

U.G. 3rd Semester Examination - 2021**PHYSICS****[PROGRAMME]****Course Code : PHY-G-CC-T-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****PHY-G-CC-T-3****(Mathematical Physics-III)****GROUP-A**1. Answer any **five** questions: $2 \times 5 = 10$

- a) Evaluate the integral $\int_C |z| dz$ where C is the straight line from $z = -i$ to $z = i$.
- b) Prove $L(1) = 1/s$.
- c) Define isolated singularity of a complex function.

- d) Determine whether $(1/z)$ is analytic or not.
- e) Write down the Convolution Theorem on Fourier Transform.
- f) Prove that $z = \pm i$ are branch points of $(z^2 + 1)^{\frac{1}{3}}$.
- g) Find the residue of $\tan z$ at its pole.
- h) State Residue theorem.

GROUP-B2. Answer any **two** questions: $5 \times 2 = 10$

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

$$f(x) = e^{-2x} + 4e^{-3x}.$$
- c) Show that the function $e^x (\cos y + i \sin y)$ is an analytic function. Find its derivative.
- d) Find the Laplace transform of $\cos^2 t$.

GROUP-C

3. Answer any **two** questions: $10 \times 2 = 20$

- a) 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

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

- c) 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

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

OPTION-B

PHY-G-CC-T-3

(Elements of Modern Physics)

GROUP-A

1. Answer any **five** questions: $2 \times 5 = 10$

- Find the ground state spin and parity of ${}_{13}^{27}\text{Al}$, in view of shell model.
- Explain how the age of the earth may be estimated from the relative abundance of the two isotopes of Uranium.
- What are the magic and semi magic numbers?
- Calculate the binding energy per nucleon of ${}^3_{\text{He}}$, taking the atomic masses of proton, neutron and ${}^3\text{He}$ as 1.007825, 1.008665 and 3.106030 mu respectively.
- Starting with 10gm of Radon, how much Radon will be there after 16 days? Half-life of Radon is 4 days.
- Write down the position-momentum uncertainty principle.
- Calculate the de Broglie wavelength of an electron having a kinetic energy of 1000 eV.
- Show that $[x, p_x] = i\hbar$.

GROUP-B

2. Answer any **two** questions: $5 \times 2 = 10$
- a) What is stopping potential in photoelectric effect? Is stopping potential depends on frequency of incident photons? The maximum kinetic energy of photoelectron is 1.3eV when ultraviolet light of wavelength 350nm is directed at a potassium surface. Find the work function of the potassium. $1+2+2$
- b) An electron and a proton have the same de broglie wavelength. Prove that the energy of electron is greater than that of the proton. An electron moves with a velocity of 5.9×10^6 m/s. Calculate its de Broglie wavelength. $3+2$
- c) Discuss with an appropriate table, how the problem of such numbers was resolved in view of the nuclear shell model. 5
- d) Write Weizsacker's mass formula and explain each term involved. Define packing fraction and explain the utility of packing fraction curve. $2+3$

GROUP-C

3. Answer any **two** questions: $10 \times 2 = 20$
- a) Using energy-momentum conservation, derive an expression for wavelength shift of photons as a function of the angle of scattering for Compton Effect. Find the value of Compton Wavelength. Derive Bohr's quantization condition from de-Broglie wavelength. $6+2+2$
- b) A particle of mass m is confined in an infinite square well such as the potential is given by
- $$V(x) = \begin{cases} 0 & 0 < x < a \\ \infty & x \leq 0 \text{ and } x \geq a \end{cases}$$
- Show that $E_n \propto n^2$, where n being their usual meaning. Hence show that for classical particle (m and a both are large) energy is not discrete. Also find the wave function of n -th state. $6+4$
- c) The nuclei are approximately spherical and have an average radius r given by $r = RA^{\frac{1}{3}}$ where A is the mass number and R a constant equal to 1.2×10^{-15} m. If the mass of proton and neutron be approximately equal to 1.6×10^{-27} kg show that the nuclear density is greater than the

density of water by a factor 10^{14} . Show from the semi-empirical mass formula, that $A \simeq 2Z$ for light nuclei.

A nucleus with $A=235$ splits into two nuclei whose mass no. are in the ratio 2:1. Find the radii of the new nuclei. ($R_0 = 1.4 \text{ fm}$) 4+4+2

- d) Write the full form of LASER. What is spontaneous emission and stimulated emission of radiation? Describe a He-Ni gas laser. How is population inversion achieved in this type of laser? Mention advantages of gas laser over a solid state laser. 1+1+1+2+3+2

OPTION-C

PHY-G-CC-T-3

(Analog Systems & Applications)

GROUP-A

1. Answer any **five** questions: 2×5=10
 - a) What is drift velocity in semiconductors?
 - b) Draw the energy band diagram of a forward biased and reversed biased p-n junction.
 - c) Define dynamic resistance of a p-n junction diode.
 - d) Draw the energy band diagram of a biased pnp transistor.
 - e) What is the relation between Alpha (α) and Beta (β) of a BJT?
 - f) Define Decibel Gain of an amplifier.
 - g) Define Barkhausen criterion of oscillation.
 - h) What is offset voltage and current of an OP AMP?

GROUP-B

2. Answer any **two** questions: 5×2=10
 - a) What is a rectifier? Calculate dc and rms value of load current of a full-wave rectifier? 1+4

- b) Explain input characteristics of a pnp transistor in CB and CE mode? $2\frac{1}{2}+2\frac{1}{2}$
- c) Draw the simplified hybrid model of a CE amplifier and calculate its current gain and voltage gain? $1+2+2$
- d) What is a voltage-series feedback amplifier? Explain stability of gain in negative feedback amplifier? $2+3$

GROUP-C

3. Answer any two questions: $10 \times 2 = 20$
- a) Explain how a transistor can act as a switch? What is Zener breakdown? Explain the principle of LED and photodiode? $3+2+2\frac{1}{2}+2\frac{1}{2}$
- b) Explain the dc load-line (bias curve) and stability of Voltage divider-self bias configuration? What is class A and B amplifier? Draw the circuit diagram of RC coupled BJT amplifier and explain its frequency response? $4+2+4$
- c) What is virtual ground of an OPAMP? Explain the effect of feedback on input impedance? Describe Hartley oscillator with a circuit

diagram and find the expression for the frequency of oscillation? $2+3+5$

- d) What is open-loop and closed-loop gain of an OPAMP? What are the characteristics of an ideal OPAMP? Draw the circuit diagram and calculate the output voltage of differentiator and integrator using OPAMP? $2+2+3+3$
