PG/IS/PHS-101/12

M.Sc. 1st Semester Examination, 2012

PHYSICS

PAPER – PHS- 101(A + B)

Full Marks : 40

Time : 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

Illustrate the answers wherever necessary

Write the answers to questions of each Group in separate books

GROUP – A

[*Marks* : 20]

Answer **Q.No.1** and any **one** from the rest

1. Answer any *five* bits : 2 × 5

(*a*) Show that if the nonsingular matrices A and B commute, so also do A^{-1} and B.

(*b*) If A and B are hermitian matrices, then show that $i[A, B]$ is also a hermitian matrix.

(*c*) Let X be an eigen vector of a hermitian matrix H. If Y is any vector orthogonal to X, show that HY is also orthogonal to X.

(*d*) Find the residue of

$$f(z) = \frac{1 - e^{2z}}{z^4}$$

at all its poles in the finite plane.

(*e*) Locate and name the singularity of the function $f(z) = z^4$.

(*f*) Write down the generating function of Hermite and Laguerre polynomials.

(*g*) Given that

$J_{\frac{1}{2}}(x) = \sqrt{\frac{2}{\pi x}} \sin x$ and $J_{-\frac{1}{2}}(x) = \sqrt{\frac{2}{\pi x}} \cos x$, express $J_{\frac{3}{2}}(x)$ and $J_{-\frac{3}{2}}(x)$ interms of trigonometric functions. When $J_n(x)$ is the Bessel function of the first kind of order n.

(*h*) Evaluate

$$\int_0^\infty x^{n-1} e^{-a^2x^2} dx$$

interms of the gamma function.

2. (*a*) Evaluate

$$\int_0^{\pi/2} \sqrt{\tan\theta}\ d\theta.$$

(*b*) Taking semi-circular contours with indents, prove that

$$\int_0^\infty \frac{(\log x)^2}{1+x^2} dx = \frac{\pi^3}{8}.$$

(*c*) Construct an orthonormal basis for R^3 out of the vectors.

$$\psi_1 = (1, 2, 2);\ \psi_2 = (1, -1, 2)\ ;\ \psi_3 = (1, 0, 1).$$

3 + 4 + 3

3. (*a*) If

$$\hat{A}(\theta) = \begin{pmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{pmatrix}$$

then prove that

$$\hat{A}(\theta)\hat{A}(\phi) = \hat{A}(\theta+\phi).$$

(*b*) Solve :

$$\frac{1}{r^2}\frac{d}{dr}\left(r^2\frac{du}{dr}\right)+\left(k^2-\frac{n(n+1)}{r^2}\right)u=0.$$

where u is a radial function.

(*c*) Expand the function

$f(x) = e^{-x}$ in terms of

Laguerre's polynomials. 3 + 4 + 3

GROUP – B

[*Marks* : 20]

Answer **Q.No.1** and any **one** from the rest

1. Answer any *five* bits : 2 × 5

(*a*) With the help of Greek letters how can you express the term plasma, discuss.

(*b*) Mathematically mention the conditions for the existence of plasma,explain.

(*c*) Elaborate the idea underlying mean free path (λ) and collision cross-section (σ_{12}) of partially ionized gas.

(*d*) Graphically present the nature of Variation of 1-V characteristics in a gas discharge at 1 torr of a cylindrical discharge tube in air.

(*e*) What do you mean by plasma Sheath.

(*f*) State and discuss the plasma parameters.

(*g*) Explain the term "distribution function" under the concept of elements of plasma kinetic theory.

(*h*) How is electrical neutrality maintained with a sustained discharge ?

(*i*) Plasma 'A' in ten times denser that plasma 'B' but has the same temperature and composition. The resistivity of 'A' relative to that of 'B' is :

(*i*) 100 times smaller

(*ii*) 10 times smaller

(*iii*) Approximatelly the same

(*iv*) 10 times larger

(*v*) 100 times larger.

2. Draw a Schematic diagram of exploding wire method used to produce ionization of a gas in the laboratory. Show the current wave forms with time for the operation. Point out its application. 5 + 3 + 2

3. What do you mean by ambipolar diffusion in plasma ? Deduce an expression for ambipolar diffusion coefficient. Establish that for $T_e = T_i$, the ambipolar diffusion coefficient is approximately twice the ion diffusion coefficient. 3 + 5 + 2