). What is the essential difference between the streamlines in the upstream (0-1) and downstream (2-3) reservoirs that justifies the response to the previous question?
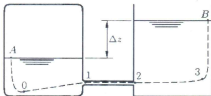

Figure 2

(e) An oil pipeline and a 1.3 m^3 rigid air tank are connected to each other by a manometer, as shown in **Fig. 3**. If the tank contains 15 kg of air at 80°C, determine (a) its absolute pressure if the pipeline and (b) the change in Δh when the temperature in the tank drops to 20°C. Assume the pressure in the oil pipeline to remain constant, and the air volume in the manometer to be negligible relative to the volume of the tank.
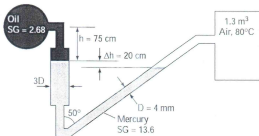
[10]
CO4, PO4
K8, P1, P3

Figure 3