मोतीलाल नेहरू राष्ट्रीय प्रौद्योगिकी संस्थान इलाहाबाद
भौतिकी विभाग
MOTILAL NEHRU NATIONAL INSTITUTE OF TECHNOLOGY ALLAHABAD
Department of Physics

Mid-Semester Examination, Academic Session 2022-23 (Even Semester)

Engineering Physics-III [PHN12503]

Time: 1 ½ hours   Max. Marks: 20

Attempt all questions. Write the sub-parts of a question at one place only. Symbols used have their standard meanings.

Q. 1 (a) Explain the Carnot cycle with the help of a neat P-V diagram. Show that the efficiency of a Carnot engine using an ideal gas as the working substance is $e = \frac{T_1 - T_2}{T_1}$, where T_1 and T_2 are the temperatures of the heat reservoir and the heat sink, respectively.

....4 marks

(b) A body of constant heat capacity C_p and at a temperature T_i is put in contact with a reservoir at a higher temperature T_f. The pressure remains constant while the body comes to thermal equilibrium with the reservoir. Show that the entropy change of universe is equal to $C_p[x - \ln(1 + x)]$ where $x = -\frac{T_f - T_i}{T_f}$.

...3 marks

Q.2 (a) Establish the thermodynamical relation $\left(\frac{\partial Q}{\partial P}\right)_T = -T\left(\frac{\partial V}{\partial T}\right)_P$

Hence show that heat is generated when a substance which expands on heating is compressed and for substances which contract a cooling should take place.

....4 marks

(b) In a $T - S$ diagram, represent clearly isothermal, adiabatic, isochoric, and isobaric transformations.

....2 marks

Q.3 (a) Derive an expression for the interplanar spacing between two parallel planes with Miller indices ($h\ k\ l$) in a crystal system.

...3 marks

(b) Consider the arrangement of circles of equal radii with their centers arranged as per 2-dimensional lattice defined as a = b, θ = 60° such that each circle is touching all its nearest neighbours. If all the void areas present are additionally occupied by smaller circles of relevant size so that the void circles are just contacting their neighbours, find the packing fraction (in percent) of the configuration.

....4 marks

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Department of Physics
End Semester Examination, Session 2022-23 (Even)

Programme: *B.Tech,*   **Branch:** *Biotech. & Chem. Engg*   **Semester:** *2nd*

Course Name: *Engineering Physics III*

Course Code: *PHN12503*   **Max. Marks:** *40*

Time: *2 ½ HRS*   **Registration No.:** 2 0 2 2 2 0 6 8

Instructions (related to question paper):

1. *Attempt all questions.*
2. *Write the sub-parts of a question at one place only.*
3. *Symbols used have their standard meanings.*

Q1	**a**	Explain what do you mean by entropy. Show that the change in entropy in a reversible cycle is zero while entropy increases in an irreversible process.	**(5)** CO1
	b	A domestic freezer is maintained at a constant temperature. In this condition the rate at which work is done on the working substance of the freezer is 400 J/s and the rate at which heat is rejected to the surroundings is 1250 J/s. Calculate the coefficient of performance of the freezer.	**(3)** CO1
Q2	**a**	Deduce Clausis-Clapeyron equation for the change of state of a substance from solid to liquid. Hence show that melting point is increased when a substance which expands on melting is compressed and for substances which contract the melting point is decreased.	**(5)** CO1
	b	One mole of molecules of an ideal gas is contained in a cylinder fitted with a frictionless piston. The gas is caused to expand reversibly from an initial volume of 1.0×10^{-3} m^3 to a final volume of 2.0×10^{-3} m^3, while its temperature is maintained constant. Calculate the change in the entropy of the gas that results from the reversible isothermal expansion.	**(3)** CO1
Q3	**a**	Below are listed the atomic weight, density, and atomic radius for three hypothetical alloys. For each determine whether its crystal structure is FCC, BCC, or simple cubic and then justify your determination.	**(5)** CO2

Alloy	Atomic Weight (g/mol)	Density (g/cm^3)	Atomic Radius (nm)
A	43.1	6.40	0.122
B	184.4	12.30	0.146
C	91.6	9.60	0.137

	b	Considering (101) and (111) planes in a cubic unit cell, determine the miller indices of the directions which are common to both the planes.	**(3)** CO2
Q4	**a**	What do you mean by the hysteresis loss? Establish the relation between the hysteresis loss and the area of B-H loop.	**(4)** CO2
	b	If K$_\alpha$ radiation of Mo (Z = 42) has a wavelength of 0.71 Å, determine the wavelength of the corresponding radiation of Cu (Z = 29).	**(2)** CO2