U.G. 3rd Semester Examination - 2020

PHYSICS

[PROGRAMME]

Course Code : PHYG-CC-3(A-C)

Full Marks : 40   Time : $2\frac{1}{2}$ Hours

The figures in the right-hand margin indicate marks.

Candidates are required to give their answers in their own words as far as practicable.

Answer all the questions from Selected Option.

OPTION-A

PHYG-CC-T-3A

(Mathematical Physics-III)

GROUP–A

1. Answer any **five** questions: 2×5=10

   a) Determine whether $(1/z)$ is analytic or not.

   b) Prove that $z = \pm i$ are branch points of $\left(z^2 + 1\right)^{\frac{1}{3}}$.

   c) Evaluate the integral $\int_C |z|\, dz$ where C is the straight line from $z = -i$ to $z = i$.

   d) Find the residue of tan z at its pole.

   e) Prove $L(1) = 1/s$.

   f) State Residue theorem.

   g) Write down the Convolution Theorem on Fourier Transform.

   h) Define isolated singularity of a complex function.

GROUP–B

2. Answer any **two** questions: 5×2=10

   a) Show that the function $e^x \left(\cos y + i \sin y\right)$ is an analytic function. Find its derivative.

   b) Verify, Cauchy theorem by integrating e^{iz} along the boundary of the triangle with the vertices at the points $1 + i$, $-1 + i$ and $-1 - i$.

   c) Find the Laplace transform of $\cos^2 t$.

   d) Find the Fourier cosine transform of

   $$f(x) = e^{-2x} + 4e^{-3x}.$$

GROUP–C

3. Answer any **two** questions: 10×2=20

   a) Show that the real and imaginary parts of the function w = log z satisfy the Cauchy-Riemann equations when z is not zero. Find its derivative. Find an analytic function $f(z) = u(r, \theta) + iv(r, \theta)$ such that $V(r, \theta) = r^2 \cos^2 \theta - r \cos \theta + 2$.

   5+5

   b) Determine the poles of the following function. Find the order of each pole.

   $$\frac{z-3}{(z-2)(z+1)^2}$$

   Evaluate the following complex integral

   $$\oint_C \frac{z-1}{(z-2)(z+1)^2} \text{ where } c \text{ is the circle } |z-i| = 2.$$

   5+5

   c) Prove $L(t^n) = \frac{n!}{s^{n+1}}$. Find the Laplace transforms of the following: $t \sin 2t$. 5+5

   d) Find the Fourier sine and cosine transform of $ae^{-\alpha x} + be^{-\beta x}$. 5+5

OPTION-B

PHYG-CC-T-3B

(Elements of Modern Physics)

GROUP-A

1. Answer any **five** questions: 2×5=10

   a) Define mean (or average) life of a radioactive nuclide.

   b) Give example of isomer, isotope and isotone.

   c) Write full form of LASER.

   d) What is Bohr magneton? Express its value in S.I unit.

   e) What is the energy in Joule of a photon of wavelength 6000 Å?

   f) Write Einstein's photoelectric equation. Explaining the terms used.

   g) Find an expression for time and energy uncertainty relation.

   h) What is the frequency of a photon having energy 100 eV?

GROUP-B

2.   Answer any **two** questions: 5×2=10

   a)   Show that group velocity and phase velocity

   related as $v_g = v_p - \lambda \dfrac{dv_p}{d\lambda}$, terms being as usual.

   Define half-life of a radioactive nuclide. Derive a relation between half-life and radioactive constant.   3+1+1

   b)   What is de Broglie hypothesis? Show that for relativistic free particle group velocity is equal to particle velocity.   2+3

   c)   Explain the terms 'mass defect' and 'packing fraction'. With figure (graph) explain the variation of packing fraction with mass number.
                                        2+3

   d)   Find the probability current density of $\psi = Ae^{ikx}$. Also find the eigen function of the operator

   given by $\left(x + \dfrac{d}{dx} \right)$.   3+2

GROUP-C

3.   Answer any **two** questions: 10×2=20

   a)   Write down the time dependent Schrödinger equation. Explain each term. Explain the existence of stationary orbits in Bohr's theory on the basis of matter waves. A particle of mass m move(i.e confined) in an infinite one dimensional square (rectangular) well its potential is given by

   $$V = 0, \quad \text{for } 0 < x < a$$
   $$= \infty, \quad \text{for } x \le 0 \text{ and } x \ge a$$

   Show that the energy eigen value is given by $E_n = \dfrac{n^2 \pi^2 h^2}{2ma^2}$, terms being as usual.
                                        1+1+3+5

   b)   What is population inversion? What is pumping? Explain optical pumping with a suitable example. What do you mean by Einstein's A and B coefficients? Establish relation between Einstein's A and B coefficient.   1+1+2+2+4

   c)   What are the basic similarities between a liquid drop and an atomic nucleus? Write Weizsacker's mass formula and explain each term involved. Which nuclei you would expect to be more stable between $_3Li^7$ and $_3Li^8$?   3+3+4

   d)   Using energy-momentum conservation, derive an expression for wavelength shift of photons as a function of the angle of scattering for Compton effect. Distinguish between nuclear fission and nuclear fusion. Find the total angular momentum and parity for the ground state of $_{13}Al^{27}$.   5+2+3

OPTION-C

PHYG-CC-T-3C

(Analog Systems & Applications)

GROUP–A

1. Answer any **five** questions: 2×5=10

   a) What are p-type and n-type semiconductors?

   b) Draw the energy band diagram for p-type and n-type semiconductors.

   c) Draw the circuit diagram of a forward and reverse biased p-n junction diode.

   d) Define dynamic resistance of a p-n junction diode.

   e) Define the current gain factors Alpha (α) and Beta (β)?

   f) Define open loop gain and closed loop gain.

   g) Define Barkhausen criterion of oscillation.

   h) What is the CMRR of an OPAMP?

GROUP–B

2. Answer any **two** questions: 5×2=10

   a) What is drift and diffusion current in semiconductors? Calculate the drift and diffusion current density in semiconductors. 2+3

   b) Find out the relation between alpha (α) and beta (β). A transistor has a collector current of 5 mA and a base current of $20 \, \mu A$. Find the values of α and β. 3+2

   c) Calculate the Q point in fixed bias configuration. Draw the h-parameter equivalent circuit of a basic CE amplifier and calculate the current gain. 2+1+2

   d) Define Class A amplifier. Draw the frequency response curve of a RC coupled amplifier. Explain the Mid-frequency range. 1+1+3

GROUP–C

3. Answer any **two** questions: 10×2=20

   a) Draw the circuit diagram of a half wave rectifier and calculate its efficiency of rectification. Explain how a transistor can act as an amplifier. What is a Zener diode? Explain its use as a voltage regulator. 5+2+1+2

   b) Draw the circuit arrangement for drawing the characteristic curves of an *npn* transistor in CB mode. Draw the input and the output characteristic curves. Discuss about the different operating regions in the output characteristics curve. What is early effect?

                                     2+2+5+1

   c) What are the effects of negative feedback? Describe RC phase shift oscillator with a circuit diagram and find the expression for the frequency of oscillation. 2+3+5

   d) What are the characteristics of an ideal OPAMP? Calculate the gain of an inverting and non-inverting amplifier. Draw a circuit diagram of an adder using OPAMP and find an expression of the output voltage. 2+5+3

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