Exam. Code : 209001
Subject Code : 5322

M.Sc. Physics 1st Semester

ELECTRONICS

Paper—PHY-401

Time Allowed—3 Hours] [Maximum Marks—100

Note :— Section-A is compulsory. Attempt *one* question from each of Sections B, C, D and E.

SECTION—A

1. (a) What are disadvantages of open-loop OP-AMP ?
(b) Race around condition exists in .... sequential circuits.
(c) Draw a circuit diagram for an antilogarithmic amplifier.
(d) Registers and counters can be designed using ....
(e) In what respect do the sequential systems differ from combinational systems ?
(f) The pairity of 01110010 is ....
(g) Give two applications of SCR.
(h) The resolution of a 12-bit D/A converter is .... of the full-scale output.
(i) Draw circuit diagram for half-adder.
(j) Give two advantages of MOSFET over BJT.

10×2=20

SECTION—B

2. Distinguish between synchronous and asynchronous counters. By drawing a suitable diagram, discuss the working of 3-bit binary ripple counter. How many flip-flops are required to construct a mod-128 counter ? 20

3. Differentiate between a basic comparator and a Schmitt trigger. Explain the response of a Schmitt trigger to sinusoidal input waveform. Calculate the upper and lower threshold voltages and plot the hyteresis (or transfer) curve for it. 20

SECTION—C

4. Draw circuit diagrams for an OP-AMP as :

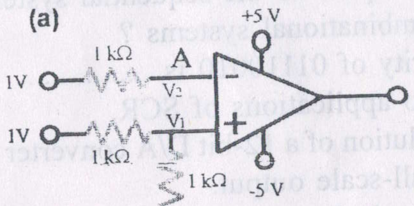
   (a) an integrator

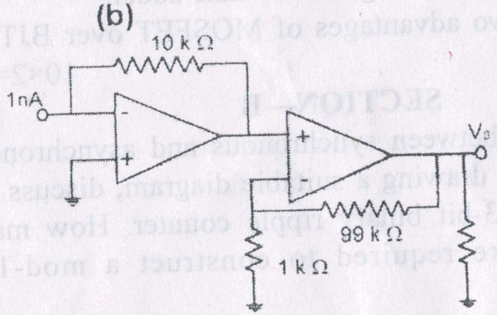
   (b) a logarithmic amplifier

   and hence obtain output as a function of input signals for these two configurations. 10+10

5. (a) In the circuit shown in the Fig. 1(a), determine the voltage at point A and output voltage.

   (b) In Fig. 1(b), determine the output voltage :





10+10=20

SECTION—D

6. Explain the working of a Master-Slave (M-S) FLIP-FLOP. How is the race-around condition avoided in M-S FLIP-FLOP ? 20

7. Explain the process of A/D conversion. Discuss the successive approximation method for A/D conversion. 20

SECTION—E

8. Simplify the following functions using Karnaugh maps :

   (a) $F = \Sigma(1, 2, 3, 5, 7, 8, 9, 10, 11, 12, 14)$

   (b) $F = (A+B+\overline{C}+\overline{D}).(\overline{A}+C+\overline{D}).(\overline{A}+B+\overline{C}+\overline{D}).(\overline{B}+C).(\overline{B}+\overline{C}).(A+\overline{B}).(\overline{B}+\overline{D})$. 10,10

9. Explain the working of a 4-bit digital-to-analog coverter with the help of R-2R ladder network. 20

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M.Sc. Physics 1st Semester

Paper—PHY-402 : MATHEMATICAL PHYSICS

Time Allowed—3 Hours] [Maximum Marks—100

Note :— Section A is compulsory. Attempt ***one*** question each from Sections B, C, D and E.

SECTION—A

1. (a) Find the Fourier transform of following function defined as :

$$f(x)=\begin{cases}\dfrac{1}{\in} & |x|\le\in \\ 0 & |x|>\in.\end{cases}$$

(b) The periodic function which has the value 0 from 0 to T/2 and the value 1 from T/2 to T, then 0 once more, and so on. What will be the Fourier series of this function ?

(c) Find the value of the integral :

$$\int_0^{2\pi}\frac{d\varphi}{1+\in\cos\varphi}$$

with $\in < 1$.

(d) Find all the roots of $\left(\frac{1+\ell}{1-\ell}\right)^{\frac{1}{7}}$.

(e) Show that :

$$\bar{A} = (6xy + z^3)\hat{i} + (3x^2 - z)\hat{j} + (3xz^2 - y)\hat{k}$$ is irrotational. Find Φ such that $\bar{A} = \bar{\nabla}\Phi$.

(f) Show that there is no isotropic tensor of order one except the null vector.

(g) Find an angle between two directions $\hat{n}$ and $\hat{n}'$ which are defined in a spherical system of coordinates by the angles θ, φ and θ', φ' respectively.

(h) Suppose x and y belong to Group G are the elements of G having orders 2 and 3. Does xy have order 6 ? Explain your answer.

(i) The self adjoint operator $\mathcal{L}$ is defined as :

$$\mathcal{L} = \bar{\nabla}\cdot[p\bar{\nabla}] + q(\bar{r})$$

where p and q are functions of positions and having continuous first derivatives. Then find the value of volume integral :

$$\iiint (v\mathcal{L}u - u\mathcal{L}v)d^3r.$$

where u and v are functions of positions and having continuous second derivatives.

(j) The origin of the Cartesian coordinates is at the Earth's center. The moon is on the z-axis, a fixed distance R away (center-to-center distance). The tidal force exerted by the moon on a particle at the Earth's surface (point x, y, z) is given by :

$$F_x = -GMm\frac{x}{R^3},\ F_y = -GMm\frac{y}{R^3},$$

$$F_z = 2GMm\frac{z}{R^3}.$$

Find the potential that yield that tidal force in terms of Legendre's polynomial. 2×10

SECTION—B

2\. (a) Expand $f(x) = x + x^2$ in Fourier series in the interval $(-\pi, \pi)$ and hence deduce that :

$$1+\frac{1}{2^2}+\frac{1}{3^2}+.........=\frac{\pi^2}{6}.$$ 10

(b) Expand f(x) as a sine series when :

$$f(x)=\begin{cases} x & 0<x<\frac{\pi}{2} \\ \pi-x & \frac{\pi}{2}<x<\pi. \end{cases}$$ 5

(c) If $F(\alpha)$ is the Fourier transform of f(t), find the Fourier transform of $\{f(t)\cos\alpha t\}$. 5

3. (a) Given $T_{mn} = \begin{bmatrix} -xy & -y^2 \\ x^2 & xy \end{bmatrix}$. Show that T_{mn} is a tensor or not. Verification may be done for only one of the components. 10

(b) If T_{ij} is a skew symmetric tensor of order two, prove that $(\delta_{ij}\delta_{lk} + \delta_{il}\delta_{jk})T_{ik} = 0$. 5

(c) Show that we can associate a vector with any anti-symmetric tensor of order 2. 5

SECTION—C

4. (a) Starting from the first principle, derive an expression for divergence of a vector in orthogonal curvilinear coordinates. 10

(b) The coordinate system (x, y, z) is rotated through an angle φ counter clockwise about an axis defined by the unit vector $\hat{n}$ into system (x, y, z). In terms of the new coordinates, the radius vector becomes :

$$\vec{r}' = \vec{r}\cos\varphi + \vec{r}\times\hat{n}\sin\varphi + \hat{n}(\hat{n}\cdot\vec{r})(1-\cos\varphi).$$

Calculate $(r')^2$. Explain the physical meaning of the result obtained by you. 10

5. (a) Locate and name the singularities of the equation :

$$(1 - x^2)^2y'' + x(1 - x)y' + (1 + x)y = 0.$$

5

(b) Define Forbenius method and hence obtain the solution of following differential equation about x = 0.

$$(x^2 - 1)x^2y'' - (x^2 + 1)xy' + (x^2 + 1)y = 0.$$

15

SECTION—D

6. (a) Show that Bessel function satisfy the following recurrence relations :

(i) $J_{n-1}(x) + J_{n+1}(x) = \frac{2n}{x} J_n(x)$

(ii) $J_{n-1}(x) - J_{n+1}(x) = 2J'_n(x)$

(b) Show that :

$$\Gamma\left(\frac{1}{2}-n\right)\Gamma\left(\frac{1}{2}+n\right) = (-1)^n \pi.$$

10,10

7. (a) Define SU(2) group. Using its properties establish all the components of this group.

(b) Find the irreducible character of G ⊗ H from the reducible character of G, H. 10,10

SECTION—E

8. (a) State and prove the Taylor's theorem for complex analytic functions.

(b) The function f(z) is analytic. Show that the derivative of f(z) with respect to z* does not exists unless f(z) is constant. 10,10

9. (a) Locate the singularities and evaluate the residues of each of the following functions :

(i) $z^{-n}(e^z - 1)^{-1}, z \neq 0$

(ii) $\dfrac{z^2 e^z}{1 + e^{2z}}$.

(b) With the calculus of residues, show that :

$$\int_0^{\pi} \cos^{2n} x dx = \pi \frac{(2n)!}{2^{2n} (n!)^2}, n = 0, 1, 2, ...$$

10,10

Exam. Code : 209001
Subject Code : 5324

M.Sc. (Physics) 1st Semester

CLASSICAL MECHANICS

Paper—PHY-403

Time Allowed—Three Hours] [Maximum Marks—100

Note :— (1) Section-A is compulsory.

(2) Attempt **FOUR** more questions, selecting **ONE** each from Sections B, C, D and E.

SECTION—A

I. (i) Which formulation you would prefer out of Newtonian and Lagrangian formalisms, and why ?

(ii) State the significance of cyclic translation and rotational coordinates by citing suitable examples.

(iii) Distinguish between Cartesian and Generalized coordinates.

(iv) Define central force by citing two examples.

(v) What are the constants of motion for a particle subjected to a conservative central force field ? State the arguments supporting the answer.

(vi) State an orthogonal transformation and the orthogonality condition.

(vii) What do you mean by principal axes of a rigid body and principal axes transformation ?

(viii) State and prove the condition under which Hamiltonian equals to total energy of the system.

(ix) Write Hamilton equations of motion in Poisson bracket form.

(x) Show that the generating function $\sum_j q_j Q_j$ generates exchange transformation. 10×2=20

SECTION—B

II. Using Newton's law of motion, deduce the conservation theorems for linear momentum, angular momentum and energy for the motion of a system of particles. 20

III. (a) State Hamilton principle and hence derive Lagrange's equations of motion for a conservative system having holonomic constraints. 14

(b) Obtain Lagrangian equations of motion for the harmonic motion of a particle on the surface of a cylinder. 6

SECTION—C

IV. (a) Show how a two-body central force problem is reduced to an equivalent one body problem. 10

(b) A particle subjected to central force field describes an orbit whose equation is $r = C\theta$, where C is constant. Deduce the force law and energy of the particle. 10

V. Obtain equation for orbit of a particle moving under the influence of an inverse square central force field. Also prove the semi-major axis depends only upon energy for elliptical orbit and hence obtain its eccentricity. 20

SECTION—D

VI. Discuss in brief the role of orthogonal transformation matrix in rigid body kinematics. Hence state and prove the various properties of orthogonal transformation matrix. 20

VII. A rigid body is rotating about an axis through the origin. Obtain angular momentum and kinetic energy in terms of inertia tensor. How these expressions get modified in the coordinate system in which the body axes coincide with the principal axes ? 20

SECTION—E

VIII. What is Δ-variation ? Discuss how it differs from δ-variation ? State and prove the principle of least action. List its various forms also. 20

IX. (a) Define canonical transformation and hence use these to solve the problem of one-dimensional harmonic oscillator. 12

(b) Show that the following transformation is canonical $Q = \sqrt{2qe^{\alpha}} \cos p, P = \sqrt{2qe^{-\alpha}} \sin p$, where α is constant.

Hence deduce generating function for the transformation. 8

200

Exam. Code : 209001
Subject Code : 5325

M.Sc. (Physics) Ist Semester

COMPUTATIONAL TECHNIQUES

Paper—PHY-404

Time Allowed—Three Hours] [Maximum Marks—100

Note :— Attempt **FIVE** questions in all selecting **ONE** question from Section B, C, D and E. Question No. **1** is compulsory. All questions carry equal marks. Use of scientific calculator is allowed.

SECTION—A

1. (i) In format shorte display format, what will be the display of the output of 100*pi in MATLAB ?

   (ii) What is the role of Mex files in MATLAB ?

   (iii) Write a MATLAB program for multiplication of two integers.

   (iv) Write the Simpson's 1/3rd formula for integration.

   (v) Explain the working of bisection formula in graphical form.

   (vi) Prove symmetry of divided differences.

   (vii) Explain the accuracy of modified Euler's method over Euler's method in graphical form.

(viii) Can Runge-Kutta method be used to find solution of 3^{rd} order differential equations ?

(ix) Explain the geometric significance of Newton-Raphson method.

(x) When the Newton's backward interpolation formula is preferred over Newton's forward interpolation formula for application. 10×2=20

SECTION—B

2. (a) Write about the various built in functions of MATLAB in terms of Graphics, Computations, External Interface and Toolboxes. 10

(b) Write the MATLAB program to print and plot a graph of circle of radius 16. 10

3. (a) Derive Newton's formula for backward interpolation. Explain its limitations. 10

(b) The following table gives the values of the probability integral corresponding to certain values of x. For what value of x (correct up to 6 decimal places), this integral is equal to ½ ? 10

x	Probability Integral
0.46	0.4846555
0.47	0.4937452
0.48	0.5027498
0.49	0.5116683

SECTION—C

4. Evaluate the following integral by using (a) Trapezoidal rule (b) Simpson's 1/3rd rule using the values in table correct up to 4 decimal places and compare the results with its actual value; $\int_0^6 dx/(1+x^2)$.

x	$1/(1 + x^2)$
0	1
1	0.5
2	0.2
3	0.1
4	0.0588
5	0.0385
6	0.027

20

5. (a) Prove the symmetry of divided differences. 10

(b) The following table gives certain corresponding values of X and $\log_{10}x$. Compute the value of log323.5 10

x	$\log_{10}x$
321.0	2.50651
322.8	2.50893
324.2	2.51081
325.0	2.51188

SECTION—D

6. Explain the working of bisection method in detail with the help of an example. 20

7. Describe the Gauss Elimination Method for finding the solution of simultaneous linear equations with the help of an example. 20

SECTION—E

8. Discuss Bairstow method in detail by using an example. 20

9. (a) Discuss about Runge-Kutta method in detail. 10

   (b) Using Runge-Kutta method, solve $dy/dx = (y^2 - x^2)/(y^2 + x^2)$ with $y(0) = 1$ at $x = 0.2, 0.4$ for step of 0.2. 10