This question paper contains 4 printed pages.

Your Roll No. .....

Sl. No. of Ques. Paper	: 102 I
Unique Paper Code	: 32221101
Name of Paper	: **Mathematical Physics - I**
Name of 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.

1. Do any *five* questions :

(a) Solve : $\frac{dy}{dx} = (1+x^2)(1+y^2)$.

(b) By calculating the Wronskian of the functions e^x, e^{-x}, and e^{-2x} check whether the functions are linearly dependent or independent.

(c) Find the area of the triangle with vertices P(2, 3, 5), Q(4, 2–1), and R(3, 6, 4).

(d) Find the unit vector normal to the surface $x^2 + y^2 + z^2 = 4$ at the point $(1, \sqrt{2}, -1)$.

(e) Show that :

$$\oiint_S (\vec{\nabla} r^2) \cdot \vec{dS} = 6V$$

(12)

where S is the closed surface enclosing the volume V.

P.T.O.

(f) Evaluate :

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

(g) Verify that :

$$\int_{-\infty}^{+\infty} \delta(a-x)\delta(x-b)\, dx = \delta(a-b)$$

(h) Form a differential equation whose solutions are e^{2x} and e^{3x}. 5×3=15

2. (a) Solve the inexact equation :

$$y(1+xy)\, dx + x(1+xy+x^2y^2)\, dy = 0.$$ 5

(b) Solve the differential equation

$$\frac{d^2y}{dx^2} - 2\frac{dy}{dx} + 4y = e^x \cos x.$$ 4

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

$$\frac{d^2y}{dx^2} + 4y = 2\sin 2x.$$ 6

3. (a) Solve the differential equation

$$\frac{d^2y}{dx^2} + 4\frac{dy}{dx} + 5y = x^2 + 5.$$ 9

(b) Solve the differential equation using method of variation of parameter

$$\frac{d^2y}{dx^2} - 4\frac{dy}{dx} + 4y = x^2e^{2x}.$$ 6

4. (a) Show that

$$\left[\left(\vec{A}\times\vec{B}\right)\times\vec{C}\right]\times\vec{D}+\left[\left(\vec{B}\times\vec{A}\right)\times\vec{D}\right]\times\vec{C}+$$

$$\left[\left(\vec{C}+\vec{D}\right)\times\vec{A}\right]\times\vec{B}+\left[\left(\vec{D}\times\vec{C}\right)\times\vec{B}\right]\times\vec{A}=0. \quad 6$$

(b) Show that :

$$\vec{F}=\left(y^2\cos x+z^3\right)\hat{i}+\left(2y\sin x-4\right)\hat{j}+\left(3xz^2+2\right)\hat{k}$$

is a conservative force field and then evaluate

$$\int_C \vec{F}\cdot\overrightarrow{dr}$$

where C is any path from (0, 1, –1) to $\left(\frac{\pi}{2}, -1, 2\right)$. 9

5. (a) If $\vec{a}$ is a constant vector and $\vec{r}=x\hat{i}+y\hat{j}+z\hat{k}$ then prove that :

$$\text{curl}\left(\frac{\vec{a}\times\vec{r}}{r^3}\right)=\frac{3\left(\vec{a}\cdot\vec{r}\right)\vec{r}}{r^5}-\frac{\vec{a}}{r^3}. \quad 7$$

(b) Evaluate :

$$\iint_S \vec{A}\cdot\hat{n}\,dS$$

where $\vec{A}=18z\hat{i}-12\hat{j}+3y\hat{k}$ and S is the part of the plane $2x + 3y + 6z = 12$ located in the first octant. 8

6. (a) Evaluate :

$$\oint_C (y-\sin x)\,dx+\cos x\,dy$$

(i) directly

(ii) using Green's theorem in the plane, where C is the boundary of a triangle enclosed by the lines $y = 0$, $x=\frac{\pi}{2}$, and $y=\frac{2}{\pi}x$. 10

(b) Verify that :

$$\nabla^2 r^n = n(n+1)r^{n-2}.$$

5

7. (a) Verify divergence theorem for

$$\vec{F} = \left(x^2 - yz\right)\hat{i} + \left(y^2 - xz\right)\hat{j} + \left(z^2 - xy\right)\hat{k}$$

taken over the rectangular parallelopiped $0 \le x \le a$, $0 \le y \le b$, $0 \le z \le c$. 10

(b) Express the position and velocity of a particle in cylindrical coordinates. 5

8. (a) Derive an expression for the divergence of a vector field in orthogonal curvilinear coordinate system. 10

(b) Evaluate Jacobian $J\left(\frac{x, y, z}{u_1, u_2, u_3}\right)$ for the transformation from rectangular coordinate system to spherical coordinate system. 5

This question paper contains 4 printed pages]

Roll No. | | | | | | | | | | |

S. No. of Question Paper : 103

Unique Paper Code : 2221102 I

Name of the Paper : Mechanics

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

Semester : I

Duration : 3 Hours Maximum Marks : 75

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

Attempt any *five* questions in all.

Q. No. 1 is compulsory.

Use of non-programmable scientific calculator is allowed.

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

(*a*) Prove that the radius vector sweeps out equal areas in equal intervals of time for any elliptical orbit under central force motion.

(*b*) Explain the theory of expanding universe using Doppler effect in light.

(*c*) What are the effects of Coriolis force due to Earth's rotation.

P.T.O.

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

(*e*) Compare gravitational mass with inertial mass of the body.

(*f*) Show that $E^2 - c^2p^2$ is invariant to Lorentz transformations.

(*g*) Show that damping has little or no effect on the frequency of a harmonic oscillator if its quality factor is large.

(*h*) Explain how a hollow cylinder is stronger than a solid cylinder having same material, mass and length.

2. (*a*) State and prove Work-Energy theorem. 7

(*b*) Show that in an elastic collision of two particles in centre of mass frame of reference, the magnitude of the velocity remains unchanged before and after the collision. 8

3. (*a*) Find the centre of mass of a uniform solid hemisphere of mass M and radius R w.r.t. its geometrical centre. 7

(*b*) Determine the moment of inertia of a uniform hollow sphere of mass M, and radius R about its diameter and tangent. 8

4. (*a*) Derive the expression for the gravitational potential due to a solid sphere of radius R and mass M at a point outside the shell and also at a point inside the shell. 10

(*b*) Show graphically the variation of both gravitational potential and gravitational field as a function of radial distance from the centre of the sphere. 5

5. (*a*) State and prove theorem of perpendicular axes of moment of inertia for a three-dimensional rigid body. 7

(*b*) Establish the relation between Y, K and *n* where Y is the Young's modulus, K is the bulk modulus and *n* is the modulus of rigidity of the material. 8

6. (*a*) Deduce the differential equation of a damped harmonic oscillator and discuss in detail the cases of overdamped, critical and underdamped oscillators. 12

(*b*) A condenser of capacity I microF, an inductance of 0.2 Henry and a resistance of 800 ohm are connected in series. Is the circuit oscillatory ? If yes, calculate the frequency and quality factor of the circuit. What do you understand by Quality factor of an oscillator ? 3

7. (*a*) What is Coriolis force ? Show that the total Coriolis force acting on a body of mass m in a rotating frame is $-2m\ \vec{\omega} \times \vec{v}_{rot}$, where $\vec{\omega}$ is the angular velocity of rotating frame and $\vec{v}_{rot}$ is the velocity of the body in rotating frame. 9

(*b*) Calculate the values of the centrifugal and Coriolis forces on a mass of 20 g placed at a distance of 10 cm from the axis of a rotating frame of reference, if the angular speed of rotation of the frame be 10 radians per second. 4

(*c*) Calculate the effective weight of an astronaut ordinarily weighing 60 kg when his rocket moves vertically upward with 5 g acceleration. 2

8. (*a*) Describe Michelson-Morley experiment and explain the significance of the null result. State the postulates of special theory of relativity. 6,2,2

(*b*) The proper mean life time of pi meson is 2.5×10^{-8} sec. Calculate :

(i) the mean life time of pi meson travelling with velocity 2.4×10^{10}cm/sec.

(*ii*) distance travelled by it before disintegrating. 3,2

[This question paper contains 4 printed pages]

Your Roll No. : .....

Sl. No. of Q. Paper : **203** **I**

Unique Paper Code : 42221101

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

Name of the Paper : Mechanics

Semester : I

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. Use of non programmable calculator is allowed.

1. (a) If A = 2i – 3j–k and B = i + 4j – 2k . Find (A+B) X (A-B). 5

(b) If $\vec{R} = e^{-t}\hat{i} + \ln(t^2+1)\hat{j} + \tan(t)\hat{k}$. 5

Find $\left|\frac{d\vec{R}}{dt}\right|$ and $\left|\frac{d^2\vec{R}}{dt^2}\right|$ at t = 0.

P.T.O.

(c) Solve the differential equation : 5

$$\frac{dy}{dx} = \frac{2y^4 + x^4}{xy^3}$$

2. (a) What is centre of mass ? Show that in the absence of an external force the velocity of centre of mass remains constant. 5

(b) A vessel at rest explodes breaking into three pieces. Two pieces having equal masses, fly off perpendicular to each other with the same speed of 30 m/sec. The third piece has three times the mass of each piece. What is the direction and magnitude of its velocity immediately after explosion. 5

(c) Show that the force $\vec{F} = yz\hat{i} + zx\hat{j} + xy\hat{k}$ is a conservative force. 5

3. (a) Define angular momentum $\hat{j}$ and torque $\vec{\tau}$.

Show that $\vec{\tau} = \frac{d\vec{j}}{dt}$. 5

(b) A 500 gm mass is whirled round in a circle at the end of a string 40 cm long. The other end of the string is held in hand. If the mass makes 5 rev/sec, what is its angular momentum. If the number of revolutions reduce to 1 rev/sec in 20 seconds, find the torque acting on the mass. 5

(c) Prove law of conservation of mechanical energy for conservative forces. 5

4. (a) State Kepler's laws of planetary motion. 6

(b) Show that the areal for a particle moving under the influence of a central force velocity is constant. 4

(c) What are geostationary satellites ? Find the height of a geostationary satellite above the surface of earth. Given, Radius of earth = 6400 km. 5

5. (a) What is simple harmonic motion ? Explain with the help of an example. Write down the differential equation of simple harmonic motion and find its solution. 10

(b) Show that for a particle executing simple harmonic motion the average potential energy is equal to half the total energy. 5

6. (a) Derive the relation $K = \frac{Y}{3(1-2\sigma)}$

where K = Bulk's Modulus, Y = Young's Modulus and σ = Poisson's ratio. 10

(b) A steel bar 2 m long, 40 mm wide and 20 mm thick is subjected to an axial pull of 160 kN along its length. Find changes in its length, width and thickness. Take Young's Modulus = 2×10^5 N/mm^2 and Poisson's ratio = 0.3 5

7. (a) Write down Lorentz transformation equations and derive the expression for length contraction. 10

(b) How fast would a rocket have to go relative to an observer on earth for its length to be contracted to 50% of its length when at rest? 5

[This question paper contains 6 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 904 **I**

Unique Paper Code : 32225103

Name of the Paper : Digital, Analog Circuits and Instrumentation

Name of the Course : **Physics : G.E. for Honours**

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 **four** questions in all including Question No. **1** which is compulsory.

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

(a) (i) Convert the decimal number 53.625 into a binary number.

(ii) Convert $(235)_{10}$ to a hexadecimal number.

(b) Write the truth table for half adder and draw its logic circuit.

P.T.O.

(c) Draw a circuit diagram for XOR gate using only NAND gates.

(d) Explain how static resistance of a diode can be determined from its V-I characteristics. Determine the static resistance for the diode whose characteristics are given below in Fig. 1.

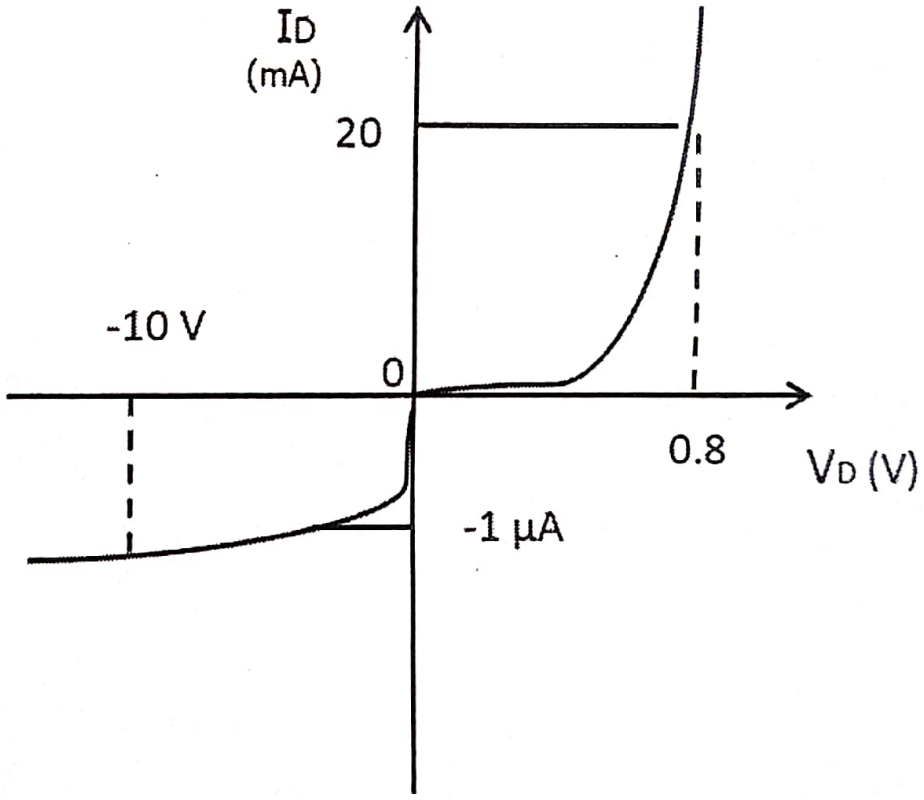


Fig. 1

(e) A transistor has β_{dc} of 200 and collector current I_C of 2 mA. Calculate the base current I_B.

(f) Give a brief description of solar cell.

(g) Calculate the output voltage for the following circuit diagram in Fig. 2.

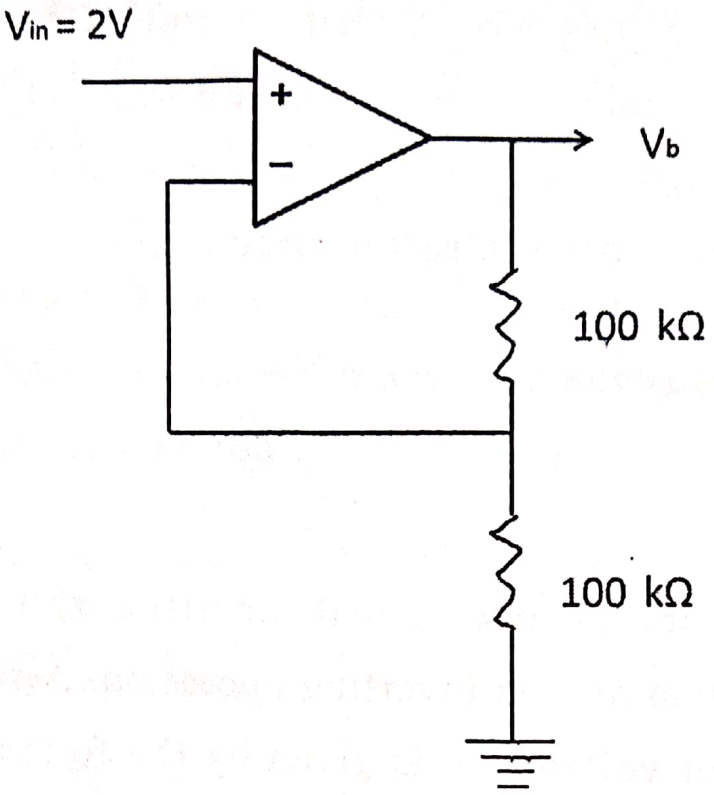


Fig. 2.

(h) Determine I_B, I_C, V_{CE}, V_B, V_C, and V_{BC}, for the following fixed bias configuration as given in Fig. 3 below. Give $\beta = 50$ and $V_{BE} = 0.7V$.

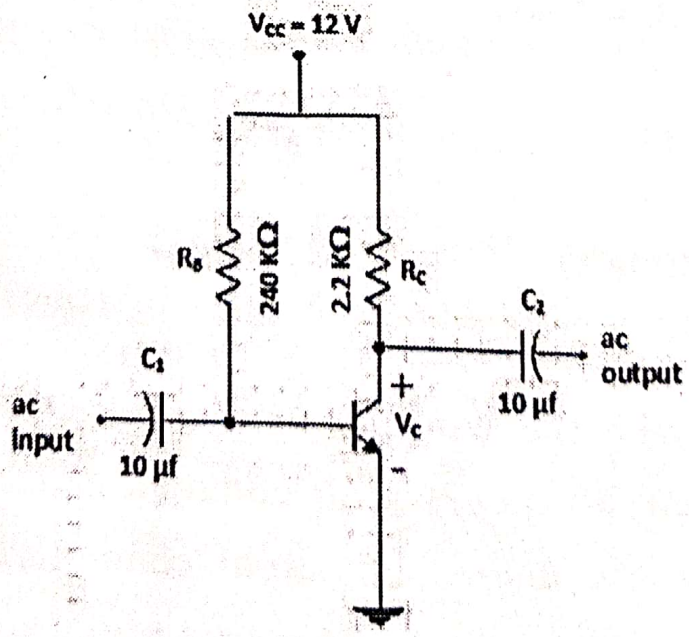


Fig. 3

P.T.O.

2. (a) Draw a properly labeled controlled inverter line and explain its functioning. Explain with the help of suitable circuit diagram how it can be used to design a 4 bit binary adder/subtractor circuit. (10)

(b) Simplify the expression $Y = \Sigma m(7,9,10,11,12,13,14,15)$ using K-map. (5)

3. (a) Describe an operational amplifier and draw a circuit diagram of it in inverting operation. Also show that the output voltage Vo is given by the following relation.

$$V_0/V_{in} = -(R_f/R_1)$$ (10)

(b) Calculate the output voltage of an op-amp summing amplifier for the following set of voltages and resistors. Use $R_f = 1M\Omega$.

$V_1 = +1V$ $V_2 = +2V$

R1=500KΩ R2=1MΩ (5)

4. (a) Describe the working of a p-n-p transistor and draw it's circuit diagram for common emitter configuration Draw the input and output characteristics and define saturation, cut-off and active regions. (10)

(b) Using hybrid equivalent model for a common emitter amplifier, derive an expression for current gain A_i in terms of h parameters and load resistance R_L. (5)

5. (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

(i) Forward biased

(ii) 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)

6. (a) Draw the block diagram of a CRO labelling all the parts. Explain its uses to measure voltage, frequency and phase of a sinusoidal wave. (10)

(b) Draw Lissajous pattern when horizontal frequency is twice the vertical frequency and vice-versa. (5)

7. (a) Draw a circuit diagram of a full wave bridge rectifier and explain its working. Show the input and output waveforms also. (10)

(b) 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. (5)

This question paper contains 4 printed pages.

Your Roll No. .....

Sl. No. of Ques. Paper	: 105	I
Unique Paper Code	: 32221302	
Name of Paper	: Thermal Physics	
Name of 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 including Question No. 1 which is compulsory.

All questions carry equal marks.

(Symbols have their usual meanings.)

1. Answer any *five* of the following :

   (a) State the first law of thermodynamics in differential form. What are its limitations?

   (b) Air is compressed adiabatically to half its volume. Calculate the change in its temperature.

   (c) Explain how the internal energy of an ideal gas differs from that of a real gas.

   (d) Give any *three* basic postulates of kinetic theory of gases.

P.T.O.

(e) State the law of equipartition of energy and apply it to obtain the specific heats C_p and C_v of a monoatomic gas.

(f) Define Temperature of Inversion and Critical Temperature of a van der Waals gas.

(g) Why is the thermal conductivity of hydrogen gas large as compared to any other gas at a given temperature? 3×5

2. (a) Describe absolute scale of temperature explaining the meaning of zero on this scale. Show that thermodynamic scale of temperature agrees with the ideal gas scale. 10

(b) Give the necessary conditions for the reversibility of a process. Give one example each of reversible and irreversible processes. 5

3. (a) State Clausius and Kelvin statements of the second law of thermodynamics and establish their equivalence. 6

(b) Describe Carnot's cycle and deduce the efficiency of the engine. Show that 100% efficient engine is not possible. 7

(c) Calculate the efficiency of a Carnot engine working between steam point and ice point. 2

4. (a) Calculate under what pressure ice would freeze at –1°C, if the increase in specific volume, when one gram of water freezes into ice at 0°C is 0.091 c.c. Latent heat of fusion of ice, L = 79.6 cal/g, 1 atm = 1.013×10^6 dynes/cm^2. 5

(b) Derive an expression for the Joule-Thomson coefficient in terms of temperature of inversion for a van der Waals gas. 10

5. (a) What is magneto-caloric effect? Describe with necessary theory and experimental setup the method of producing very low temperatures by adiabatic demagnetisation. 10

(b) Verify TdS equation :

$$TdS = C_V\,dT + T\left(\frac{\partial P}{\partial T}\right)_V dV \qquad 5$$

6. (a) Define four thermodynamic potentials. Using these derive four Maxwell's thermodynamic relations. 8+1

(b) Using Maxwell's thermodynamic relations derive :

(i) Clausius Clapeyron equation $\frac{dP}{dT} = \frac{L}{T(v_2 - v_1)}$ 3

(ii) $\left(\frac{\partial C_P}{\partial P}\right) = \left(\frac{\partial^2 S}{\partial P\,\partial T}\right) = -T\left(\frac{\partial^2 V}{\partial T^2}\right)_P$ 3

7 (a) Derive Maxwell-Boltzmann law of distribution of speeds for an ideal gas. Show the distribution graphically for various temperatures. 10

(b) For a gas if the number of molecules per cubic meter is $n = 3\times10^{25}$, average velocity is $v = 426$ m/sec, radius of the molecule is $r = 1.8\times10^{-10}$ m, compute the mean free path and the collision frequency. 5

8. (a) Describe Andrew's experiments on CO_2. Discuss the results obtained. 7

(b) Derive van der Waals equation of state. Compare the van der Waals theoretical isotherms with Andrew's experimental results. 8

Given J = 4.18 Joule cal^{-1}, R = 8.314×10^7 ergs K^{-1} $mole^{-1}$

This question paper contains 4 printed pages]

Roll No. | | | | | | | | | | |

S. No. of Question Paper : 106

Unique Paper Code : 32221303 I

Name of the Paper : Digital Systems and Applications

Name of the Course : B.Sc. (H) Physics CBCS

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 any *four* from the rest.

Attempt *five* questions in all.

(Non-programmable scientific calculators are allowed)

1. Answer any *five* of the following : 3×5

(*a*) Solve 11001 - 11100 using 2's complement method.

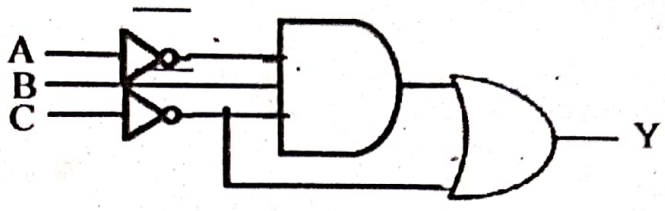
(*b*) Reduce the expression given below using Boolean Algebra

$$AB+\overline{AC}+A\bar{B}C(AB+C)$$

(*c*) What is the function of delay line in a C.R.O. ?

P.T.O.

(*d*) Write Boolean expressions for the following circuit :



(*e*) Define what is SSI, MSI, LSI in an IC.

(*f*) Distinguish between synchronous and asynchronous counter.

(*g*) Define ROM, PROM and EPROM.

(*h*) List any *three* functions which a microprocessor performs.

2. (*a*) Explain with an appropriate logic circuit the working of a 4 bit adder subtractor. 7

(*b*) Simplify the expression using K-Map and draw its logic circuit using NAND gates : 8

$$F = \Sigma m(0, 1, 4, 6, 8, 9, 11) + d(2, 7, 13)$$

3. (*a*) Draw the circuit for a monostable multivibrator using IC555 and explain its operation. Derive an expression for the time period of the output waveform. Give *one* application of monostable multivibrator. 8

(*b*) Draw a labelled block diagram of CRO. What is the function of time-base circuit in CRO. How is the CRO used for frequency determination ? 7

4. (*a*) What are decoders ? Draw and explain the working of a 3 to 8 line decoder. 6

(*b*) Draw the circuit of a 4 bit shift left register with parallel loading and explain its working. 5

(*c*) What do you understand by parity ? Describe a method for generating odd parity. 4

5. (*a*) What is a flip flop ? Explain the working of RS flip flop. How the racing condition is avoided in a J K master slave flip flop ? 8

(*b*) Design an asynchronous decade counter. Explain the working of a ring counter as a periodic switch. 7

6. (*a*) What is the function of the following : 4

(*i*) Program counter

(*ii*) Stack Pointer.

(*b*) Describe different addressing modes available in 8085 microprocessor. Give *one* example of each addressing mode. 5

P.T.O.

(*c*) Describe the various flags used in 8085 microprocessor and show their bit position. What is the mnemonic of an instruction that uses AC flag. 6

7. (*a*) Write a program to add the two hex numbers : A5, 98. Store the sum in memory location 200AH and carry in 200BH. 4

(*b*) Write the classification of instructions for 8085 μP. Explain briefly different instructions of the branch group. 5

(*c*) How is de-multiplexing of address and data buses done in 8085 μP ? Explain with the help of timing diagram. 6

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 1033 **I**

Unique Paper Code : 32225310

Name of the Paper : Waves and Optics

Name of the Course : **Physics – GE for Honours**

Semester : III

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. Question No. **1** is compulsory.
3. **All** questions carry equal marks.

1. Attempt any **five** of the following questions : (5×3=15)

   (a) State essential conditions for obtaining sustained interference pattern.

   (b) What are beats? How are they formed?

   (c) Distinguish between "Fizeau" and "Haidinger" Fringes? Give examples.

P.T.O.

(d) State and explain Huygens Principle of secondary waves.

(e) Distinguish between Fraunhofer and Fresnels' diffraction.

(f) How is a zone plate different from convex lens?

(g) Calculate the change in intensity level when the intensity of sound increases 100 times its original intensity.

2. (a) What are Lissajous figures? (3)

(b) Obtain analytically the shape of Lissajous figures traced out by a particle subjected to two perpendicular simple harmonic motions of equal frequencies, unequal amplitudes and phase differing by (i) zero, (ii) $\pi/4$, (iii) $\pi/2$, (iv) π. (12)

3. (a) Explain the physical characteristics that determine quality, pitch and loudness of a musical sound. (3)

(b) Explain the formation of standing waves on a stretched string with necessary theory. (12)

4. (a) What are Newton's rings? Give the necessary theory for their formation? (10)

(b) How would you use Newton's rings to measure wavelength of light? (5)

5. (a) Derive an expression for intensity of Fraunhoffer diffraction due to a single slit and discuss the intensity pattern. (12)

(b) A light of wavelength 6000 Å is incident on a slit of width 0.30 mm. The screen is placed at a distance of 2 m from the slit. Find the distance between the central maxima and the first minima. (3)

6. Derive an expression for intensity of Fresnel diffraction due to a straight edge and discuss the intensity distribution. (15)

7. (a) What is a Nicol prism? How is it used to obtain polarized light? (10)

(b) How polarized light is obtained by reflection? State and explain Brewster's law. (5)

8. Write short notes on any **three** of the following : (3×5=15)

(a) Fresnel's Biprism

(b) Stoke's treatment

P.T.O.

(c) Michelson's interferometer

(d) Linearity and superposition principle

[This question paper contains 4 printed pages]

Your Roll No. : .....

Sl. No. of Q. Paper : **7499** **IC**

Unique Paper Code : 12031302

Name of the Course : **B.A.(Hons.) English - CBCS**

Name of the Paper : Popular Literature

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 **all** questions.

Section - A

Note : Each question carries **10** marks.

1. The Red Queen in *Through the Looking Glass.*

P.T.O.

OR

The apocalyptic ending of *Through the Look* *Glass.*

2. Discuss the motif of 'Water and Shelter' *Bhimayana.*

OR

Bhimayana presents "conversion" as a alternative for Dalits. Do you agree ?

(For visually challenged students in lieu Bhimayana) :

Write a short notes on any **one** instan describing the discrimination witnessed Ambedkar as a young man.

OR

What were the challenges faced by the childr while travelling in Ambedkar's *Waiting for a Vis*

3. Black Tie.

OR

The role of Caroline in *The Murder of Ro* *Ackroyd.*

Section - B

Note : Each question carries **15** marks.

4. Critically examine how the personal intersects with the political in Selvadurai's *Funny Boy*.

OR

Discuss Selvadurai's *Funny Boy* as a coming-of-age narrative.

5. Critically comment on the narrative technique used by Agatha Christie in *The Murder of Roger Ackroyd*.

OR

In *The Murder of Roger Ackroyd*, Christie destabilises conventional associations between physiognomy, occupation and criminality. Do you agree ?

6. The special attitude to language in *Through the Looking Glass* explains its appeal for an adult readership. Discuss with examples from the text.

OR

Bhimayana reinvents the novel as a medi
narration. Do you agree ? Give a reas
answer .

**(For visually challenged students in li
Bhimayana) :**

Discuss how Ambedkr's *Waiting for A Visa* re
upon caste-based oppresssion
marginalisation.

This question paper contains 4 printed pages.

Your Roll No. .....

Sl. No. of Ques. Paper: **107** I

Unique Paper Code : **32221501**

Name of Paper : **Quantum Mechanics and Applications**

Name of Course : **B.Sc. (Hons.) 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.
Q. No. 1 is compulsory.
All questions carry equal marks.

Non-programmable calculators are allowed.

1. Attempt any *five* of the following:

   (a) State linearity and superposition principle.

   (b) Prove that:

$$[x^n, \hat{p}] = -in\hbar x^{n-1}.$$

   (c) What are stationary states? Why are they called so?

   (d) What are the conditions for a wavefunction to be physically acceptable?

P. T. O.

(e) What do you mean by space quantization? Explain.

(f) Write the quantum numbers for the state represented by:

$$3^2 D_{3/2}.$$

(g) Define group velocity and phase velocity.

$5 \times 3 = 15$

2. (a) Set up the time dependent Schrödinger equation and hence derive the time independent Schrödinger equation.

(b) Derive the expressions for probability density and probability current densities in three dimensions and hence derive the equation of continuity. 7,8

3. (a) Give the theory to explain spreading of a Gaussian wave packet for a free particle in one dimension.

(b) Normalize the following wave function for a particle in one dimension:

$$\begin{cases} A \sin\left(\frac{\pi x}{a}\right) & 0<x<a \\ 0 & \text{outside} \end{cases}$$

10,5

4. (a) Solve the Schrödinger equation for a Linear

Harmonic Oscillator to show that the energy eigenvalues are:

$$E_n = \left(n+\frac{1}{2}\right)\hbar\omega.$$

(b) A Harmonic Oscillator has a wave function which is superposition of its ground state and first excited state normalized eigenfunctions are given by:

$$\Psi(x)=\frac{1}{\sqrt{2}}\,[\psi_0(x)+\psi_1(x)].$$

Find the expectation value of the energy. 10,5

5. Write the Schrödinger equation for a 3D hydrogen atom in spherical polar coordinates. Derive three separate equations for r, θ, φ using the method of separation of variables. Solve the equation for φ to obtain the normalized eigenfunctions and show that they are orthogonal. 15

6. (a) Describe Stern Gerlach experiment with necessary theory. What does it demonstrate?

(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.

P. T. O.

(b) Show the result of an LS coupling of two non-equivalent p-electrons. 10,5

This question paper contains 3 printed pages]

Roll No. | | | | | | | | | | |

S. No. of Question Paper : 108

Unique Paper Code : 32221502 I

Name of the Paper : Solid State Physics

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

Semester : V

Duration : 3 Hours Maximum Marks : 75

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

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*) Draw P-E hysteresis loop for a ferroelectric material. Write mathematical statement of Curie-Weiss law for ferroelectric materials.

(*b*) Differentiate between acoustical and optical phonons.

(*c*) Explain the formation of cooper pair in superconductors.

(*d*) Write the primitive translational vectors of hexagonal lattice.

P.T.O.

(*e*) Show that every reciprocal lattice vector $\vec{G}_{hkl}$ is normal to the plane (*h k l*).

(*f*) Calculate the Hall coefficient of Na based on free electron model. Na has b.c.c structure and side of the cube is 4.28 Å.

(*g*) Draw the variation of total polarizability with frequency of external electric field.

(*h*) What is the difference between Phonon and Plasmon ?

2. (*a*) Derive Bragg's law in the reciprocal lattice. 8

(*b*) In a simple cubic crystal, show that the first order reflection from (n00) planes is equivalent (mathematically) to the *n*th order reflection from (100) plane ? 7

3. (*a*) Derive an expression for the specific heat of a solid on the Debye model and show that, at low temperature, it follows T^3-law. 10

(*b*) Derive the dispersion relation for a linear monoatomic lattice and show that the group velocity and phase velocity of a wave are equal in the long wavelength limit. 5

4. (*a*) Show that the classical paramagnetic susceptibility is given by $\chi = \frac{\mu_0 N}{3kT}\mu^2$, where symbols have their usual meanings. 10

(*b*) How was the classical Langevin's theory of paramagnetism modified by Weiss ? 5

5. (*a*) Derive an expression for the electronic polarizability in a time varying electric field, and hence derive the Cauchy and Sellmeir relations. 12

(*b*) Distinguish between normal and anomalous dispersion ? 3

6. (*a*) Explain the formation of allowed and forbidden energy bands for the motion of an electron in one-dimensional periodic potential in solids. 10

(*b*) Prove that effective mass of electron is given by $m^* = \hbar^2 / (d^2E / d^2k)$. 5

7. (*a*) Explain how the *Meissner-effect* was explained by London. 6

(*b*) What is *Isotope effect* ? 3

(*c*) What do you understand by Piezoelectric effect, Pyroelectric effect & Electrostrictive effect ? 6

8. (*a*) Prove that reciprocal lattice of bcc is fcc and that of fcc is bcc. 10

(*b*) Show that five-fold rotational symmetry does not exist ? 5

This question paper contains 3 printed pages.

Your Roll No. .....

I

Sl. No. of Ques. Paper : **263**

Unique Paper Code : **32223903**

Name of Paper : **Electrical Circuits and Network Skills**

Name of Course : **B.Sc. (Hons.) / B.Sc. (Prog.) : SEC**

Semester : **V**

Duration : **3 hours**

Maximum Marks : **50**

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

Question No. 1 is compulsory.
Attempt five questions in all.
All questions carry equal marks.
Use of Scientific calculators is allowed.

1. Attempt any *five*:

(a) Draw the V-I characteristics for linear and non-linear resistors.

(b) Write two differences between half wave and full wave rectifiers.

(c) Discuss the basic difference between single-phase and three-phase alternating current sources.

(d) Draw electrical symbols for a LED and a Bipolar NPN transistor.

(e) What do you understand by a fuse and MCB?

P. T. O.

(f) What do you mean by 'open' and 'short' in an electrical circuit?

(g) How can a galvanometer be converted into a voltmeter? 2×5

2. (a) Explain the principle, construction and working of AC generator.

(b) Define active and reactive components of ac power. 8,2

3. (a) Explain the construction and working of center tap full wave rectifier.

(b) What is the value of ripple factor for half wave and full wave rectifiers? 8,2

4. (a) Find the expression for impedance of AC sourced R-L circuits.

(b) A 100 Ω resistor and a 2 μF capacitor are connected in series across a 16 V, 1 kHz source. Determine:

(i) Z

(ii) I

(iii) V_R

(iv) Power factor. 6,4

5. (a) Describe the construction and working of transformer.

(b) If phase angle between voltage and current is 30° and active component of AC power is 10 watts, find the apparent power. 7,3

6. (a) Give the comparison between ac and dc transmission of power.

(b) In a circuit, the resistances of star connection are 3 Ω, 4 Ω and 5 Ω. Convert this circuit into equivalent delta connection. 5,5

7. Write short notes on any *two* of the following:

(a) Ladder diagram

(b) Single and three phase AC motor

(c) Different types of conductors and cables

(d) Average power in AC circuit containing capacitor and inductor.

(e) Preparation of extension board. 5,5

This question paper contains 3 printed pages.

Your Roll No. .....

Sl. No. of Ques. Paper: **307** I

Unique Paper Code : **32223904**

Name of Paper : **Basic Instrumentation Skills**

Name of Course : **B.Sc. (Prog.) Physics : SEC**

Semester : **V**

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, including Q. No. 1 which is compulsory.
All questions carry equal marks.

1. Attempt any *five* of the following:

   (a) Two resistors $R_1=36\Omega\pm5\%$ and $R_2=75\Omega\pm5\%$ are connected in series. Find the total resistance.

   (b) What is the function of delay line in CRO?

   (c) What is advantage of using digital instruments over analog instruments?

   (d) What is the significance of Lissajous pattern?

   (e) Write two advantages of DSO over CRO.

   (f) An ammeter of 0–25 A range has a guaranteed accuracy of 1% of full scale reading. The current measured is 5 A. What is the limiting error?

P. T.O.

(g) Why is the use of Maxwell's bridge limited to the measurement of medium Q coils (*i.e.*, $1<Q<10$)?

$5\times2=10$

2. (a) Explain what is precision and sensitivity of an instrument. 5

(b) For a digital multimeter explain the principles of measurement of dc voltage and dc current. 5

3. (a) What is the advantage of electronic voltmeter over conventional voltmeter? 5

(b) Draw a circuit diagram to show how a PMMC instrument can be used as an ac ammeter. Explain its' working. 5

4. (a) Draw the block diagram of basic CRO components. 5

(b) With the help of diagram, explain the front panel controls of a DSO/CRO. 5

5. (a) Explain signal generator with the help of block diagram. 5

(b) What is wave analyser? Explain it using an LC circuit. 5

6. (a) Explain the working principles of basic RLC bridge. 5

(b) What is Q-factor of a circuit? Explain it using a LR circuit. 5

7. (a) What is gating error and time base error in frequency counters? Explain. 5

(b) Explain the loading effect of a multimeter while measuring voltage across a low resistance and /or high resistance. 5

[This question paper contains 4 printed pages]

Your Roll No. : .....

Sl. No. of Q. Paper : **461** **IC**

Unique Paper Code : 42227929

Name of the Course : **B.Sc.(Prog.) : DSE - 3A**

Name of the Paper : Elements of Modern 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 **five** questions in **all.**

(c) Question **NO.1** is compulsory.

1. Answer any **five** of the following : 3×5

(a) For a relativistic massless particle establish

$$E = pc$$

where E is the total energy, p is the momentum and c is the velocity of light.

(b) Enlist three problems of Rutherford's atomic model.

P.T.O.

(c) How does the double-slit experiment establish the wave nature of an electron?

(d) Give the significance of the probability density of a particle.

(e) The wave function for a particle confined in a 1-dimensional box is

$$\psi(x) = A \sin\left(\frac{n\pi x}{L}\right)$$

show that $A = \sqrt{\left(\frac{2}{L}\right)}$

(f) The radius of C^{12} is 3.0×10^{-15} m. Deduce the radius of He^4.

(g) Define work function and threshold frequency in the photoelectric effect.

(h) 1 gram of an unknown radioactive substance X^{226}, disintegrates at the rate of 6.02×10 disintegrations per second. Calculate its mean life.

2. (a) Describe Davisson-Germer experiment and discuss its results.

(b) One of the diffraction peaks observed by Davisson and Germer for a 65 keV electron beam was such that the angle between the incident beam and the scattered beam is 60^0. For what value of crystal spacing is this peak seen in the first order ?

3. (a) Stating Bohr's postulates, obtain the expression for various energy levels of a hydrogen atom. 10

(b) If an electron makes a transition from n = 4 to n = 2, determine the wavelength of emitted radiation. 5

4. (a) What is a wave packet? Prove that the deBroglie wave packet associated with a moving body travels with the same velocity as the body. 10

(b) Estimate the ground state energy of a particle in a one dimensional box of length L using uncertainty principle. 5

5. (a) Obtain the time independent Schrodinger wave equation for a non-relativistic particle. What is the significance of a wave function? Also give the conditions for an acceptable wave function. 10

(b) Correlate operator $\hat{H}$ and $\hat{p}$ to its corresponding physical quantity. 5

6. A particle of mass m and energy $E < V_0$ travelling along x-axis has a potential barrier defined by

$$V(x) = \begin{cases} 0 \ldots\ldots\ldots & x < 0 \\ V_0 \ldots\ldots & 0 < x < a \\ 0 \ldots\ldots\ldots & x > 0 \end{cases}$$

Derive the expressions for reflection and transmission coefficient of the particle. 15

7. (a) Find the size and density of the $^{12}_{6}C$ nucleus. Given $R_0 = 1.2$fm. 5

(b) What is binding energy? Obtain semi empirical binding-energy formula which gives the binding energy of a nucleus in terms of its atomic number Z and mass number A. Give the graph of variation of binding energy/nucleon versus atomic mass number. 10

8. (a) Discuss β-particle spectra in β-decay and hence the concept of neutrino. 10

(b) Complete the following nuclear reactions : 5

$$^{27}_{12}Mg \rightarrow ^{27}_{13}Al + ?? + ??$$

$$^{236}_{94}Pu \rightarrow ^{232}_{92}U + ??$$

$$^{22}_{11}Mg \rightarrow ^{22}_{10}Ne + ?? + ??$$

Constants :

$h = 6.62 \times 10^{-34}$ Js

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

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

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

$m_n = 1.6749 \times 10^{-27}$ kg = 1.00866u

$m_p = 1.6726 \times 10^{-27}$ kg = 1.00728u

$R = 1.097 \times 10^{7}$ m^{-1}

[This question paper contains 4 printed pages]

Your Roll No. : .....

Sl. No. of Q. Paper : **618** I

Unique Paper Code : 32227502

Name of the Course : **B.Sc.(Hons.) Physics : DSE - I**

Name of the Paper : Advanced Mathematical 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 in all taking at least **two** questions from each section.

(c) **All** questions carry equal marks.

(d) Attend **all** parts of each question together.

Section - A

1. (a) Determine whether the identity element exist or not for the binary operation * defined as: $a * b = a^b$ 4

P.T.O.

(b) Let $T : R^3 \to R^3$ be defined by

$T(x, y, z) = (x+y-2z, x+2y+z, 2x+2y-3z)$.

Show that T is a non-singular transformation. 5

(c) Linear transformation T on R^2 is defined as :

$$T(x, y) = (3x - 4y, x + 5y)$$ 6

Find the matrix representation of T relative to the u-basis :

$$\{u_1 = (1, 3) \text{ and } u_2 = (2, 5)\}.$$

2. (a) Determine whether (1, 2, 5) ; (2, 5, 1) ; (1, 5, 2) are linearly dependent or not. 5

(b) Consider the following subspace of R^4 :

$W = \{(a, b, c, d) : a + b = 0, c = 2d\}$

Find the dimension and basis of W. 2,3

(c) Assume that A, $I - A$, $I - A^{-1}$ are all non-singular matrices, show that : 5

$$(I - A)^{-1} + (I - A^{-1})^{-1} = I.$$

3. (a) Given a matrix $A = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}$, prove that its eigenvalue equation is given by

$$\lambda^2 - \lambda Tr(A) + \det(A) = 0.$$ 5

(b) If $B = \begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix}$, prove that :

$$e^{\theta B} = \begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix}.$$ 10

2

4. (a) Find the condition for the following matrix to be orthogonal : 7

$$\begin{bmatrix} a+b & b-a \\ a-b & a+b \end{bmatrix}.$$

(b) Evaluate C^{20}, where $C = \begin{bmatrix} -1 & 3 \\ 1 & 1 \end{bmatrix}$. 8

Section - B

5. (a) Show that every second order tensor can be expressed as a sum of symmetric and skew-symmetric tensor. 3

(b) Prove that $\left(\vec{A}\times\vec{B}\right)\times\vec{C} = \vec{B}\left(\vec{A}\cdot\vec{C}\right) - \vec{A}\left(\vec{B}\cdot\vec{C}\right)$, using tensors. 7

(c) Given a vector $\vec{A} = (x\ ,\ x+y\ ,\ x+y+z)$.

Find the matrix elements of the second order skew-symmetric tensor associated with it. 5

6. (a) Prove that $\in_{ijk}$ is an isotropic tensor of order three. 3

(b) Prove that :

$$\vec{\nabla}\cdot\left(\vec{A}\times\vec{B}\right) = \left(\vec{\nabla}\times\vec{A}\right)\cdot\vec{B} - \left(\vec{\nabla}\times\vec{B}\right)\cdot\vec{A} \qquad 7$$

(c) Using tensors, show that scalar product of two vectors is invariant. 5

7. (a) Stress tensor (p_{ij}) satisfies the equations $p_{ij} \in_{ijk} = 0$ and $p_{ij} = f_i n_j$, where f_k is the restoring force per unit area across the plane along x_k-axis and $\hat{n}$ is the unit vector normal to that surface. Prove that stress tensor is a symmetric tensor of order two. 7

(b) Stress tensor and strain tensor are related as

$$p_{ij} = \omega_{ijks} e_{ks},$$

where, elastic tensor ω_{ijks} is symmetric in i, j and k, s and its general form is

$$\omega_{ijks} = \lambda\delta_{ij}\delta_{ks} + \mu\delta_{ik}\delta_{js} + \gamma\ \delta_{is}\delta_{jk} ..$$

Prove that :

(i) $\omega_{ijks} = \lambda\delta_{ij}\delta_{ks} + \mu\left(\delta_{ik}\delta_{js} + \gamma_{is}\delta_{jk}\right)$

(ii) $P_{ii} = (3\lambda + 2\mu)e_{ii}$ 4,4

8. (a) A covariant tensor has components xy, $2y - z^2$, xz in cartesian co-ordinates. Find its covariant components in cylindrical co-ordinates. 10

(b) Prove that g^{jk} is a symmetric contravariant tensor of order two. 5

This question paper contains 4 printed pages.

Your Roll No. .....

S. No. of Paper	: **764** **I**
Unique Paper Code	: **32227504**
Name of the Paper	: **Nuclear and Particle Physics**
Name of the Course	: **B.Sc. (H) Physics : DSE-2**
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 **four** questions from the remaining set of questions. Use of scientific calculator is permitted.*

1. Attempt any *five* questions:

(a) Calculate the Fermi energy, Fermi momentum and the well depth of a nucleus with $N = Z = A/2$.

(b) What isospin value is expected from an even mass nuclide (Z, N) ?

(c) Why do unstable nuclei emit alpha particles and not protons or neutrons?

(d) Define separation energy for neutrons.

(e) Give the Lepton and Baryon numbers for electrons, protons, neutrons and positrons.

(f) What is meant by the saturation of nuclear forces?

$3 \times 5 = 15$

P. T. O.

2. (a) Find the most stable isobar for A = 57 using the liquid drop model. Assume the constants as a_1 = 14 MeV, a_2 = 13 MeV, a_3 = 0.59 MeV, a_4 = 19 MeV, a_5 = $(\pm, 0)$ 33.5 MeV where a_1 is the volume constant, a_2 is the surface energy constant, a_3, a_4, a_5 are respectively coulombic, asymmetric and pairing constants. Do not derive the semi-empirical mass formula.

(b) Thermal neutrons are captured by $^{10}B_5$ to form $^{11}B_5$ which decays by α-particle emission to $^{7}_{3}Li$. Calculate:

(i) The Q value of the decay in MeV.

(ii) The kinetic energy of the α-particles in MeV.

8,7

3. (a) Determine the applied voltage required to operate a proportional counter with a maximum radial field of 10^6 Vm^{-1}. The radius of the wire and tube are respectively 0.003 cm and 1 cm.

(b) The alpha particles emitted in the decay of $^{219}_{86}Ru$ have energies 6.82 MeV, 6.55 MeV and 6.43 MeV. Determine the energies of gamma rays emitted by the daughter nuclei.

(c) Give three characteristics of nuclear forces. 5,5,5

4. (a) In an absorption experiment with 1.14 MeV γ radiation from $^{65}_{30}Zn$, it is found that the intensity of radiation is reduced to 2% when it passes through 25 cm of aluminium. Determine the mass absorption coefficient of aluminium for this radiation. Density of aluminium is 2700 kg/m^3 and $M(^{26}_{13}Al) = 26.9815$.

(b) Calculate the binding energy per nucleon for $^{56}_{26}Fe$ and compare this with the value of the proton separation energy. Given $M(^{56}_{26}Fe)=55.934939$ u, $M(^{55}_{25}Mn)=54.938046$ u.

(c) Find the height of the Coulomb barrier between an alpha particle and daughter nucleus $^{A}_{Z}D$, assuming that the nuclear potential has a sharp edge at a radius of $1.4\ A^{1/3}$ fm. 5,5,5

5. (a) Using the quark model draw the Baryon octet. State the quantum number of all the particles in the octet.

(b) Give the principle of a linear accelerator.

(c) A cyclotron, in which the transverse magnetic flux density is 1.5 weber/m^2, is used to accelerate protons. Determine the frequency of the source. 7,4,4

6. (a) What are the advantages of a GM counter over the ionization chamber for radiation detection?

(b) Give *two* differences between direct and compound nuclear reactions.

(c) Indicate giving reasons if the following reactions proceed through the weak, strong or electromagnetic interactions or they do not occur:

(i) $\pi^0 \rightarrow \gamma + \gamma$

(iii) $e^+ + e^- \rightarrow \mu^+ + \mu^-$ 5,5,5

P. T. O.

7. (a) What is Cerenkov radiation? Calculate the thresh velocity for electrons to produce this radiation whe travels through a medium of refractive index 1.6.

(b) Alpha particles and deuterons are accelerated un identical conditions in a cyclotron. The extract beam of these particles is passed through an absorb What is the ratio of the range of alpha particle to range of the deuteron?

(c) Using the uncertainty principle, estimate the energy required for a proton to be a part of the nucleus.

5,5,5

USEFUL DATA:

$M(^{11}_{5}B) = 11.0119305$ u ; $M(^{1}_{1}H)=1.007825$ u ; Mass of a neutron=1.008665 u; $M(^{7}_{3}Li) = 7.016004$ u; $M(^{4}_{2}He) = 4.002603$ u.