WEST BENGAL STATE UNIVERSITY

B.Sc. Honours PART-I Examinations, 2018

ELECTRONICS-HONOURS

PAPER-ELTA-I

Time Allotted: 4 Hours | Full Marks: 100

The figures in the margin indicate full marks.
Candidates should answer in their own words and adhere to the word limit as practicable.
All symbols are of usual significance.

Group-A

1. Answer any ***ten*** questions from the following: 2×10 = 20

(a) In any triangle ABC, prove vectorially

$\cos A = \dfrac{b^2 + c^2 - a^2}{2bc}$ (usual notation is used).

(b) Prove that $\vec{A} \cdot \dfrac{d\vec{A}}{dt} = 0$, if $\vec{A}$ is a constant vector.

(c) Obtain the solution of the differential equation :

$\dfrac{dN}{dt} = -\lambda N$ [λ = constant], with the boundary condition, $N = N_0$ at $t = 0$.

(d) If $A = \begin{bmatrix} 1 & 2 \\ -2 & 1 \end{bmatrix}$, find A^2.

(e) Find the Laplace transform of $e^{4x}\sin(2x)\cos(x)$.

(f) Show that $(AB)^n = A^n B^n$ if $AB = BA$, where A, B are matrices.

(g) State maximum power transfer theorem.

(h) One mole of a gas expands isothermally to four times its initial value. Calculate the change in entropy in terms of R, the gas constant.

(i) What is meant by chemical potential of a system?

(j) What is meant by 3 dB point of the frequency response characteristics of a low-pass filter?

(k) What is meant by active and reactive power in an a.c. circuit?

(l) What is meant by quasistatic process?

(m) Define intensive and extensive thermodynamic variables.

(n) What is meant by thermodynamic equilibrium?

Group-B

Answer any ***four*** questions from the following 10×4 = 40

2. (a) Prove that $\vec{\nabla}\times\left(\frac{\hat{i}x+\hat{j}y}{x+y}\right)=\frac{x-y}{(x+y)^2}\hat{k}$. 5

   (b) Show that $\nabla^2\left(\frac{1}{r}\right)=0$, where $r=(x^2+y^2+z^2)^{\frac{1}{2}}$. 5

3. (a) If $\vec{A}=2yz\hat{i}-x^2y\hat{j}+xz^2\hat{k}$, 3+2

   $\vec{B}=x^2\hat{i}+yz\hat{j}-xy\hat{k}$ and

   $\phi=2x^2yz^3$,

   Find (i) $(\vec{A}\times\vec{\nabla})\,\phi$, (ii) $\vec{A}\times\vec{\nabla}\phi$.

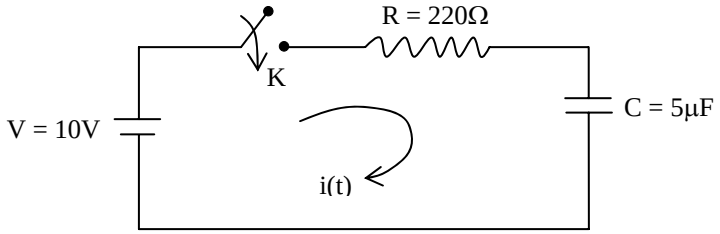
   (b) If $\vec{F}=(x+2y+4z)\hat{i}+(2x-3y-z)\hat{j}+(4x-y+2z)\hat{k}$, show that $\vec{F}$ is conservative and can be expressed as $\vec{\nabla}\phi$. Find the scalar potential ϕ. 5

4. (a) Solve $\frac{d^2y}{dx^2}-\frac{dy}{dx}-2y=e^{2x}$. 4

   (b) Find the power series solution of linear harmonic oscillator equation: 6

   $\frac{d^2y}{dx^2}+\omega^2y=0$.

5. (a) Calculate the current flowing through the following circuit shown below using Laplace transformation, assuming that the capacitor is initially uncharged. 5



   (b) Derive Newton-Raphson formula $x_{n+1}=x_n-\frac{f(x_n)}{f'(x_n)}$ for finding the roots of the equation $f(x)=0$. 5

6. (a) Find the eigen values and eigen vectors of the matrix $\mathbf{A}=\begin{bmatrix}1&0&0\\0&0&1\\0&1&0\end{bmatrix}$. 5+1

   Is the matrix A is unitary?

(b) Solve $\frac{d^2y}{dx^2} - 2\frac{dy}{dx} + y = xe^x \sin x$. 4

7. (a) Two constant forces $\vec{P} = 6\hat{i} - \hat{j} + 3\hat{k}$ and $\vec{Q} = 3\hat{i} - 2\hat{j} + \hat{k}$ act simultaneously on a particle. Calculate the work done in displacing the particle from (1, –2, 8) to (6, 4, –2). 7

(b) Find the inverse Laplace transform of $\frac{4}{s^2 + 64}$. 3

8. (a) Find the root of the equation $x^3 - x - 3 = 0$ using bisection method. 3

(b) Prove $\iiint_V (\phi \nabla^2 \Psi - \Psi \nabla^2 \phi)\, dV = \iint_s (\phi \vec{\nabla} \Psi - \Psi \vec{\nabla} \phi).d\vec{S}$. 7

Group-C

Answer any ***two*** questions from the following 10×2 = 20

9. (a) Find the expression of current in a series L-C-R circuit with D.C. excitation. 6

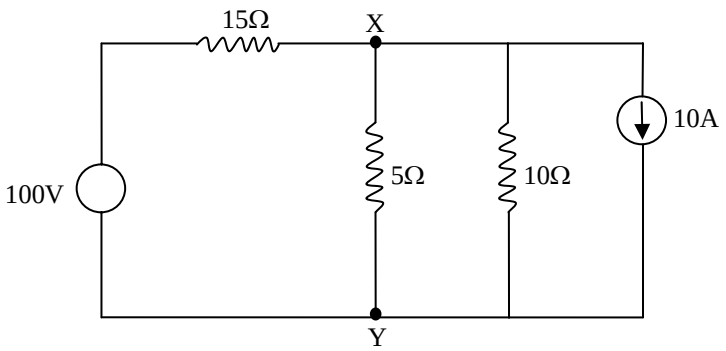
(b) Discuss all the possible cases. 4

10.(a) An electric lamp of resistance 10 Ω operates on 100 V D.C. It is required to operate the lamp from 220 V 50 Hz A.C. supply. Calculate the value of the inductance of the coil. 5

(b) How does a low-pass RC-circuit behaves as an integrator? 5

11.(a) State and prove Thevenin's theorem. 2+4

(b) Using Thevenin's theorem, calculate the current in the branch XY of the circuit shown below: 4



Group-D

Answer any ***two*** questions from the following 10×2 = 20

12.(a) State Kelvin-Plank's and Clausius statement of the second law of thermodynamics and show their equivalence. 6

(b) Justify the statement— "The entropy that becomes unavailable for work during an irreversible process is T_0 times the increase in entropy of the universe". 4

13.(a) Define "free path" and collision frequency. Show that the possibility of a gas molecule traversing a distance x without collision is $e^{-x/y}$, where y is the mean free path of a gas molecule. 6

(b) Calculate the mean free path, collision rate and molecular diameter of H_2 given $x = 85\times10^{-6}$ dynes/sq-cm, per unit velocity gradient, given $\eta = \frac{1}{3}mn\bar{c}\lambda$, $\bar{c} = 16\times10^{-4}$ cm/s and $\rho = 89\times10^{-6}$ gm/cc. 4

14.(a) Prove that $PV^{\gamma} =$ constant, is the equation for an adiabatic change of an ideal gas, where $\gamma = \frac{C_P}{C_V}$. 3

(b) Show that adiabatic curve is steeper than isothermal curve. 3

(c) Show that for a Van der Waal's gas 4

$$\left(P + \frac{a}{V^2}\right)(V - b) = RT,$$

$$C_P - C_V \simeq R\left(1 + \frac{2a}{RTV}\right).$$

15.(a) State the fundamental postulates of the kinetic theory of gaes. 3

(b) Derive an expression of pressure exerted by an ideal gas. 3

(c) What is the temperature at which all molecular motion ceases? Why does it cease? 4

——×——

WEST BENGAL STATE UNIVERSITY

B.Sc. Honours PART-I Examinations, 2018

ELECTRONICS-HONOURS

PAPER-ELTA-II-A

Time Allotted: 2 Hours | Full Marks: 50

The figures in the margin indicate full marks.
Candidates should answer in their own words and adhere to the word limit as practicable.
All symbols are of usual significance.

Group-A
(Statistical Mechanics)

Answer Question No. 1 and any *two* from the rest

1. Answer any ***five*** questions from the following: 1×5 = 5

(a) Plank's law of black body radiation is valid for

(i) All wavelength region (ii) Infrared region only

(iii) Ultraviolet region only (iv) Microwave region only

(b) A system is called strongly degenerate if

(i) $\frac{N_i}{g_i}=1$ (ii) $\frac{N_i}{g_i}<<1$ (iii) $\frac{N_i}{g_i}>>1$ (iv) $g_i=0$

(c) How Rayleigh-Jeans formula can be obtained from Plank's distribution law?

(d) What is Bose-condensation?

(e) The de Broglie wavelength of a moving particle of mass *m* and momentum *p* is given by

(i) $\lambda = hp$ (ii) $\lambda = \frac{p}{h}$ (iii) $\lambda = \frac{h}{p}$ (iv) none of these

(f) Do electrons have zero energy at 0K? Explain your answer.

(g) What is the physical significance of a wave-function $\psi(r, t)$?

2. (a) What is Fermi-Dirac distribution function? What is its physical significance? 3

(b) Using the expression of F-D distribution of energy among electrons within a metal, prove that at absolute zero, the average kinetic energy is $E_{av}=\frac{3}{5}E_F$ where E_F is the Fermi energy at 0K. 5

(c) Under what condition FD-distribution approaches to MB-distribution? 2

3. (a) Starting from basic postulates, deduce BE-distribution function. 6

(b) Show that sodium behaves as a metal in ordinary room temperature. Given that density of Na = 9.7×10^3 kg/m^3 and atomic weight of Na = 23. 4

4. (a) Derive an expression of the density of states of an electron. 5

   (b) Give a comparative discussion of basic postulates of MB; FD and BE-statistics. 5

Group-B

(Quantum Mechanics)

Answer Question No. 5 and any *two* questions from the rest

5. Answer any ***five*** questions from the following: 1×5 = 5

   (a) What is Compton Wavelength?

   (b) State Heisenberg's uncertainty principle.

   (c) What do you mean by expectation value of a variable?

   (d) Find the dimension of the wave function $\psi(r, t)$.

   (e) If the wave function is $\psi(x)$ normalized, $\int_{-\infty}^{+\infty} \psi(x)\,\psi^*(x)d\tau$ is then equal to

   (i) 1 (ii) 0 (iii) $+\infty$ (iv) $-\infty$

   (f) The energy operator $\hat{E}$ is given by

   (i) $\hat{E} = i\hbar\frac{\partial}{\partial t}$ (ii) $\hat{E} = -i\hbar\frac{\partial}{\partial t}$ (iii) $\hat{E} = \hbar\frac{\partial}{\partial t}$ (iv) $\hat{E} = \frac{\hbar}{i}\frac{\partial}{\partial t}$

   (g) Which physical parameter has the same dimension as Plank's constant?

   (i) Energy (ii) Entropy

   (iii) Linear momentum (iv) Angular momentum

6. (a) Write down Einstein's photo electric equation. Explain the characteristics of photo electric effect from Einstein's equation. 2+3

   (b) Derive an expression of Compton shift of scattered photon. 5

7. (a) The wave function of a particle is given by $\psi(x, t) = Ae^{i(kx-\omega t)}$. Obtain momentum and energy eigen values. 1.5+1.5

   (b) Solve Schrodinger's wave equation for a particle of mass *m* confined in a one dimensional potential well of width *W* and obtain its energy level. Show that the energy eigen values are degenerate. 7

8. (a) An electron remains in excited state for 10^{-11} sec. What is the minimum uncertainty in energy of the excited state? 4

   (b) Show the zero point energy of a linear harmonic oscillator is $\frac{1}{2}\hbar\omega$. 6

——×——