

This question paper contains 4+2 printed pages]

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S. No. of Question Paper : 6671

Unique Paper Code : 32221101

HC

Name of the Paper : Mathematical Physics—I

Name of the Course : B.Sc. (Hons.) Physics

Semester : I

Duration : 3 Hours

Maximum Marks : 75

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt five questions in all.

48

Question No. 1 is compulsory.

1. Do any five of the following :

5×3=15

(a) Two sides of a triangle are formed by the vectors :

$$\vec{A} = 3\hat{i} + 6\hat{j} - 2\hat{k} \quad \text{and} \quad \vec{B} = 4\hat{i} - \hat{j} + 3\hat{k}$$

Determine the angle between these two sides and length of the third side.

P.T.O.

- (b) Show that the area bounded by a simple closed curve C is given by :

$$\frac{1}{2} \oint_C (x dy - y dx).$$

- (c) If \vec{a} is a constant vector, then prove that :

$$\vec{\nabla} \times (\vec{a} \times \vec{r}) = 2\vec{a}.$$

- (d) Solve :

$$\iint_R \sqrt{x^2 + y^2} dx dy$$

where, R is the region bounded by the circle,

$$x^2 + y^2 = 9.$$

- (e) Check whether the following functions are linearly independent or not :

$$e^x, x e^x.$$

- (f) Solve the differential equation :

$$(b^2 + 2xy + y^2)dx + (x + y)^2 dy = 0.$$

(g) Form a differential equation whose solution is given

by :

$$y = A e^{2x} + B e^{3x}.$$

(h) Solve :

$$(i) \int_0^5 \delta(x - \pi) \cos 2x \, dx$$

$$(ii) \int_{-2}^2 [x^2 + \log x] \delta(x - 1) \, dx.$$

(a) Find the constants 'a' and 'b' so that the surface $ax^2 - byz = (a + 2)x$ will be orthogonal to the surface

$$4x^2y + z^3 = 4 \text{ at the point } (1, -1, 2). \quad 4$$

(b) If $\vec{A} = r^n \vec{r}$, then find the value of n for which \vec{A} is solenoidal. 5

(c) Prove that : 6

$$\vec{\nabla} \cdot \left[r \vec{\nabla} \left(\frac{1}{r^3} \right) \right] = \frac{3}{r^4}$$

$$\text{where, } r = \sqrt{x^2 + y^2 + z^2}.$$

P.T.O.

3. (a) Prove that :

6

$$\vec{A} \times \left(\vec{\nabla} \times \vec{A} \right) = \frac{1}{2} \vec{\nabla} A^2 - \left(\vec{A} \cdot \vec{\nabla} \right) \vec{A}.$$

(b) Evaluate $\iint_S \left(\vec{A} \cdot \hat{n} \right) dS$, where :

$$\vec{A} = y\hat{i} + 2xz\hat{j} - z\hat{k}$$

And,

S is the surface of the plane, $2x + y = 6$ in the first octant cut-off by the plane, $z = 4$.

9

4. (a) Prove that :

5

$$\oiint_S r^5 \hat{n} dS = \iiint_V 5r^3 \vec{r} dV$$

where, simple closed surface S encloses volume V.

(b) Write the mathematical form of Gauss's Divergenc

theorem and hence verify it for $\vec{F} = 4xz\hat{i} - y^2\hat{j} + yz\hat{k}$

where S is the surface of the cube bounded by $x =$

$x = 1, y = 0, y = 1, z = 0, z = 1$.

1

5. (a) Evaluate :

$$\iiint_V (2x + y) dV,$$

where, V is the closed region bounded by the cylinder

$$z = 4 - x^2 \text{ and the planes, } x = 0, y = 0, y = 2, z = 0. \quad 6$$

(b) Derive an expression for curl of a vector field in orthogonal curvilinear coordinates. Express it in cylindrical coordinates. 72

5. Solve the differential equations :

(a) $(x^2y - 2xy^2)dx - (x^3 - 2x^2y)dy = 0$ 7

(b) $(D^2 + 1)y = \operatorname{cosec} x \quad \left(D = \frac{d}{dx} \right)$ 8

(a) Solve the differential equation : 7

$$(D^2 - 6D + 8)y = (e^{2x} - 1)^2.$$

(b) Using method of variation of parameters, solve the differential equation : 8

$$(D^2 + 4)y = x \sin 2x.$$

P.T.O.

8. (a) Solve the differential equation :

$$(D^2 - 4D + 3)y = xe^{2x}.$$

- (b) Using method of undetermined coefficients, solve the differential equation :

$$(D^2 - 1)y = e^x + 2x.$$

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Roll No.

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S. No. of Question Paper : 6672

Unique Paper Code : 32221102

HC

Name of the Paper : Mechanics

Name of the Course : B.Sc. (Hons.) Physics

Semester : I

Duration : 3 Hours

Maximum Marks : 75

Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt *five* questions in all.

Question No. 1 is compulsory.

All questions carry equal marks.

Use of non-programmable scientific calculator is allowed.

Attempt any *five* of the following questions :

- (i) Locate the centre of mass of a system of three particles masses 1 kg, 2 kg and 3 kg placed at the corners of an equilateral triangle of side 1 m.

P.T.O.

- (ii) When a particle moves under a central force, prove that the particle moves in a fixed plane.
- (iii) Show that damping has little or no effect on the frequency of a harmonic oscillator if its quality factor is large.
- (iv) State Kepler's laws of planetary motion.
- (v) Show that a conservative force can be expressed as $\vec{F} = -\nabla V$, where V is the potential energy.
- (vi) What is potential energy curve? Identify stable, unstable and neutral equilibrium from the curve.
- (vii) Calculate the recessional velocity of a galaxy at a distance of 3×10^9 light years. Is this velocity relativistic?
- (viii) Explain the physical significance of negative result obtained from Michelson-Morley experiment. $3 \times 5 = 15$
2. (a) Find the centre of mass of a homogeneous semi-circular plate of radius R .

(b) An object falling in the earth's gravitational field gains mass from surrounding stationary material :

(i) Show that :

$$M \frac{dv}{dt} + v \frac{dM}{dt} = Mg,$$

where v is the instantaneous downward velocity of the object when its mass is M . 2

(ii) If :

$$\frac{dM}{dt} = kM,$$

where k is a constant, show that the object acquires a terminal velocity and determine this velocity. 4

(c) A particle is projected with a velocity of 40 m/s at an elevation of 30° . Calculate (i) the greatest height attained (ii) the horizontal range and (iii) the velocity and direction at a height of 12 m. 2,2,2

3. (a) Show that in the case of an elastic and glancing collision between two particles of masses m_1 and m_2 respectively, the maximum value of scattering angle θ_1 in the

P.T.O.

laboratory frame corresponds to the scattering angle θ in the centre mass reference frame, where $\theta = \cos^{-1} (-m_2/m_1)$.

Also show that this maximum value of the scattering

$$\text{angle } \theta_1 = \tan^{-1} \left(\frac{m_1^2}{m_2^2} - 1 \right)^{1/2} . \quad 52$$

(b) Show that if a heavy particle is incident on a light particle initially at rest, the heavy particle will not bounce backward as a result of collision. 3

(c) Prove that in centre of mass system, the magnitude of the velocities of the particles remains unaltered in elastic collision. 5

4. (a) Find the moment of inertia of a uniform solid cylinder of radius R , height H and mass M about an axis passing through its centre of mass and perpendicular to its axis of symmetry. 8

(b) Show that the ratio of rotational to translational kinetic energy for a solid cylinder rolling down a plane without slipping is 1 : 2. 3

- (c) Moment of inertia of a bigger solid sphere about its diameter is I . 64 smaller, equal spheres are made out of bigger sphere. What will be the moment of inertia of such smaller sphere about its diameter ? 4
5. (a) Derive the expressions for gravitational field and potential at a point inside and outside a uniform solid sphere of radius R and mass M . 5,5
- (b) Represent the variations of field and potential graphically with respect to distance from the centre of the shell. 5
6. (a) Derive differential equation for a forced harmonic oscillator and find its steady state solution. Obtain the amplitude and phase of the steady state solution. 2,6,2,2
- (b) What is the displacement of a particle executing SHM from its mean position when its KE is half of its PE ? 3
7. (a) What is longitudinal and transverse Doppler effect in light. Obtain an expression for the apparent frequency of light pulse in case of longitudinal Doppler effect in a moving frame of reference. 2,9

P.T.O.

(b) How does mass of a material particle change with velocity ? Show that c is the ultimate speed of the particle in free space. 22

8. (a) Derive the relativistic law of variation of mass with velocity. For a relativistic particle, show that : 72

$$E^2 = p^2c^2 + m_0^2c^4.$$

(b) Find the velocity that an electron must be given so that its momentum is 10 times its rest mass times the speed of light. What is the energy at this speed ?

(Rest mass of electron = 9×10^{-31} kg). 32

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Roll No.

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S. No. of Question Paper : 6673

Unique Paper Code : 32221301

HC

Name of the Paper : Mathematical Physics—II

Name of the Course : B.Sc. (Hons.) Physics

Semester : III

Duration : 3 Hours

Maximum Marks : 75

(Write your Roll No. on the top immediately on receipt of this question paper.)

Question No. 1 is compulsory.

Attempt *five* questions in all.

In the question paper $y \equiv y(x)$, $y' \equiv \frac{dy}{dx}$ and $y'' \equiv \frac{d^2y}{dx^2}$.

1. Attempt any *five* questions :

(a) Evaluate the integral :

$$I = \int_0^1 \sqrt{y(1-y)} dy.$$

P.T.O.

- (b) Identify and name the singularities (if any) of the following differential equations :

$$(i) \quad (1-x)y'' - (2x-1-x^2)y' + (x-1)y = 0$$

$$(ii) \quad y'' - \frac{x}{x-1}y' + \frac{3x}{(1-x)^2}y = 0.$$

- (c) Show that for Legendre polynomials :

$$xP'_n = nP_n + P'_{n-1}.$$

- (d) Demonstrate the linear dependence of $J_n(x)$ and $J_{-n}(x)$ where n is an integer.

- (e) Determine if the following functions are odd, even or neither of them :

$$(i) \quad f(x) = |x| \quad \text{if } -5 < x < 5$$

$$(ii) \quad g(x) = \begin{cases} \cos(-x) & \text{if } -\pi < x < 0 \\ \cos(x) & \text{if } 0 < x < \pi \end{cases}$$

$$(iii) \quad h(x) = \sin(x) \quad \text{if } -\pi < x < \pi.$$

- (f) A guitar has six strings of equal length. They are arranged in such a way that the mass of each string is larger than the previous one. Also the tension in each of them can be controlled. Which string will produce the sound of highest pitch ? How can one manipulate the frequency of the sound emanating from each string ?

- (g) Find the value of y if :

$$y'' = -y.$$

5×3=15

2. (a) The 1-D wave equation is given as :

$$\frac{\delta^2 y(x, t)}{\delta x^2} = c^2 \frac{\delta^2 (x, t)}{\delta t^2}.$$

Derive the same for a stretched string clearly mentioning the necessary assumptions.

- (b) Evaluate :

$$\int_0^{\pi/2} \sin^4(\theta) \cos^5(\theta) d\theta.$$

12+3=15

P.T.O.

3. (a) The Rodrigue's formula for Legendre polynomials is

given as :

$$P_n(x) = \frac{1}{n!2^n} \frac{d^n}{dx^n} (x^2 - 1)^n.$$

Prove the validity of the entity.

- (b) Find the value of :

$$\int_{-1}^1 x^2 P_5(x) dx.$$

10+5=15

4. The general Bessel's equation is given as :

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

Starting from the Bessel's equation, obtain the expression of the

Bessel's function of first kind. Also obtain the second solution

of the Bessel's equation if ν is not an integer.

15

5. (a) State if the given function $f(x)$ is an odd function.

Find its Fourier series expansion :

$$f(x) = \frac{x^2}{2} \text{ if } -\pi < x < \pi.$$

- (b) Determine the value of 'D' and 'E' if :

$$D = 1 + \frac{1}{4} + \frac{1}{9} + \frac{1}{16} + \dots \text{ and}$$

$$E = 1 - \frac{1}{4} + \frac{1}{9} - \frac{1}{16} + \dots \quad .9+6=15$$

6. (a) Show that :

$$\beta(m, n) = \frac{\Gamma(m)\Gamma(n)}{\Gamma(m+n)}$$

- (b) Demonstrate that :

$$\Gamma\left(\frac{1}{2}\right) = \sqrt{\pi}.$$

P.T.O.

- (c) State and prove the Parseval's identity associated with Fourier series. 3×5=15

7. Solve the following differential equation :

$$xy'' + (1 - x)y' + \lambda y = 0.$$

Here λ is a real constant. Show that one of the solutions

of this equation becomes a polynomial of order ' n ' if

$\lambda = n = 0, 1, 2, \dots$. Name the Polynomial.

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This question paper contains 4 printed pages.]

Your Roll No.....

Pr. No. of Question Paper : 6674 HC

Unique Paper Code : 32221302

Name of the Paper : Thermal Physics

Name of the Course : B.Sc. (Hons.) Physics

Semester : III

Duration : 3 Hours

Maximum Marks : 75

Instructions for Candidates

Write your Roll No. on the top immediately on receipt of this question paper.

Attempt **five** questions in all, including **Question No. 1** which is compulsory.

All questions carry equal marks.

Answer any five of the following:

(a) Distinguish between first and second order phase transitions with the help of phase diagrams.

(b) Show that the slope of an adiabatic is γ times the slope of an isothermal passing through a common point.

P.T.O.

- (c) At what temperature, pressure remaining constant, will the RMS velocity of H_2 gas be doubled of its Value at NTP?
- (d) Define extensive and intensive thermodynamic variable. Give one example of each.
- (e) Find an expression for work done during the adiabatic expansion of an ideal gas.
- (f) What is the advantage of T-S diagram over P-V diagram of a Carnot cycle?

(g) Establish the relation $U = F - T \left(\frac{\partial F}{\partial T} \right)_V$ where the symbols have their usual meanings. (5×3=15)

2. (a) Write Kelvin-Planck statement and Clausius statement of second law of thermodynamics. Show that the violation of one leads to the violation of the other.
- (b) The efficiency of a Carnot engine changes from $1/6$ to $1/3$ when the source temperature is raised by $100^\circ C$. Calculate the temperature of the sink.
- (c) Prove $E_s/E_T = C_p / C_v = \gamma$, Where E_s and E_T are the adiabatic and isothermal elasticities of a substance. (5,5)

- (a) Derive an expression for change in entropy of a perfect gas in terms of temperature and pressure. Show that there is always an increase in entropy during an irreversible process.
- (b) Formulate second law of thermodynamics in terms of entropy.
- (c) One mole of an ideal gas ($\gamma = 1.4$), initially at 17°C , is compressed adiabatically so that its pressure become 10 times its original value. Find its final temperature.
(7,4,4)

- (a) Using various thermodynamical potentials derive Maxwell's four thermodynamical relations.
- b) Using suitable Maxwell's thermodynamical relations, prove

$$(i) \quad C_p - C_v = T \left(\frac{\partial P}{\partial T} \right)_v \left(\frac{\partial V}{\partial T} \right)_P$$

$$(ii) \quad \left(\frac{\partial V}{\partial T} \right)_P = T \left(\frac{\partial P}{\partial T} \right)_v - P \quad (9,6)$$

- (a) Derive Maxwell-Boltzmann distribution law of molecular velocities for a perfect gas. Hence find the expression for the most probable and root mean square velocities.

P.T.O.

- (b) Briefly discuss any experiment for the verification of Maxwell-Boltzmann distribution law. (12)
6. (a) Draw the schematic arrangement of Porous-Plate experiment and discuss its important results.
- (b) Derive expression for Joule - Thomson coefficient for
- (i) Perfect gas and
- (ii) Real gas (9)
7. (a) Derive expression for critical constants in terms of van der Waal's constants and hence show that $RT_c / P_c V_c = 8/3$, where R is universal gas constant.
- (b) Derive van der Waal's equation in terms of reduced formula of P_r , V_r and T_r . (9)
8. (a) What are transport phenomena? Derive an expression for coefficient of viscosity on the basis of kinetic theory.
- (b) What is magneto-caloric effect? Give principle and experimental method to produce low temperature adiabatic demagnetization. (9)

This question paper contains 4 printed pages]

Roll No.

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S. No. of Question Paper : 6675

Unique Paper Code : 32221303

HC

Name of the Paper : Digital System and Applications

Name of the Course : B.Sc. (Hons.) Physics

Semester : III

Duration : 3 Hours

Maximum Marks : 75

Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt *five* questions in all.

Question No. 1 is compulsory.

All questions carry equal marks.

Attempt any *five* of the following : $5 \times 3 = 15$

- What is meant by SSI, LSI and VLSI in integrated circuits ?
- Explain K-map simplification for sum-of-products method.
- Using 2's complement method perform the following subtraction :

(1001011001011001).

P.T.O.

- (d) How many bytes are used in the hex code of the following instructions :

MOV L, A; CMP B; JPE 2010 ?

- (e) What is the function of Stack Pointer ?
- (f) Explain briefly 8-to-1 Multiplexer and 3-to-8 Decoder
- (g) What is the difference between a Combinational circuit and a Sequential circuit. Give *one* example of each type.

2. (a) Using K-map solve the following function :

$$F(A, B, C, D) = \sum m (1, 3, 5, 7, 9, 12, 13) + d(10, 11)$$

and draw a NOR-NOR gate circuit using duality theorem

- (b) Draw the block diagram of a Cathode Ray Oscilloscope and explain Electron Gun, Deflection system, Time base and Deflection sensitivity. 2×7½

3. (a) Design a 4-to-16 decoder using a NOT gate and two 3-to-8 decoders, and draw its truth table.

- (b) Explain the working of a JK flip-flop. Which are the Synchronous and Asynchronous inputs in a JK flip-flop. 2×7½

4. (a) Draw and explain a 4-bit universal shift register circuit capable of performing all four shift functions viz. Serial In-Serial Out; Serial In-Parallel Out; Parallel In-Serial Out; and Parallel In-Parallel Out.
- (b) Explain in detail the working of a Monostable Multivibrator. $2 \times 7\frac{1}{2} = 15$
5. (a) Draw the circuit, waveform and truth table of a Decade Counter.
- (b) Draw the circuit of a 4-bit Adder/Subtractor using controlled inverter and full adders. Under what conditions this circuit works as an Adder circuit or a Subtractor circuit. $2 \times 7\frac{1}{2} = 15$
6. (a) Draw the memory map (with diagram) of 2048 Bytes of Memory if only memory chips of 1KBytes are available. Choose the starting address of memory location as 4000H.

P.T.O.

- (b) Draw the pin-out diagram of an intel 8085 microprocessor and explain in detail the purpose of the following :
Multiplexed Address/Data Bus; Externally initiated signals; Control and status signals. $2 \times 7\frac{1}{2} = 15$
7. (a) Draw the timing diagram of MOV D, C (code : 51H) instruction and explain it.
- (b) Using a schematic diagram explain how the $AD_7 - AD_0$ bus is demultiplexed and the role of ALE signal in this process. $2 \times 7\frac{1}{2} = 15$

This question paper contains 3 printed pages]

Roll No.

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S. No. of Question Paper : 6676

Unique Paper Code : 32221501 HC

Name of the Paper : Quantum Mechanics and Applications

Name of the Course : B.Sc. (Honors) Physics

Semester : V

Duration : 3 Hours

Maximum Marks : 75

(Write your Roll.No. on the top immediately on receipt of this question paper.)

Attempt *five* questions in all. Question No.1 is compulsory.

All questions carry equal marks.

Non-programmable calculators are allowed.

1. Attempt any *five* of the following :

- Give the expressions for Energy, Linear momentum and Angular momentum in operator form.
- Calculate the commutator $[\widehat{L}_x, \widehat{p}_x]$. (given $[\widehat{x}, \widehat{p}_x] = i\hbar$)
- Explain uncertainty principle with an example.

P.T.O.

- (d) Derive the relation between 'magnetic dipole moment' and 'orbital angular momentum' of an electron revolving around a nucleus.
- (e) Write the quantum numbers for the state represented by $4^2F_{5/2}$.
- (f) What are symmetric and antisymmetric wave functions?
- (g) What are free and bound states ? Explain. $5 \times 3 = 15$
2. Consider a particle trapped inside a one-dimensional finite square well. Solve the time independent Schrödinger equation for the system and obtain the bound state eigenfunctions. Discuss how the energy levels are obtained graphically ? 15
3. (a) Calculate the expectation value of the momentum for wavefunction.
- $$\begin{cases} \sqrt{\frac{2}{a}} \sin\left(\frac{nx}{a}\right) & \text{for } 0 < |x| < a \\ 0 & \text{for } |x| > a \end{cases}$$
- (b) Give the theory to explain spreading of a Gaussian wave packet for a free particle in one-dimension. 5,10

4. (a) Solve the Schrödinger equation for a Linear Harmonic Oscillator and hence obtain first three eigenfunctions.
- (b) A particle of mass 1 mg is attached to a spring of spring constant 0.001 Nm^{-1} . Calculate its zero point energy. 10,5

5. The ' θ ' equation obtained after applying separation for variables to the Schrödinger equation for a 3D hydrogen atom in spherical polar coordinates, is given by

$$\frac{1}{\sin \theta} \frac{d}{d\theta} \left(\sin \theta \frac{d\Theta}{d\theta} \right) + \left(\lambda - \frac{m_l^2}{\sin^2 \theta} \right) \Theta = 0.$$

Solve the above equation for $m_l = 0$ (or otherwise) to show that :

$$\lambda = l(l+1), \quad l = 0, 1, 2, \dots \quad 15$$

6. (a) What is Larmor Precession ? Derive the expression for Larmor frequency.
- (b) Explain Normal Zeeman Effect with examples and energy diagram. 8,7
7. (a) What is spin orbit coupling ? Calculate the change in the energy levels due to this.
- (b) Show the result of a JJ coupling of two nonequivalent p-electrons. 10,5

[This question paper contains 4 printed pages]

Your Roll No. :

Sl. No. of Q. Paper : **6677** **HC**

Unique Paper Code : 32221502

Name of the Course : **B.Sc. (Honours)**
Physics

Name of the Paper : Solid State Physics

Semester : V

Time : 3 Hours **Maximum Marks : 75**

Instructions for Candidates :

- (a) Write your Roll No. on the top immediately on receipt of this question paper.
- (b) Attempt any **five** questions. Question No. **1** is compulsory. **All** questions carry equal marks

1. Attempt any **five** of the following :

5×3=15

(a) Prove that c/a ratio in hcp is

$$\sqrt{\frac{8}{3}}$$

- (b) Sketch the dependence of polarization in dielectrics on the frequency of the applied electric field clearly indicating frequency ranges for the electronic, ionic, and dipolar polarization.

P.T.O.

6677

5. (a) Derive an expression for diamagnetic susceptibility on the basis of classical Langevin's theory. 9
- (b) Distinguish between dia, para, ferro- and ferri-magnetic materials with examples. 6
6. (a) Obtain an expression for local electric field inside a dielectric with cubic symmetry. 10
- (b) Derive Clausius-Mossotti formula constant. 5
7. (a) Discuss the Kronig - Penny model for a linear lattice. How does it lead to the formation of energy bands in solids? Find the energy of electron with the change in the strength of the periodic potential under following cases : 9+3+3
- (i) $V \rightarrow \infty$
- (ii) $V \rightarrow 0$
8. (a) Derive London equations for a superconductor and obtain an expression for penetration depth. 12
- (b) A superconducting tin has a critical temperature of 3.7 K in zero magnetic field and a critical field of 0.0306 tesla at 0K. Find the critical field at 2K. 3

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 6871 HC

Unique Paper Code : 42221101

Name of the Paper : Physics - I (Mechanics)

Name of the Course : B.Sc. (Prog.) Science

Semester : I

Duration : 3 Hours

Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt any five questions in all, including Q. No. 1 which is compulsory.
3. Use of nonprogrammable calculator is allowed.

4. Attempt any five of the following: (5×3=15)

(a) What are the two postulates of special theory of relativity?

(b) Differentiate b/w inertial and non-inertial reference frames with one example.

P.T.O.

- (c) What do you understand by inertial mass
gravitational mass?
- (d) Show that addition of vectors is associa
i.e. $\vec{A} + (\vec{B} + \vec{C}) = (\vec{A} + \vec{B}) + \vec{C}$
- (e) If $\vec{r} = (t^3 + 2t) \mathbf{i} - 3e^{-2t} \mathbf{j} + 2 \sin 5t \mathbf{k}$, find d^2r/dt^2 at t
- (f) Solve differential equation $\frac{d^2y}{dx^2} - 6 \frac{dy}{dx} + 9y = 0$
- (g) A spring of spring constant 'k' is loaded by mass
If this spring is cut half in length and same ma
loaded on it, what will be new time period?
- (h) What is Hook's law in elasticity? What do you mea
elastic limit and breaking stress?
2. (a) What are polar and axial vectors? Give one examp
each.
- (b) Solve differential equation $\frac{d^2y}{dx^2} + 4 \frac{dy}{dx} + 5y = 0$
where, $y = 2$ and $\frac{dy}{dx} = \frac{d^2y}{dx^2}$, when $x = 0$
- (c) Prove that $\vec{A} \times (\vec{B} \times \vec{C}) = \vec{B}(\vec{A} \cdot \vec{C}) - \vec{C}(\vec{A} \cdot \vec{B})$

(a) Find the centre of mass of a uniform solid hemisphere of radius 'R'. (5)

(b) A bomb of mass '4M' in flight explodes into two fragments when its velocity is $(10\hat{i} + 2\hat{j})$ m/sec. If the smaller mass 'M' flies with velocity $(20\hat{i} + 50\hat{j})$ m/sec, deduce the velocity of the larger mass '3M'. (5)

(c) State and prove the 'work-energy' theorem. (5)

(a) Describe the principle of a rocket? Why multistage rocket is necessary? Establish the following relation for a rocket, $V = V_0 + v \log_e (M_0/M)$, where v is the exhaust Velocity of gases relative to rocket, M_0 , V_0 are initial mass and velocity of rocket respectively, M and V are mass and velocity of rocket at any time 't'.

(3,3,4)

(b) For a particle of mass $m = 10$ gm, position $\vec{r} = (10\hat{i} + 6\hat{j})$ cm and velocity $\vec{v} = 5\hat{i}$ cm/s, calculate the angular momentum about the z-axis through origin. (5)

(a) Show that the ratio of rotational to translational kinetic energy for a solid cylinder rolling down a plane without slipping is 1:2. (5)

P.T.O.

- (b) Define the central forces. Show that the path or orbit of the particle under the central force must be a plane curve and its areal velocity is constant. (2,4)
6. (a) What do you understand by a damping or a dissipative force? Deduce the differential equation of damped harmonic oscillator and discuss in detail the cases of critical and under-damped cases. (
- (b) A smooth straight tunnel is bored through the centre of the earth. A particle of mass 'm' is dropped into the tunnel. Prove that the motion is simple harmonic and calculate its time period.
7. (a) If Y , η and K represent Young modulus, coefficient of rigidity and bulk modulus, respectively, then prove that
- $$\frac{9}{Y} = \frac{3}{\eta} + \frac{1}{K}$$
- (b) Write down the Lorentz space-time transformation equations. Discuss the time dilation in special theory of relativity.
- (c) Two objects are moving in the opposite direction, each with a speed of $0.9c$. Find the relative speed of the two objects. (c =velocity of light in free space)

This question paper contains 4 printed pages.]

Your Roll No.....

No. of Question Paper : 6872

HC

Unique Paper Code : 42231102

Name of the Paper : ANIMAL DIVERSITY

Name of the Course : B.Sc. (Prog.)

Semester : I

Duration : 3 Hours

Maximum Marks : 75

Instructions for Candidates

Write your Roll No. on the top immediately on receipt of this question paper.

There are two sections, Section A and Section B to be answered on separate answer-books.

Answer three questions from each section, including Question No. 1 which is compulsory.

Draw labelled diagrams wherever necessary.

SECTION A

NONCHORDATA

(a) Define the following terms:

(i) Metamorphosis

P.T.O.

- (ii) Conjugation
 - (iii) Parasite
 - (iv) Radial symmetry
- (b) Give the scientific names of the following and class upto classes:
- (i) Brittle star
 - (ii) Cuttlefish
 - (iii) Centipede
- (c) Differentiate between the following terms:
- (i) Primary host and secondary host
 - (ii) Cilia and flagella
 - (iii) Moulting hormone and juvenile hormone
2. (a) Define polymorphism. Describe the different types zooids in a polymorphic Colony and add a note on significance,
- (b) Give a labelled diagram of the Water vascular system of starfish. (9)
3. Explain the structure of the Compound eye in Arthropods and discuss the types of images formed. Draw suitable diagrams. (1)

Write short notes on any two of the following:

- (a) Locomotion in Amoeba
- (b) Canal system in Sycon
- (c) Parasitic adaptations in Ascaris
- (d) Torsion in gastropods (6,6)

SECTION B

CHORDATA

(a) State whether the following statements are true or false:

- (i) All mammals give birth to young ones
- (ii) An operculum Covers the gills of bony fishes
- (iii) Salamander is a tailed amphibian
- (iv) All reptiles possess pentadactyl limbs (2)

(b) Define the following terms:

- (i) Enterocoel
- (ii) Retrogressive metamorphosis
- (iii) Ectothermy (3)

P.T.O.

(c) Classify the following animals upto orders:

(i) Anguilla

(ii) Branchiostoma

(iii) Sorex

(d) Differentiate between the following terms:

(i) Monotremes and Marsupials

(ii) Poisonous and non-poisonous snakes

(iii) Urodela and Anura

2. (a) Describe the process of osmoregulation in teleosts.

(b) Give an account of parental care in Amphibians. (6,6)

3. Give the general features of the class Aves. How are they adapted for their aerial mode of life? (12)

4. Write short notes on any two of the following:

(i) Biting mechanism in Snakes

(ii) Origin of mammals

(iii) General features of Agnatha

(iv) Phylogeny of Hemichordates

(6,6)

(220)

This question paper contains 4+2 printed pages]

Roll No.

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S. No: of Question Paper : 6822

Unique Paper Code : 42343306 HC

Name of the Paper : Office Automation Tools

Name of the Course : B.Sc. (Prog.)/B.Sc. Math. Sciences : SEC

Semester : III

Duration : 2 Hours

Maximum Marks : 25

(Write your Roll No. on the top immediately on receipt of this question paper.)

(i) **Section A** : Consists of 10 questions of 1 mark each (MCQ).

All questions are compulsory.

(ii) **Section B** : Answer any *three* questions.

Section A

1. Portrait and Landscape are :

(A) Page Orientation

(B) Paper Size

(C) Page Layout

(D) All of the above

P.T.O.

2. Which of the following is not a font style ?
- (A) Bold
 - (B) Italics
 - (C) Regular
 - (D) Superscript
3. Which of the following mail merge terms combines a document with a list of names and addresses to produce individualized documents ?
- (A) Main document
 - (B) Data source
 - (C) Mail merge
 - (D) Merge field
4. In order to edit a chart in Excel, you can :
- (A) Triple click the chart object
 - (B) Click and drag the chart object
 - (C) Double click the chart object
 - (D) Click the chart object

5. To insert three columns between columns D and E you would :
- (A) Select column D
 - (B) Select column E
 - (C) Select columns E, F and G
 - (D) Select columns D, E, and F
6. How are data organized in a spreadsheet ?
- (A) Lines and spaces
 - (B) Layers and planes
 - (C) Rows and columns
 - (D) Height and width
7. Which of the following is not a valid data type in excel?
- (A) Number
 - (B) Character
 - (C) Label
 - (D) Date/time

P.T.O.

8. Special effects used to introduce slides in a presentation are called :

- (A) Effects
- (B) Custom animations
- (C) Transitions
- (D) Present animations

9. The effect applied to display when slides changes in slide show view is :

- (A) Slide Animation
- (B) Custom Animation
- (C) Custom Transition
- (D) Slide Transition

10. How can you stop a slide show ?

- (A) Press the right arrow
- (B) Press Escape
- (C) Press the left arrow
- (D) Press the down arrow

Section B

1. Rajesh uses a spreadsheet to record information about the result of students in an examination as shown below :

	A	B	C	D
1	Name	Marks out of 40	Percentage	Result(Pass or Fail)
2	Raju	30	75	PASS
3	Ramanl	21		
4	Vicky	11		
5	Ram	44		
6	Arman	25		
7	Dinesh	33		
8	Sonali	6		
9	Average			

- (A) Write the formula to calculate percentage in cell C2 ? 1
- (B) How to get the percentage formula in other cells without typing it again ? 1
- (C) The passing percentage is 50%. Write the function to produce the result in cell D2. 2
- (D) Write the function to find average marks in cell B10. 1

P.T.O.

2. What is Mail Merge ? Explain in brief the process of Mail Merge in MS-Word. 5
3. (A) Explain the different PowerPoint views in which a presentation can be created and organized ? 4
- (B) Write the steps to insert slide number in the presentation. 1
4. Differentiate between : 5
- (i) COUNT() and COUNTIF()
- (ii) SUM() and SUMIF()
5. (i) Add $(1010101)_2$ and $(1110000)_2$ 2
- (ii) Convert $(2016.234)_{10}$ to $()_2$. 3

This question paper contains 3 printed pages]

Roll No.

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S. No. of Question Paper : 6975

Unique Paper Code : 42163302

HC

Name of the Paper : Biofertilisers

Name of the Course : B.Sc. (Prog.) : SEC

Semester : III

Duration : 3 Hours

Maximum Marks : 37.5

(Write your Roll No. on the top immediately on receipt of this question paper.)

All questions are compulsory.

1. (a) Define the following and elaborate in *one-two* sentences (any *five*) : 5

(i) Biopesticides

(ii) Chitinases

(iii) Root nodule

(iv) Symbiosis

(v) Organic farming

(vi) Vesicle

(vii) Compost.

P.T.O.

(b) Match the following :

2.5

(i) Organisms which associates (a) *Azotobacter*

symbiotically to form root

nodules

(ii) Organisms which form (b) *Azolla*

arbuscules

(iii) Free living nitrogen fixers (c) *Rhizobium*

(iv) Symbiotically associating (d) *Nostoc*

pteridophyte

(v) Blue green algae important in (e) AMF

rice cultivation

2. Write short notes on the following (any three) :

(a) *Rhizobium* as wonder biofertiliser

(b) Vermicomposting

(c) Ectomycorrhiza

(d) Biocontrol agents.

3. Attempt any two :

15

- (i) What is organic farming ? How green manure is superior to chemical fertilizers ? Explain with suitable examples.
- (ii) Blue green algae acts as important biofertilisers. Explain with suitable examples.
- (iii) What are AM fungi ? What are the methods employed in mass multiplication ?

Roll No.

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S. No. of Question Paper : 7005

Unique Paper Code : 32223903

HC

Name of the Paper : Electrical Circuits and Network Skills

Name of the Course : B.Sc. (Hons.) Physics/B.Sc.

(Prog.) : SEC

Semester : III

Duration : 3 Hours

Maximum Marks : 50

(Write your Roll No. on the top immediately on receipt of this question paper.)

All questions carry equal marks.

Question No. 1 is compulsory.

Attempt five questions in all.

Use of scientific calculators is allowed.

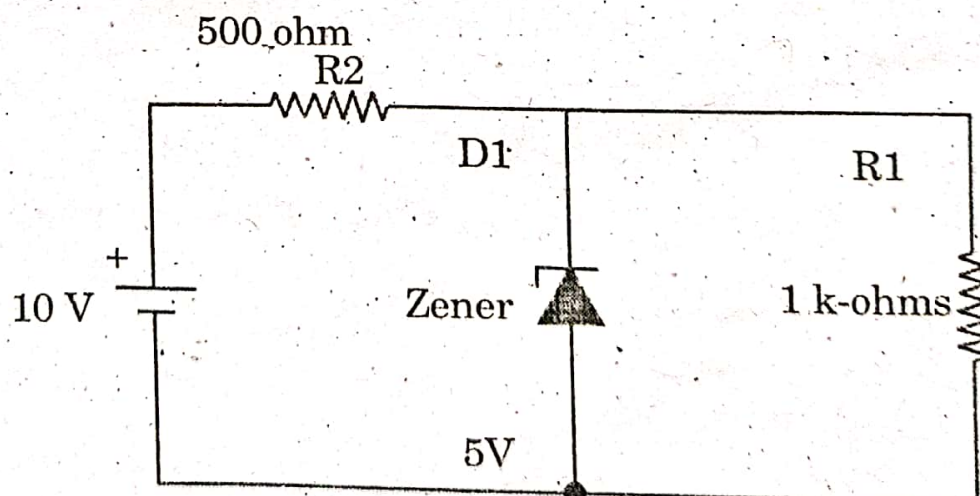
1. Attempt any five of the following : $5 \times 2 = 10$

(i) Draw electrical symbols for a Relay and a transformer.

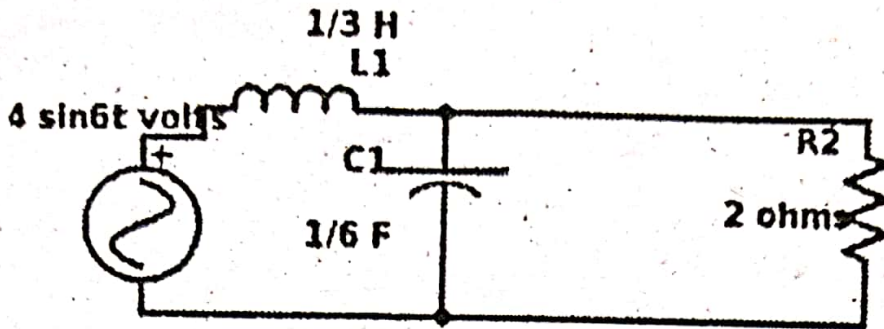
(ii) Define the terms static and dynamic resistance of a diode.

P.T.O.

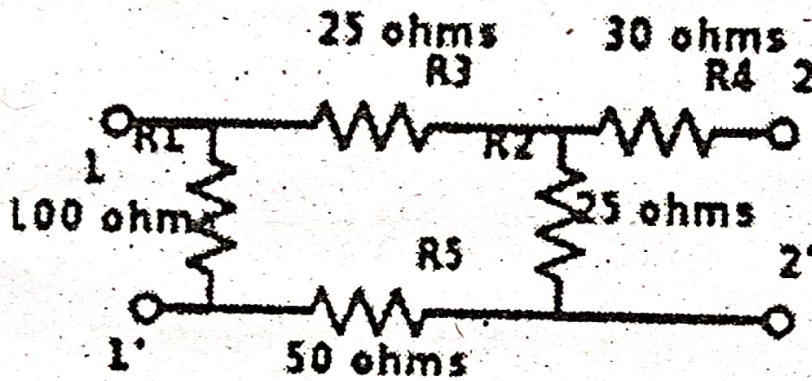
- (iii) What is the frequency of the output in a half wave rectifier and a full wave rectifier connected to 220 V, 50 Hz mains ?
- (iv) State Kirchhoff's laws.
- (v) What is full form of mcb ? Where and why are they used ?
- (vi) Given a transformer with 20,000 turns in the primary and 10,000 turns in the secondary, connected to an ac source of 220 V rms, 50 Hz. Calculate the voltage across the secondary.
- (vii) Find the current flowing through the Zener diode



2. (a) Find the voltage across the resistor $R_2 = 2$ ohms :



- (b) For the given circuit, find :

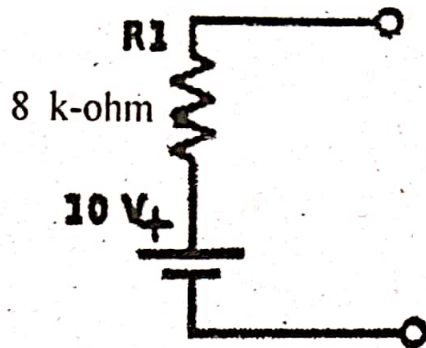


- (i) Resistance between terminals $11'$, when $22'$ is open circuited and
- (ii) Resistance between $22'$, when $11'$ is short circuited.

3. (a) Discuss the basic design and working of a single-phase motor. What are the advantages of a polyphase motor ?
- (b) Define the speed of an ac motor. What does it depend on ?
4. (a) Describe with circuit diagram construction and working of a full wave rectifier with a center tap.
- (b) What are the advantages and disadvantages of a Bridge Rectifier over a centre tap ?
5. (a) Describe the construction and working of a dc generator. Support your answer with relevant diagrams.
- (b) List the different kinds of losses that occur in a dc generator ?
6. (a) What are ideal current and voltage source ? Under what conditions do practical sources behave like ideal sources ?

(b) The following figure represents a voltage source.

Convert it into equivalent current source : 8,2



Write short notes on any *two* of the following : 5,5

- (1) Star and Delta wiring
- (2) Regulated power supply
- (3) Fuses and surges
- (4) Relay
- (5) Splices.

This question paper contains 3 printed pages]

Roll No.

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S. No. of Question Paper : 7006

Unique Paper Code : 32223904

2017
HC

Name of the Paper : Basic Instrumentation Skills

Name of the Course : B.Sc. (Hons.) Physics/B.Sc. (Prog.) :

SEC

Semester : III

Duration : 3 Hours

Maximum Marks : 50

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt *five* questions in all.

1. (a) Explain accuracy, precision and sensitivity of an instrument.

(b) A set of independent voltage measurement taken by five observers was recorded as 1.001 V, 1.002 V, 0.999 V, 0.998 V and 0.997 V. Calculate average voltage and average deviation. 5,5

P.T.O.

2. (a) Explain with the help of a graph, the limitations of a multimeter while measuring high frequency current and voltage.
- (b) Explain the advantages of an electronic voltmeter over a conventional multimeter for the voltage measurement with respect to input impedance and sensitivity.
- (c) Calculate the value of multiple resistance on the 50 V range of a dc voltmeter that uses a $550 \mu\text{A}$ meter movement with an internal resistance of $2 \text{ k}\Omega$. 4,42
3. (a) What is a CRO ? Explain it with the help of a block diagram.
- (b) What is the sweep generator circuit in CRO ? Why is it used ? 6,4
4. (a) Explain the working of a low frequency signal generator with the help of a block diagram.
- (b) Explain how the harmonic distortion is measured by using a distortion meter ? 5,5

5. (a) How is the digital voltmeter different from analog voltmeter ?
- (b) Explain the operation of a Q-meter with the help of a diagram. 3,7
- (a) Explain any LCR bridge in detail and obtain its balance condition.
- (b) A Maxwell inductance bridge uses a capacitor of $C_3 = 0.1 \mu\text{F}$ and operates at a supply frequency of 100 Hz. Balance is achieved when $R_1 = 1.26 \text{ k}\Omega$, $R_3 = 470 \Omega$ and $R_4 = 500 \Omega$. Calculate the resistance and inductance of the measured inductor. 6,4
- (a) How is the universal counter used for the period measurement ?
- (b) What is a multimeter ? How is it used as an ammeter ? 5,5

[This question paper contains 2 printed pages.]

Your Roll No.....

No. of Question Paper : 8595

HC

Unique Paper Code : 32223905

Name of the Paper : Renewable Energy and Energy Harvesting

Name of the Course : B.Sc. Physical Sciences – Skill Enhancement Course

Semester : V

Duration : 3 hours

Maximum Marks : 50

Instructions for Candidates

Write your Roll No. on the top immediately on receipt of this question paper.

Question No. 1 is compulsory.

Attempt any **four** questions in all.

Attempt any **four** questions :

- (a) Name at least three green house gases responsible for global warming.
- (b) What are different types of geothermal resources?
- (c) Write any four differences between renewable and non-renewable sources.

P.T.O.

- (d) What is meant by pitch angle, pitch control and tethering?
- (e) Differentiate tide and wave. What are the spring and neap tides?
- (f) Give three types of solar energy collectors.
- (g) How the wind mills are classified? Define Vertical Axis Wind Turbine (VAWT). (4×5)
2. Explain the main features of non conventional energy sources. Also discuss the importance of non conventional energy sources in context of global warming. (5+5)
3. What is principle behind nuclear energy harvesting? Mention the associated nuclear reactions. What are pros and cons of nuclear energy? (5+2+3)
4. What do you understand by a clean energy sources? Describe the procedure to convert the biomass into a clean energy sources. (5+5)
5. Describe green house effect. What do you understand by green energy? (5+5)
6. With the help of neat diagram describe the working and V-I characteristics of a solar cell. (5+5)

[This question paper contains 4 printed pages]

Your Roll No. :

Sl. No. of Q. Paper : **7474** **HC**

Unique Paper Code : 32225310

Name of the Course : **Physics : Generic
Elective for Honours**

Name of the Paper : Waves and Optics

Semester : III

Time : 3 Hours **Maximum Marks : 75**

Instructions for Candidates :

- (a) Write your Roll No. on the top immediately on receipt of this question paper.
- (b) Attempt any **FIVE** questions in **all**.
- (c) Question **No.1** is compulsory.

1. Attempt any five of the following : $3 \times 5 = 15$

- (a) Define simple harmonic motion. Give examples.
- (b) What is the difference between travelling and stationary wave ?

P.T.O.

7474

- (c) Differentiate between intensity and loudness of sound waves.
 - (d) Explain Stoke's treatment of reflection and refraction.
 - (e) What is the role of compensating plate in Michelson's interferometer ?
 - (f) Distinguish between Fresnel and Fraunhofer classes of diffraction.
 - (g) How many orders will be visible if the wavelength of incident radiation is 5000 \AA and the number of lines in a plane diffraction grating are 2620 per inch (1inch=2.54 cm) ?
2. (a) Trace graphically the motion of a particle that is subjected to two perpendicular simple harmonic motions of equal frequencies, different amplitudes and phases differing by (i) zero and (ii) $\pi/4$

10

- (b) A tuning fork A of frequency 380 Hz gives 5 beats per second when sounded with another tuning fork B. On loading B with a little wax, the number of beats per second becomes 3. What is the frequency of B ?

5

3. (a) Explain the formation of standing waves on a stretched string by giving necessary theory. 10
- (b) A string of length L is fixed on its two ends. Discuss and obtain different harmonics. 5
4. (a) Explain the Fresnel biprism experiment and derive the conditions for maxima and minima of intensity for a biprism. 10
- (b) How is the separation between the two virtual sources determined in this experiment? 5
5. (a) Differentiate between division of wavefront and division of amplitude methods for producing interference fringes. 3
- (b) How can Michelson's interferometer be used to determine the difference between two close wavelengths? 8
- (c) Calculate the distance between two successive positions of the movable mirror of Michelson's interferometer giving rise to distinct fringes in case of sodium lines having wavelength 5890\AA and 5896\AA . 4

7474

6. (a) Derive and discuss the intensity distribution of Fraunhofer diffraction pattern obtained with a narrow single slit illuminated by a parallel beam of monochromatic light. 10
- (b) Light of wavelength 6000\AA is incident on a slit of width 0.30 mm . The screen is placed a distance of 2 m from the slit. Find the distance between the first minima and the central maximum. 5
7. (a) Explain Fresnel's division of a cylindrical wavefront into half period zones. 5
- (b) How is the diffraction pattern due to straight edge explained in terms of Fresnel division of a wavefront into half period elements. 10
8. (a) What is double refraction? Define ordinary ray and extraordinary ray. 5
- (b) What is Nicol prism and how is it used to produce polarized light? 10

S. NO. of Question Paper : **H 6109**
 Unique Paper Code : 2221502
 Name of the Paper : Electromagnetic Theory
 Name of Course : ~~Erstwhile FYUP~~ B.Sc. (Hons) Physics
 Semester : V

F-9

Duration: 3Hours

Maximum Marks: 75

Instructions: Attempt five questions in all. All questions carry equal marks. Question No. 1 is compulsory.

1. **Answer the following questions (any five):** (5 x 3 = 15)

- (a) Obtain the boundary condition for electric displacement field vector.
- (b) Describe the meaning of plane polarized, circularly polarized and elliptically polarized light.
- (c) Calculate the skin depth for a conductor at 1 GHz, given that $\sigma = 3.8 \times 10^7$ mho/m, $\mu = 2.57 \times 10^{-7}$ H/m.
- (d) Briefly explain the concept of total internal reflection using Snell's law.
- (e) What is Lorentz gauge? Explain its use.
- (f) Write down the Maxwell's equation for linear isotropic dielectric medium.
- (g) Write the constitutive relations that hold for time-varying fields in a linear, homogenous and isotropic medium (μ, ϵ, σ).

2 (a) Show how Maxwell modified Ampere's law to make it consistent with the equation of continuity. Explain the significance of the term displacement current. 7

(b) Show that, for an electromagnetic plane wave, the two vectors \vec{E} and \vec{H} are in the same phase in a dielectric medium. 8

3 (a) Show that Maxwell's equation can be expressed as a pair of coupled second order partial differential equations in terms of scalar and vector potentials. Give comparison between Lorentz and Coulomb gauge conditions. 10

- (b) Show that the expression for time averaged Poynting vector for time varying fields is given by: 5

$$\langle \vec{S}(\vec{r}, t) \rangle = \text{Re} \left\{ \frac{1}{2} \vec{E}(\vec{r}) \times \vec{H}^*(\vec{r}) \right\}$$

4. (a) Consider propagation of e m plane waves in a conducting medium and solve for the electric and magnetic fields. Show that for a good conductor the time averaged magnetic contribution dominates the time averaged electric contribution in the e m energy density. 12
- (b) Show that the maximum phase difference between \vec{E} and \vec{H} vectors inside the conducting medium is $\pi/4$. 3
- 5 (a) Derive Fresnel's relations for reflection and transmission of e m wave's incident on an interface between two dielectric media, when incident wave has its \vec{E} vector perpendicular to the plane of incidence. 10
- (b) Find the expression for the Brewster's angle at which the reflected wave is completely extinguished. Why this angle is called polarizing angle? 5
- 6 Show that electric field dominates in the near field zone of an electric dipole. Determine the total power radiated. 15
- 7 Starting from Maxwell's equations, setup the wave equation for an inhomogeneous dielectric medium. Show that there exists only one symmetric TE mode for $0 < V < \pi$, in a step index planar dielectric waveguide, V being the dimensionless wave guide parameter. 15

This question paper contains 4 printed pages]

Roll No.

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No. of Question Paper : 6792

Unique Paper Code : 42227929

HC

Name of the Paper : Elements of Modern Physics

Name of the Course : Physics : DSE

Semester : V

Duration : 3 Hours

Maximum Marks : 75

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt five questions in all.

Question No. 1 is compulsory.

Attempt any five of the following : 5×3=15

- (a) If the average time duration between the excitation and the emission of the radiation from the atom is 1.0×10^{-8} s, find the inherent uncertainty in the frequency of the emitted photon using energy-time uncertainty relation.
- (b) The half-life of a thorium isotope is 14×10^{10} years. Calculate the time required for 10% of a sample of thorium to disintegrate.

P.T.O.

- (c) Show that the group velocity of the de Broglie waves associated with a moving particle is equal to the velocity of the particle.
- (d) The maximum wavelength for photoelectric emission in Tungsten is 230 nm. What wavelength of light must be used in order for electrons with maximum energy of 1.5 eV to be ejected ?
- (e) In a Compton scattering experiment, the X-ray photon is scattered at an angle of 180° and the electron recoils with an energy of 4 keV. Calculate the wavelength of the incident photon.
- (f) The shortest wavelength of the Balmer series in Hydrogen spectrum is 3646\AA . Calculate the Rydberg constant.
- (g) An electron at rest is accelerated through a potential difference of 1500 V. Find the de Broglie wavelength for this electron.
2. (a) Establish the time-dependent Schrodinger equation for a non-relativistic particle. 5
- (b) Determine the energy levels and the corresponding normalized wave function of a particle of energy 'E' bound in a one-dimensional square well of infinite height, having a length "L". 10

3. Write the time independent Schrodinger equation for a particle of energy E tunnelling across a rectangular potential barrier of height V_0 ($V_0 > E$) and width " l ". Find the expression for the transmission probability. 5,10
4. (a) Discuss the Liquid Drop model of the nucleus and hence derive the Semi-Empirical Mass formula. 3,10
- (b) Draw the Binding Energy per Nucleon V_s Atomic Mass graph. 2
5. (a) What are the laws of radioactive decay ? Derive the expression for the half-life in terms of decay constant. 5
- (b) Illustrate with a graph, the variation in the number of neutrons (N) V_s number of protons (Z) for stable nuclides. Also show the $N = Z$ line in the graph. 3
- (c) What is beta-decay ? Discuss the arguments that led Pauli to predict the existence of neutrinos. 7
6. (a) What are the Bohr's quantization rules ? 3
- (b) Derive an expression for the energy associated with the quantum states for hydrogen like atoms. 12

P.T.O.

7. (a) Discuss the aim, apparatus and the results of the Davisson-Germer experiment. 10
- (b) What is the Heisenberg's Uncertainty principle ? 2
- (c) Using uncertainty principle, estimate the minimum energy of an electron confined to region of 1 \AA . 3
8. (a) Deduce the expression for Compton scattering :

$$\Delta\lambda = (h/m_e c) (1 - \cos \theta).$$
 10
- (b) X-rays of wavelength 0.01 nm are scattered from a target. Find the wavelength of X-ray scattered through 45° . Also find the maximum wavelength present in the scattered X-rays. 5

PHYSICAL CONSTANTS

$$c = 3 \times 10^8 \text{ m/s}$$

$$m_e = 9.1 \times 10^{-31} \text{ kg}$$

$$e = 1.6 \times 10^{-19} \text{ C}$$

$$m_n = 1.00866 \text{ u}$$

$$h = 6.6 \times 10^{-34} \text{ Js}$$

$$m_p = 1.00728 \text{ u}$$

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 8379

HC

Unique Paper Code : 32227502

Name of the Paper : Advanced Mathematical Physics

Name of the Course : Physics : DSE

Semester : V

Duration : 3 Hours

Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt five questions in all taking at least two questions from each section.
3. All questions carry equal marks.

Section A

- (a) Show that the set Q_+ of all positive rational numbers with the binary operation $*$ defined by

$$a * b = \frac{ab}{3}$$

form a group.

(5)

P.T.O.

- (b) Determine whether or not W is a subspace of \mathbb{R}^3 where W consists of all vectors (a, b, c) in \mathbb{R}^3 such that

$$a + b + c = 0. \quad (3)$$

- (c) Find a basis and the dimension of solution space W of the following homogeneous system :

$$x + 2y - z + 3s - 4t = 0$$

$$2x + 4y - 2z - s + 5t = 0$$

$$2x + 4y - 2z + 4s - 2t = 0. \quad (3, 4)$$

2. (a) Consider $T : \mathbb{R}^3 \rightarrow \mathbb{R}^2$ defined by $T(x, y, z) = (2x + 7y, 5y - 3z)$. Determine whether or not T is a linear transformation. (5)

- (b) It is given that $\{a, b, c\}$ is a set of linearly independent vectors. Determine whether the vectors $a - 2b, a + b + c, b - c$ are linearly independent or not. (5)

- (c) If H is a Hermitian matrix, prove that e^{iH} is a unitary matrix ($i = \sqrt{-1}$). (5)

3. (a) Find the eigenvalues and eigenvectors of the matrix

$$A = \begin{bmatrix} a & b & b \\ b & a & b \\ b & b & a \end{bmatrix} \quad (10)$$

- (b) Write Cayley – Hamilton theorem and verify it for the matrix

$$B = \begin{bmatrix} 3 & -4 \\ 1 & 5 \end{bmatrix} \quad (1,4)$$

4. (a) Solve the following system of differential equations using matrix method

$$\dot{y} = z$$

$$\dot{z} = y$$

$$\text{where, } y(0) = 4, z(0) = 2. \quad (10)$$

- (b) Find e^C for the matrix $C = \begin{bmatrix} 3 & -1 \\ 4 & -2 \end{bmatrix}$. (5)

Section B

5. (a) Express in tensor form, the

(i) dot product of two vectors,

(ii) cross product of two vectors and

(iii) scalar triple product. (2,3,4)

- (b) Given $\vec{T} = 2\hat{i} + 3\hat{j} + 4\hat{k}$. Determine the matrix elements of second order skew-symmetric tensor associated with

$$\vec{T}. \quad (6)$$

P.T.O.

6. Using tensors, prove that

$$(a) \quad \vec{\nabla} \times (\vec{A} \times \vec{B}) = \vec{A} (\vec{\nabla} \cdot \vec{B}) - \vec{B} (\vec{\nabla} \cdot \vec{A}) + (\vec{B} \cdot \vec{\nabla}) \vec{A} - (\vec{A} \cdot \vec{\nabla}) \vec{B} \quad (8)$$

$$(b) \quad (\vec{A} \times \vec{B}) \times (\vec{C} \times \vec{D}) = \vec{B} (\vec{A} \cdot \vec{C} \times \vec{D}) - \vec{A} (\vec{B} \cdot \vec{C} \times \vec{D}) \quad (7)$$

7. (a) Derive an expression for the moment of inertia tensor. Prove that it is a symmetric tensor of order two.

(6,4)

(b) If A_q is a vector, show that $F_{pk} \equiv \frac{\partial A_p}{\partial x_k} + \frac{\partial A_k}{\partial x_p}$ is second order tensor. (5)

8. (a) If $ds^2 = 3(dx^1)^2 + 5(dx^2)^2 + 4(dx^3)^2 - 6dx^1 dx^2 + 4dx^2 dx^3$, then find the matrices

(i) (g_{ps}) ,

(ii) (g^{ps}) , and

(iii) the product of (g_{ps}) and (g^{ps}) . (3,5,3)

(b) Prove that velocity is a contravariant tensor of order one. (4)

This question paper contains 4 printed pages]

Roll No.

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S. No. of Question Paper : 8520

Unique Paper Code : 32227504 HC

Name of the Paper : Nuclear and Particle Physics

Name of the Course : Physics : DSE

Semester : V

Duration : 3 Hours

Maximum Marks : 75

(Write your Roll No. on the top immediately on receipt of this question paper.)

Five questions have to be attempted.

Question No. 1 is compulsory.

Attempt any four from the remaining set of questions.

Use of Scientific Calculator is permitted.

Attempt any five (5) questions :

- Represent graphically the variation of average binding energy per nucleon with the mass number A . Indicate the stable and unstable regions due to fusion and fission.
- Calculate the binding energy per nucleon for ${}_{42}^{98}\text{Mo}$.
- In a fission reaction of Uranium, each reaction releases 200 MeV of energy. Calculate the number of fissions per second in a 150 MW (mega Watt) reactor.

P.T.O.

- (d) State *two* differences between internal conversion and beta decay.
- (e) What is the Q value of a nuclear reaction ?
Find the Q value for the following reaction.

$${}_2\text{He}^4 + {}_7\text{N}^{14} \rightarrow {}_8\text{O}^{17} + {}_1\text{H}^1$$
- (f) Define "dead time" in GM counter. 5×3=15
2. (a) What are direct reactions ? Explain deuteron pick up and stripping reaction.
- (b) Consider a nucleus with $A = 237$. Use the semi-empirical mass formula to find Z for the most stable isobar for this A . Do not derive the semi-empirical formula.
- (c) Estimate the typical range of the nuclear force if it is assumed that the nucleon-nucleon interaction arises due to the exchange of particles with mass $m = 782.7 \text{ MeV}/c^2$. 5,5,5
3. (a) What is the Geiger Nutall rule ? Represent it graphically.
- (b) Calculate the threshold velocity of electrons to produce Cerenkov radiation in a medium of refractive index 1.52.

- (c) ${}^A_Z X_N \rightarrow {}^{A-4}_{Z-2} X'_{N-2} + {}^4_2\text{He}$ represents the spontaneous emission of an alpha particle. If the parent nucleus is at rest, derive the expression for the kinetic energy of the alpha particle $T_\alpha = \frac{Q}{\left(1 + \frac{m_\alpha}{m'_x}\right)}$. Use non-relativistic kinematics. Q , m_α , m'_x are the disintegration energy, mass of the emitted alpha particle and the mass of the daughter nucleus respectively. 5,5,5

4. (a) Alpha particles of energy 6 MeV pass through an ionization chamber at the rate of 20 per second. Assuming all the energy is used in producing ion pairs, calculate the current produced if 34 eV is required to produce an ion pair.
- (b) Determine the ratio of the heights of the Coulomb barrier for ${}^{16}_8\text{O}$ as seen by a proton and an alpha particle. 7,8
- i. (a) Indicate, with an explanation, whether the following reactions proceed through the strong, electromagnetic or weak interactions, or whether they do not occur.
- (i) $\tau^+ \rightarrow \mu^+ + \gamma$
- (ii) $p \rightarrow \pi^0 + e^+$
- (iii) $p \rightarrow n + e^+ + \nu_e$

P.T.O.

- (b) Discuss the principle of a linear accelerator.
- (c) A cyclotron with dees of radius 90 cm is subjected to a transverse magnetic field of 0.8 Tesla. Calculate the energy to which a deuteron of mass 3.34×10^{-27} kg can be accelerated. 6,5,4
6. (a) Sketch the Baryon Octet based on the quark model and assign the required quantum numbers.
- (b) When does a nucleus undergo gamma decay ? State the differences between internal conversion and photoelectric effect. 8,7
7. (a) State *four* characteristics of nuclear forces.
- (b) The radius of Ge is found to be twice the radius of ${}^9_4\text{Be}$. Using this information, determine the number of nucleons in Ge.
- (c) Find the threshold wavelength of gamma rays needed to produce a proton anti-proton pair. 5,5,5

Useful data :

$$M({}_1^1\text{H}) = 1.007825\text{u}, \text{ Mass of neutron} = 1.008665\text{u}$$

$$M({}_1^2\text{H}) = 2.014102\text{u}, M({}_2^4\text{He}) = 4.002603\text{u}$$

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 8594

HC

Unique Paper Code : 32223904

Name of the Paper : Basic Instrumentation Skills

Name of the Course : Physics : SEC

Semester : V

Duration : 3 Hours

Maximum Marks : 50

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.

2. Attempt any five questions in all.

1. (a) Differentiate between accuracy and precision in measurement of a physical quantity using an electronic measuring device. Give suitable example of each.

(3,2)

(b) Give step by step procedure for testing a transistor by a multi-meter.

(5)

P.T.O.

2. (a) What are the essential characteristics of a sensor? Give account of three main characteristics. (2,3)

(b) Using two multi-meters A and B, resistance of a conductor is measured at various temperatures as :

	20°C	21°C	22°C	23°C	24°C	25°C
A	2.00Ω	2.01Ω	2.02Ω	2.03Ω	2.04Ω	2.05Ω
B	2.001Ω	2.014Ω	2.026Ω	2.037Ω	2.049Ω	2.053Ω

Which is more sensitive multi-meter? Which of the two give accurate value of temperature coefficient of resistance? Justify your answer. (2,3)

3. (a) What is loading effect in measurement of voltages across a load by a voltmeter? What is the cause of this effect? Suggest suitable methods of minimising this effect? (2,1,2)

(b) Why digital multi-meters are preferred over the conventional analog multi-meters for testing an electronic circuit? Which of the two will you prefer for testing an electrolytic capacitor? Give suitable reason for it. (2,1,2)

In the help of a suitable diagram give necessary construction and working of a Cathode Ray Tube (T). (5)

Using block diagram explain the working of a Digital Storage Oscilloscope (DSO). (5)

Using block diagram explain the working of function generator. (5)

What is duty cycle of a square wave? What is the advantage of taking FFT (Fast Fourier Transform) of a signal. (2,3)

Give step by step procedure of measurement of Q-factor of a coil by LCQ meter. (5)

Name the basic bridges used for measurement of capacitive reactance. Give its necessary theory. (1,4)

What do you understand by calibration of a function generator? How is the calibration of this instrument done? (2,3)

(b) Name four important errors in measurement of a physical quantity by an electronic device. Suggest methods of minimising the same.

This question paper contains 4+2 printed pages]

Roll No.

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S. No. of Question Paper : 7342

Unique Paper Code : 32225103 HC

Name of the Paper : Digital, Analog and Instrumentation

Name of the Course : Physics : Generic Elective for Honours

Semester : I

Duration : 3 Hours

Maximum Marks : 75

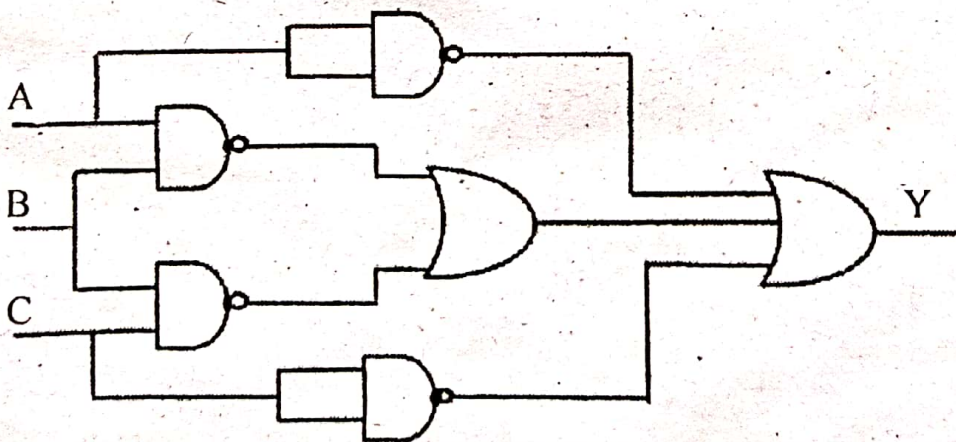
(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt four questions in all including

Q. No. 1 which is compulsory.

1. Attempt any six of the following : 6×5=30

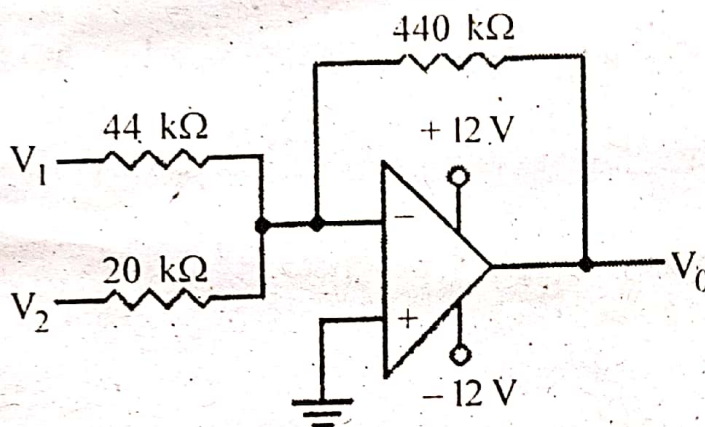
(a) Give the Boolean expression and truth table for the following circuit :



P.T.O.

- (b) Convert a decimal number 378.93_{10} to its binary equivalent and a binary number 11011.101_2 to its decimal equivalent.
- (c) Name the universal logic gates and tell why are they called so ? Design logic gates (AND, OR and NOT) using only any of the universal logic gate.
- (d) Explain the difference between a photodiode and an LED. Why is an LED preferred over a conventional incandescent lamp as an indicator device in an electrical circuit ?
- (e) For the semiconductor material of a light emitting diode energy gap is 1.25 eV. What is the wavelength of the emitted light ? Given : $h = 6.62 \times 10^{-34}$ Joule sec, $c = 3 \times 10^8$ m/sec.
- (f) A certain transistor has α_{dc} of 0.98 and a collector leakage current I_{co} of $1 \mu\text{A}$. Calculate the collector and the base currents, when $I_E = 1\text{mA}$.

- (g) What is a DC load line and Q-point ? Where will you fix the operating point for designing in CE amplifier ?
- (h) Give the pin-out diagram of Op-Amp IC 741. Define CMRR and slew rate.
- (i) Determine the output voltage of the following circuit when $V_1 = -0.2 \text{ V}$ and $V_2 = 0 \text{ V}$.

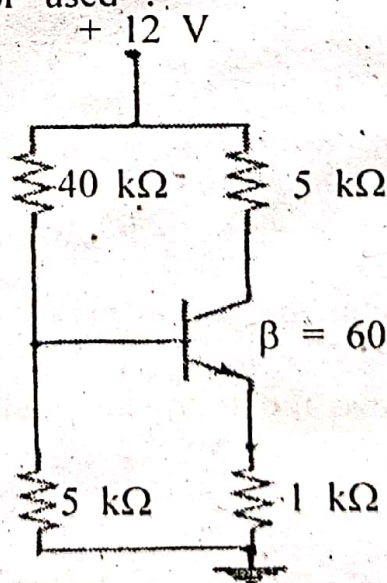


- (j) Draw the pin out diagram of IC-555 and explain the function of pin 5 and pin 6. Give any two applications of an IC 555 timer.
2. (a) What is full subtractor in digital electronics ? How by using two half subtractor and OR gate, can a full subtractor be achieved ? 8
- (b) Minimize the following logic function using Karnaugh map ;

$$f(A, B, C, D) = \sum m(1, 3, 4, 10, 11, 12, 14) + \sum d(2, 6, 13, 15). \quad 7$$

P.T.O.

3. (a) With the help of a suitable diagram, explain the formation of depletion region in a p-n junction. How does its width change when junction is :
- Forward biased
 - Reverse biased. 8
- (b) Draw the circuit diagram of a p-n junction diode in forward and reverse biasing. Draw the V-I characteristics for each biasing. 7
4. (a) Draw the circuit diagram of a CE single stage transistor amplifier. 4
- (b) Calculate the dc bias voltages and currents for the circuit of figure. Assume $V_{BE} : 0.3V$ and $\beta = 60$ for the transistor used. 7



- (c) When the emitter current of a transistor is changed by 1 mA, its collector current changes by 0.995 mA.

Calculate :

(i) its common-base short circuit gain, α and

(ii) its common-emitter short circuit current gain β . 4

5. (a) Derive an expression for the closed loop gain of operational amplifier configured in non-inverting mode. 8

- (b) Draw a circuit for a basic op-amp differentiator. Draw the output waveform if the input to this circuit is a square wave. 7

6. (a) Draw the schematic diagram of a full-wave rectifier. Explain its working and obtain an expression for its ripple factor and rectification efficiency. 8

- (b) The turns ratio of the transformer used in a bridge rectifier is $n_1 : n_2 = 12 : 1$. The primary is connected to 220 V, 50 Hz power mains. Assuming that the diode voltage drops to be zero, find the dc voltage across the load. What is peak inverse voltage of each diode? 7

P.T.O.

7. (a) Draw the block diagram of CRO labelling all the parts. Explain its uses to measure voltage, frequency and phase of a sinusoidal wave. 8
- (b) Draw the circuit diagram and explain the working of 555 timer as an astable multivibrator. How will you achieve 50% duty cycle in astable multivibrator. 7

[This question paper contains 6 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 6773

HC

Unique Paper Code : 42351101

Name of the Paper : Calculus and Matrices

Name of the Course : B.Sc. (Mathematical Sciences)-I
B.Sc. (Physical Sciences)-I

Semester : I

Duration : 3 Hours

Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt any two questions from each section.

SECTION-I

(a) (i) Let $X = \begin{bmatrix} 1 \\ 2 \end{bmatrix}$ and $Y = \begin{bmatrix} 2 \\ -3 \end{bmatrix}$. Determine $X+Y$.

Sketch a directed line segment in R^2 representing each of the vectors X , Y and $X+Y$.

P.T.O.

(ii) Find the value of c for which the set $\left\{ \begin{bmatrix} 1 \\ -2 \end{bmatrix}, \begin{bmatrix} c \\ -4 \end{bmatrix} \right\}$ of vectors in \mathbb{R}^2 is linearly dependent. (6)

(b) Let W be the subset of \mathbb{R}^3 consisting of all the vectors

of the form $\begin{bmatrix} a \\ b \\ 1 \end{bmatrix}$, where a and b are real numbers.

Show that W is not a subspace of \mathbb{R}^3 . (6)

2. (a) Let $T: \mathbb{R}^3 \rightarrow \mathbb{R}^3$ be defined by

$$T \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} -x \\ y \\ z \end{bmatrix}$$

Show that T is a linear transformation. Also find a matrix representation for T . (6)

(b) Find the eigenvalues of the matrix $\begin{bmatrix} 1 & 0 & 0 \\ 2 & 4 & 0 \\ 3 & 5 & 7 \end{bmatrix}$. (6)

(a) Find the inverse of the matrix using elementary row

operations: $\begin{bmatrix} 1 & 1 & 1 \\ 0 & 2 & 3 \\ 5 & 5 & 1 \end{bmatrix}$. (6)

(b) Solve, if consistent, the following system of linear equations

$$x + y + 3z = 1$$

$$2x + 3y - z = 3$$

$$5x + 7y + z = 7 \quad (6)$$

SECTION-II

(a) Discuss the convergence of the sequences

(i) $\langle a_n \rangle$, where $a_n = (-1)^n$

P.T.O.

(ii) $\langle b_n \rangle$, where $b_n = \frac{2n}{3n+1}$ (6)

(b) Find the n^{th} derivative of $y = \frac{1}{1+3x}$ (6)

(c) If $y = \ln(x + \sqrt{1+x^2})$, prove that $(1+x^2)y_{n+2} + (2n+1)xy_{n+1} + n^2y_n = 0$. (6)

5. (a) Sketch the graph of $y = -2(x+1)^2 - 3$. (6)

(b) A dose of 5 ml of a medicine is injected into a patient's body. In 1 hour 1 ml of the medicine was absorbed by the body. In how much time will 90% of the medicine be absorbed by the body. (6)

(c) Derive the Maclaurin series expansion for $\cos x$ assuming the validity of the expansion. (6)

6. (a) Draw the level curves of $f(x, y) = y^2 - x^2$ at heights $k = 0, 1, 2$. (6)

(b) Find all the second order partial derivatives off
 $(x,y) = x^2y^3 + xy^5$. (6)

(c) Verify that $w(x, t) = \exp(-c^2k^2t) (a \cos kx + b \sin kx)$;
 a and b are constants, is a solution of the diffusion
equation. (6)

SECTION-III

(a) Describe the set of points z in the complex plane that
satisfy $|z - (1 + i)| = 4$. (2½)

(b) Find the product of $z_1 = 1 - i$, $z_2 = \sqrt{3} + i$ using polar
representation of complex numbers. (2½)

(c) Find the radius and center of the circle

$$z\bar{z} - (2 + 3i)z - (2 - 3i)\bar{z} + 9 = 0. \quad (2\frac{1}{2})$$

(a) Form an equation whose roots are the n^{th} powers of the
roots of the equation.

$$x^2 - 2x\cos\theta + 1 = 0. \quad (3\frac{1}{2})$$

(b) Evaluate $\frac{(\cos\alpha + i\sin\alpha)^4}{(\cos\alpha + i\sin\alpha)^5}$ (4)

P.T.O.

9. (a) If $\cos\alpha + 2\cos\beta + 3\cos\chi = \sin\alpha + 2\sin\beta + 3\sin\chi =$
prove that $\cos 3\alpha + 8\cos 3\beta + 27\cos 3\chi = 18\cos(\alpha + \beta + \chi)$. (3)

(b) Solve the equation $z^7 + z = 0$. (4)