

19-12-22

10.30 am

Deccan Education Society's
FERGUSON COLLEGE (Autonomous) Pune-4
Affiliated to Savitribai Phule Pune University
FYBSc (Semester: I)
Subject: Physics
Paper Title: Mechanics and Properties of Matter
Paper Code: PHY1101
2019 Pattern (2 Credits)

[Time: 2.5 Hours]

[Max. Marks : 50]

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Neat diagrams must be drawn wherever necessary.
- 3) Figures to the right side indicate full marks.
- 4) Use of logarithmic tables and scientific calculators are allowed

Que 1: Attempt any **five** of the following (2 M each)

- a. Write the formula for moment of inertia of a circular ring of mass M and radius R about a tangent perpendicular to its plane.
- b. State the working principle of gyroscope.
- c. If radius of circular orbit of a planet around a star is doubled what will happen to its period of revolution.
- d. What do you mean by the term "compressibility" in fluids?
- e. How does an external pressure and temperature affect the viscosity of fluids?
- f. Define the term 'Elastic Hysteresis'.
- g. State the difference between streamline flow and turbulent flow.

Que 2. Attempt any **five** of the following (3 M each)

- a. Elaborate briefly three Kepler's laws of planetary motion.
- b. The mass of the planet Venus is 0.814 times that of the earth (5.98×10^{24} kg) and its radius is equal to 0.967 of that of the earth (6.38×10^6 m). Calculate the velocity of escape from it. Given $G = 6.67 \times 10^{-11} \text{ N-m}^2/\text{kg}^2$.
- c. If four particles of mass 3 Kg each are sitting on vertices of a square of 2 m, find magnitude of resultant gravitational force on any one of them because of the other masses.
- d. The inter-molecular distance between two atoms of Hydrogen (H_2) molecule is $0.77 \text{ \AA}$ and the mass of H-atom is 1.67×10^{-27} Kg. Calculate the moment of inertia of H_2 molecule.
- e. A wire of area of cross-section 3 mm^2 and original length 50 cm is fixed at one end and mass of 2.1 kg is hung from the other end. Find the elastic potential energy store in the wire. Given Young's modulus of wire, $Y = 1.9 \times 10^{11} \text{ N/m}^2$ and acceleration due to gravity, $g = 9.81 \text{ m/s}^2$.

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- f. Obtain the equation of flow rate of fluid through Venturimeter.
- g. A capillary tube of 0.5 mm bore stands vertically in a wide vessel containing a liquid of surface tension 0.03 N/m. The liquid wets the tube and has density $0.8 \times 10^3 \text{ kg/m}^3$ and acceleration due to gravity of 9.81 m/s^2 . Calculate the rise of liquid in the tube.

Que 3: Attempt any **five** of the following (5 M each)

- a.) A flywheel which can turn about horizontal axis is set in motion by a 2 kg weight hanging from a thin string that passes round the axle held in position at height of 100 cm. After the wheel has made 1 revolution, the string is detached from the axle and the weight drops off. Then wheel makes 20 revolutions in 8 sec before being to rest by friction. The radius of the axle is 1 cm. Assuming the work done against friction in each revolution is always the same, calculate the moment of Inertia of the flywheel about its axel.
 - b.) How much energy is required to lift the 9000 kg Suyoz-vehicle from the Earth's surface to the height 400 km above the surface? Given that the mass of the Earth = $5.98 \times 10^{24} \text{ kg}$ and its radius = $6.37 \times 10^6 \text{ m}$. (Gravitational constant, $G = 6.67 \times 10^{-11} \text{ N m}^2/\text{kg}^2$)
 - c.) Calculate moment of inertia of a solid sphere of mass M and radius R about a chord whose perpendicular distance from center of sphere is $\frac{3}{5} R$ (Hint: use expression for M.I. of sphere about its diameter)
 - d.) A bar of length 1 cm, breadth 1.2 cm and depth 1.4 cm is clamped horizontally at one end and a weight of 2 Kg is applied at the other end. Neglecting the weight of the bar calculate depression of the loaded end if Young's modulus of the material of the rod is $Y = 9.78 \times 10^8 \text{ N/m}^2$ and acceleration due to gravity, $g = 9.81 \text{ m/s}^2$.
 - e.) Derive an expression which shows the relationship between Young's modulus, Bulk modulus and Poisson's ratio.
 - f.) Derive a Poiseuille's equation for a flow of liquid through horizontal capillary tube.
 - g.) Calculate the length of the wire that will break under its own weight when suspended vertically. Given- breaking stress = $9.8 \times 10^8 \text{ N/m}^2$, density of wire = 10^4 Kg/m^3 and acceleration due to gravity $g = 9.8 \text{ m/s}^2$.
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28/11/2022

2:30 pm

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Deccan Education Society's
FERGUSON COLLEGE (Autonomous) Pune-4
Affiliated to Savitribai Phule Pune University

F.Y.B.Sc. (Semester : I)
Subject: Physics
Paper Title: Mechanics and Properties of matter
Paper Code: PHY1101
2019 Pattern (2 Credits)

[Time: 2:30 Hours]

[Max. Marks : 50]

Instructions to the candidates:

- All questions are compulsory.
 - Draw neat and labelled diagrams wherever necessary.
 - Figures to the right indicate full marks.
 - Use of logarithmic tables and pocket calculators is allowed.
-

1. Answer the following questions (Any Five).

[2 × 5] M

- a) State perpendicular axis theorem.
- b) State Newton's law of gravitation and write dimension of gravitational constant.
- c) If modulus of rigidity $\eta = 8 \times 10^{11} \text{ N/m}^2$ and Young's modulus $Y = 20 \times 10^{11} \text{ N/m}^2$ for iron, calculate its Poisson's ratio.
- d) Define intensity of gravitational field.
- e) State Newton's law of viscous flow of a fluid. What is co-efficient of viscosity?
- f) Calculate radius of gyration of a solid sphere rotating about its diameter if its radius is 6 cm.
- g) What is the critical velocity of a fluid? Write the formula for critical velocity..

2. Answer the following questions (Any Five).

[3 × 5] M

- a) What is the magnitude of gravitational field intensity at a point in a gravitational field where a mass of 3 Kg experiences a force of 5 N due to the field.

- b) The flat surface of a hemisphere of radius r is cemented to one flat surface of a cylinder of radius r and length L . If the total mass is M , then find the moment of inertia of a combination about the axis of the cylinder.
- c) Calculate the self energy of the sun, taking its mass to be equal to 2×10^{30} Kg and its radius to be very nearly 7×10^8 metre. ($G = 6.67 \times 10^{-11}$ N-m/kg²).
- d) Find the greatest length of the wire that can hang vertically without breaking. Breaking stress for steel = 7.9×10^9 dynes/sq.cm. Density of steel = 7.9 gm/c.c.
- e) In an experiment the diameter of the rod was 1.26 cm and distance between the knife edges 0.7 m. On putting a load of 0.9 kg at the mid-point, the depression was 0.025 cm. Find the Young's modulus of elasticity of the material rod.
- f) A gas bubble of diameter 2 cm rises steadily through a solution of density 1.75 gm/cc at the rate of 0.35 cm/sec. Calculate the coefficient of viscosity of the solution. (Neglect density of the gas)
- g) A hollow steel sphere has its inner and outer radii 5 cm and 12 cm respectively. Calculate its moment of inertia about a diameter. Density of steel is 7.8×10^3 kgm⁻³.

3. Answer the following questions (Any Five).

[5 × 5] M

- a) Derive the expression for the moment of inertia of a spherical shell about its diameter.
- b) State and prove Bernoulli's principle. Explain its application in lifting airplanes.
- c) What is a gyrostat? Explain its working and mention some of its applications.
- d) Explain the method of determination of Y (Young's modulus) by bending of a uniformly loaded beam.
- e) Explain streamline flow and turbulent flow. What should be the value of Reynolds number for the flow to be turbulent?
- f) Obtain expression for moment of inertia of annular ring of mass M and inner and outer radii r and R respectively.
- g) Obtain the expression for gravitational self energy of a galaxy.

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2:30pm

Deccan Education Society's
FERGUSON COLLEGE (Autonomous) Pune-4

F. Y. B. Sc., Semester : I

PHYSICS

PHY1102: Heat and Thermodynamics

2019 Pattern (2 Credits)

Time: 2 Hours 30 minutes

Max. Marks : 50

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Draw neat and labelled diagrams wherever necessary.
- 3) Figures to the right indicate maximum marks.

Q1 Answer ANY FIVE of the following.

2×5=10

- a) A Carnot's engine absorbs 10^4 calories of heat from a reservoir at 627°C and rejects heat to a sink at 27°C . What is the efficiency? How much work does it perform? (1 calorie = 4.2 joule).
- b) Define: i) critical temperature and ii) critical pressure.
- c) What are Virial coefficients?
- d) Define the coefficient of performance.
- e) Find the efficiency of the Carnot's engine working between the steam point and the ice point.
- f) Calculate the change in entropy when 20 gm of ice at 0°C is converted into water at the same temperature. (Latent heat of ice = 80 cal/gm)
- g) Find the temperature on Fahrenheit scale corresponding to -40°C .

Q2 Answer ANY FIVE of the following.

3×5=15

- a) Calculate the work done when one mole of an ideal gas expands isothermally at 27°C to double its original volume. ($R=8.3\text{ J/K mol}$)
- b) A thermocouple with test junction at $t^\circ\text{C}$ on gas thermometer scale and reference junction at ice point gives emf as, $E = 0.25t - 5 \times 10^{-4}t^2\text{mV}$, The millivoltmeter is calibrated at ice and steam points. What is the reading on this thermometer when the gas thermometer reads 60°C ?
- c) Find the change in entropy in van der Waal's equation of state.
- d) What are essential requisites of good thermometer?
- e) State the first law of thermodynamics and give its physical importance.

- f) Differentiate between Diesel engine and Otto engine.
- g) One-gram molecule of a monatomic ($\gamma = 5/3$) perfect gas at 27°C is adiabatically compressed in a reversible process from an initial pressure of 1 atmosphere to a final pressure of 50 atmosphere. Calculate the resulting difference in temperature.

Q3 Answer ANY FIVE of the following.

5×5=25

- a) Derive the expression for Clausius- Clapeyron first equation. Explain its importance.
 - b) Explain the construction and working of the gas filled thermometer.
 - c) Derive an expression for efficiency of a Diesel engine.
 - d) When lead is melted at atmospheric pressure, (the melting point is 600 K), the density decreases from 11.01 to 10.65 gm/cm³ and the latent heat of fusion is 34.5 J/gm. What is the melting point at a pressure of 100 atmospheres?
 - e) Derive an expression for critical constants P_c , V_c , T_c and show that for gas obeying van der Waals equation, $\frac{RT_c}{P_c V_c} = \frac{8}{3}$.
 - f) Describe a Carnot's engine and show that its efficiency is a function of working temperature only.
 - g) Prove that for an ideal gas, during adiabatic process:
 - i. $PV^\gamma = \text{constant}$
 - ii. $TV^{\gamma-1} = \text{constant}$
 - iii. $\frac{P^{\gamma-1}}{T^\gamma} = \text{constant}$
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14/11/2022 O/C

Deccan Education Society's
Fergusson College (Autonomous) Pune 411004

F. Y. B. Sc. Semester II

Physics Paper I

PHY1201 : Introduction to Mathematical Physics

Time : 2:30 Hours

Maximum Marks 50

Instructions to Candidates:

- a) All questions are compulsory.
- b) Figures to the right indicate full marks
- c) Use of log table and calculator is permitted.

Question1. Answer any five.

10 marks

- a) What is complex plane?
- b) Using Euler's Formula show that $\cos(\theta) = \frac{e^{i\theta} + e^{-i\theta}}{2}$.
- c) For complex number $z = 7 + i8$, find mod z .
- d) Define partial differential equation.
- e) Show that $dF = (y^2 + y + 2xy)dx + (x^2 + x + 2xy)dy$ is exact differential equation.
- f) Define the gradient of scalar field.
- g) Prove that $\sinh(i\theta) = i \sin(\theta)$

Question 2. Answer any five.

15 marks

- a) Express the complex number $3+4i$ into (i) polar and (ii) exponential form.
- b) If $F = f(x,y) = 2x^3y + y^3$ find $\frac{\partial f}{\partial x}, \frac{\partial f}{\partial y}, \frac{\partial^2 f}{\partial x^2}, \frac{\partial^2 f}{\partial y^2}$.
- c) If $z = x + iy$, interpret the equation geometrically: $|z + 3| = 2|z - 3|$.
- d) Find the unit vector normal to the surface $x^2 + 3y^2 + 2z^2 = 6$ at point $(2,0,1)$
- e) If $\phi = 3x^2y + y^3z^2$, find grad ϕ at $(2,2,2)$.

- f) Draw a neat label circuit diagram for growth of current in an inductive RC circuit. Derive the equation for the same.
- g) What do you mean by implicit and explicit function?

Question 3. Answer any five.

25 marks

- a) If $z = \frac{1 + \sqrt{3}i}{2}$ find the value of z^3 .
- b) Show that the curl of gradient of scalar field $\phi = 0$.
- c) Show that $\vec{\nabla} \times (\phi \vec{A}) = \phi (\vec{\nabla} \times \vec{A}) + (\nabla \phi) \times \vec{A}$
- d) With neat diagram explain the physical significance of curl of a vector field.
- e) If $u = x + y + z$, $v = x^2 + y^2 + z^2$ and $w = xy + yz + zx$ prove that grad u , grad v and grad w are coplanar vectors.
- f) Using Argand diagram explain subtraction of two complex numbers.
- g) Prove that $\text{grad}(\phi + \psi) = \text{grad}(\phi) + \text{grad}(\psi)$

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Deccan Education Society's
FERGUSON COLLEGE (Autonomous) Pune-4
F.Y. B.Sc, Semester: II

PHYSICS
Electricity and Magnetism (PHY1202)
(2019 Pattern) (2 Credits)

Time: 2 hours 30 mins

Max. Marks: 50

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Draw neat and labelled diagrams wherever necessary.
- 3) Figures to the right indicate full marks.
- 4) Use of logarithmic tables and pocket calculators is allowed.

Q.1 Attempt ANY FIVE of the following questions. (2 x 5 = 10)

- a) Classify the following given molecules into polar and non-polar molecules CH_4 , CCl_4 , C_6H_6 , H_2O , $\text{C}_6\text{H}_5\text{Cl}$ and CS_2 .
- b) What is the maximum allowed value of resistance in LCR circuit for oscillatory charge?
- c) Why permanent magnets can not be made from paramagnetic substances?
- d) Define the dielectric constant of a material.
- e) What is meaning of time constant in LR circuit?
- f) Draw waveform of voltage and current in AC RC circuit.
- g) Why power factor for inductor and capacitor is zero?

Q.2 Attempt ANY FIVE of the following questions. (3 x 5 = 15)

- a) A charge of $4 \times 10^{-8} \text{ C}$ is distributed uniformly on the surface of a sphere of radius 1cm. Find the electric field at a point 2cm away from the centre.
- b) A parallel plate capacitor is formed by two plates, each of area 100 cm^2 , separated by distance 1mm. A dielectric material of dielectric constant 5 and dielectric strength $1.9 \times 10^7 \text{ Vm}^{-1}$ is filled between the plates. Find the maximum charge that can be stored on the capacitor without causing any dielectric breakdown.
- c) A long solenoid is formed by winding 40 turns per cm. What current is necessary to produce a magnetic field of 40mT inside the solenoid?
- d) The maximum value of permeability of an alloy is 0.126 TmA^{-1} . Find maximum relative permeability and susceptibility.
(Given $\mu_0 = 4\pi \times 10^{-7} \text{ TmA}^{-1}$)
- e) An LCR series circuit with $L=100\text{mH}$, $C=100\mu\text{F}$, $R=120\Omega$ is connected to AC source of emf $E=(30\text{V}) \sin(100\text{sec}^{-1})t$. Find the resonant frequency of the circuit.
- f) A resistor with resistance $10\text{M}\Omega$ is connected in series with a capacitor of capacitance $1 \mu\text{F}$ and a battery with emf 12 V. Before the switch is closed at $t=0$, The capacitor is uncharged.
 1. What is time constant?
 2. What fraction of final charge is there on plate at time $t=46 \text{ sec}$?

- g) The minimum capacitance of a variable capacitor in a radio is $4.18\mu\text{F}$. What is inductance of coil to be connected to this capacitor to get frequency of LC circuit 1600KHz ?

Q.3

Attempt ANY FIVE of the following questions. (5 x 5 = 25)

- a) Determine the electric field due to an uniformly charged non-conducting sphere with radius R , as a function of distance r .
- b) Derive Gauss's law for dielectrics.
- c) Derive the equation of discharging of a capacitor through an inductor in a series LC circuit.
- d) A coil of resistance 60 ohm and inductance 3 henry is connected in series with a condenser of $4\mu\text{F}$ and an ac supply of 200V , 50 cps . Calculate i) The impedance in the circuit, ii) The phase difference between current and voltage, iii) The potential difference across the inductance coil, iv) The p.d. across the capacitor. Give the vector diagram for the current and p.d. acting across the components of the circuit.
- e) What is a solenoid? Determine the magnetic field at a point inside the solenoid.
- f) An inductor of 3H and resistance 6Ω is connected to the terminals of a battery of emf 12V and of negligible internal resistance. Calculate
i) The initial rate of increase of current in the circuit,
ii) The rate of increase of current at the instant when the current in the circuit is 1A ,
iii) The instantaneous value of current 0.2sec after the circuit is closed
iv) The final steady state current
v) The power input to the inductor at the instant when the current is 0.5A .
- g) Compare diamagnetic, paramagnetic and ferromagnetic materials.
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Deccan Education Society's

Fergusson College (Autonomous) Pune-4

S.Y.B.Sc. (Physics)

Semester III

Oscillations, Waves and Sound (PHY-2301)

(Paper-1) (2016 Pattern)

Time: 2Hours

Max Marks:50

Instructions: a) All questions are compulsory and carry equal marks.

b) Neat and labelled diagrams must be drawn wherever necessary.

c) Figures to right indicate full marks.

d) Use of non-programmable calculator is allowed.

Q.1 Answer Any Five of the following questions:

(2×5=10 marks)

a) What is reverberation time?

b) Define Energy density of wave .Give its S.I. unit.

c) What is meant by half-width of resonance curve? On which factors half width depends?

d) A capacitor of $0.4\mu\text{F}$, an inductor of 80 mH and a resistor of 400 ohms are joined in series. Can the electrical circuit be oscillatory?

e) Define linear simple harmonic motion.

f) Distinguish between forced oscillations and damped oscillations.

g) The equation of longitudinal wave motion is expressed by $y = y_0 \sin 2\pi(0.1x - 34t)$. Where x and t are measured in metres and seconds respectively. Find the wave velocity.

Q.2 Answer Any Five of the following questions:

(3×5=15 marks)

a) A particle of mass 0.2 Kg moves simple harmonically according to the law $x = 0.08 \sin(20\pi t + \pi/4)$. Find the velocity of the particle, its acceleration and the acting force as well as amplitudes of respective quantities.

b) Write note on: Logarithmic decrement. Show that ratio of successive amplitude is constant.

c) An alternating emf of peak value 200 volt is applied across the series combination of an inductor of inductance 20 mH , a capacitor of capacitance $2\text{ }\mu\text{F}$ and resistance of $50\text{ }\Omega$. Determine resonant frequency, quality factor and bandwidth.

d) A fixed source emits sound of frequency 1000 Hz . What is the frequency as heard by the listener.

(i) at rest (ii) moving towards the source at constant speed of 20 m/s and (iii) moving away from the source at the same rate (at constant speed of 20 m/s).

e) What is Intensity of wave? Show that intensity of wave at a point is directly proportional to the square of the amplitude of a particle situated at the point.

f) Discuss the phenomenon of sharpness of resonance and show how it depends on the damping factor.

g) For damped harmonic oscillator, its amplitude reduced to $(1/10)^{\text{th}}$ of its value after 100 oscillations. If its time period be 1.15 second, calculate the damping constant $(R/2M)$. If the observed value of the 1st amplitude of the oscillator be 2 cm, what would be its value in the absence of damping?

Q.3 Answer Any Five of following questions:

(5×5=25 marks)

a) Derive the general equation for path of a particle for composition of two mutually perpendicular SHMs in the frequency ratio 1:2.

What will be the resultant motion of the particle when (1) $\phi=0$ or $\phi=\pi$. (2) when $\phi=\pi/2$, $\sin\phi=1$. Also represent its motion diagrammatically.

b) A body of mass 2Kg executes damped SHM under a restoring force 10 N/m and a damping force 4N/m sec^{-1} . Find the displacement time equation if the initial displacement is 4m and initial velocity is -4m/sec .

c) Explain in detail power and Bandwidth of forced oscillations.

d) Derive the expression for differential equation of a transverse wave. Give expression for velocity of transverse wave on the string.

e) Explain Doppler effect in light. If source of light moving away from stationary observer, what will be the change in wavelength $(d\lambda)=?$

f) What is blue shift and red shift? What is their significance?

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Deccan Education Society's
FERGUSSON COLLEGE (Autonomous) Pune-4
S.Y. B.Sc, Semester: III

PHYSICS
Principles and Applications of Optics (PHY2302)
(2019 Pattern) (2 Credits)

Time: 2 hours 30 mins

Max. Marks: 50

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Draw neat and labelled diagrams wherever necessary.
- 3) Figures to the right indicate full marks.
- 4) Use of logarithmic tables and pocket calculators is allowed.

Q.1 Attempt ANY FIVE of the following questions. (2 x 5 = 10)

- a) What is relation between optical path difference and geometrical path difference?
- b) Why Newton's rings are circular?
- c) In nonreflecting single layer of a lens coating is to be done on the lens of refractive index 1.78. Determine the refractive index of coating material required to produce zero reflection of light for light of wavelength 550nm.
- d) Due to which phenomenon resolving power of an optical instrument is limited?
- e) What is Zone plate?
- f) Write one application of Brewster's law.
- g) A dot is marked on a white paper and viewed through calcite crystal from the top. How many images are expected to be seen and why?

Q.2 Attempt ANY FIVE of the following questions. (3 x 5 = 15)

- a) If in a Newton's ring arrangement, the air is replaced by a liquid of refractive index 1.3, in what proportion would the diameters of the ring changes?
- b) In an experiment with Michelson interferometer the micrometer readings for maximum contrast were found to be 0.6939mm and 0.9884mm. If the mean wavelength for the two components of the line be $5893\text{\AA}$, determine the difference between the two wavelengths.

- c) A collimated beam of mercury light at 546.1nm is normally incident on a slit 0.015 cm wide. Lens of focal length 60cm is placed behind the slit. A diffraction pattern is formed on a screen placed in the focal plane of the lens. Determine the distance between the central maxima and first minima.
- d) Calculate resolving power of a telescope whose objective lens has a diameter of 508 cm and wavelength 6000 Å.
- e) Zone plate has the radius of first ring 0.05cm if plane waves 5000 Å falls on the plate where should the screen be placed so that the light is focused to a bright spot?
- f) Light of wavelength 580 nm is incident on a slit having a width of 0.300 mm. The viewing screen is 2.00 m from the slit. Find the width of the central bright fringe.
- g) Two polarizing plates have polarizing directions parallel so as to transmit maximum intensity of light. Through what angle must either plate be turned if the intensity of transmitted beam is one third of the intensity of incident beam.

Q.3 Attempt ANY FIVE of the following questions. (5 x 5 = 25)

- a) How Michelson interferometer is used to determine the separation between two wavelengths very close together? Explain.
- b) A beam of monochromatic light of wavelength 5.82×10^{-7} m falls normally on a wedge film with the wedge angle 20 arc seconds. If the refractive index of glass is 1.5, find the number of dark fringe per cm of wedge length.
- c) Intensity distribution of diffraction pattern due to double slit ,each slit of width 'a' separated by 'd=3a' is given by

$$I = 4I_0 \frac{\sin^2 \alpha}{\alpha^2} \cos^2 \beta$$
 where I_0 is intensity and $\alpha = \frac{\pi a \sin \theta}{\lambda}$, $\beta = \frac{\pi d \sin \theta}{\lambda}$ are diffraction parameters, λ is wavelength of incident light. Plot the intensity distribution.
- d) What are half period zones? Determine the amplitude due to large wavefront at a point in front.
- e) How circularly polarized light can be analysed?
- f) Obtain condition for constructive and destructive interference of light transmitted from uniform thickness film.
- g) Obtain expression for thickness of QWP and HWP in terms of wavelength of incident light and refractive indices of E ray and O ray. Calculate the thickness of a half wave plate and quarter wave plate for light of wavelength 600nm. (Given $\mu_e = 1.544$ and $\mu_o = 1.533$).

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Deccan Education Society's
FERGUSON COLLEGE (Autonomous) Pune-4
S.Y.B.Sc, Semester-IV

PHYSICS
Introductory Quantum Physics and Special Theory of Relativity
(PHY2401)
(2019 Pattern) (2 Credits)

Time: 2 hours 30 mins

Max. Marks: 50

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Draw neat and labelled diagrams wherever necessary.
- 3) Figures to the right indicate full marks.
- 4) Use of logarithmic tables and pocket calculators is allowed.
- 5) mass of electron = 9.11×10^{-31} kg, charge of electron = 1.6×10^{-19} C and Planck's constant = 6.62×10^{-34} J.s.

Q.1 Attempt ANY FIVE of the following questions. (2 x 5 = 10)

- a) Write Einstein's postulates of special theory of relativity.
- b) Write Heisenberg's Uncertainty principle.
- c) What are quarks?
- d) Define black body radiation.
- e) Calculate the de-Broglie wavelength of an electron moving with a kinetic energy of 10 eV.
- f) What are bosons?
- g) Explain in short, pair production.

Q.2 Attempt ANY FIVE of the following questions. (3 x 5 = 15)

- a) X-rays of wavelength 10.0 pm are scattered from a target.
 - i) Find the wavelength of the x-rays scattered through 45° .
 - ii) Find the maximum wavelength present in the scattered x-rays.
 - iii) Find the maximum kinetic energy of the recoil electrons.
- b) Show that pair production cannot occur in empty space.
- c) Derive the formula for time dilation using the inverse Lorentz transformation.

- d) A certain particle has a lifetime of 10^{-7} s when measured at rest. How far does it go before decaying if it's speed is $0.99c$ when it is created?
- e) A hydrogen atom is 5.3×10^{-11} m in radius. Use the uncertainty principle to estimate the minimum energy an electron can have in its atom.
- f) Write the classification of elementary particles.
- g) Show that $\Delta L \Delta \theta \geq \hbar/2$ and $\Delta E \Delta t \geq \hbar/2$

Q.3 Attempt ANY FIVE of the following questions. (5 x 5 = 25)

- a) Describe the Michelson Morley experiment and explain the physical significance of negative result.
- b) Explain in brief discoveries of an electron, proton and neutron.
- c) Explain the working of an electron microscope.
- d) Discuss in detail the Y-ray microscope to illustrate the uncertainty principle.
- e) What is Compton effect? Explain the experimental verification of Compton theory.
- f) Calculate the glancing angle at which an electron of energy 100 eV must be incident on the lattice planes of the metal crystal to give a strong Bragg reflection in the first order.
Use the following data:
Lattice spacing = $2.15 \text{ \AA}$, mass of electron = 9.11×10^{-31} kg,
electron charge = 1.6×10^{-19} C and Planck's constant = 6.62×10^{-34} Js.
- g) Two twins Dick and Jane, each of 20 years age, Dick is at rest and Jane takes a round trip space voyage to a star with a velocity $0.98c$ relative to Dick. Star is 15 light years distant from earth. Determine the age of Dick and Jane after Jane finishes her journey.

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Deccan Education Society's
Fergusson College (Autonomous), Pune-4
End Semester Examination (ESE)
S. Y. B. Sc. (Physics) Semester IV (2016 Pattern)
Paper I: PHY 2401: Introductory Quantum Physics and Relativity

Time: 2 Hrs

Max. Marks: 50

Instruction to candidates:

i) All questions are compulsory.

ii) Figures to the right indicate full marks.

iii) Draw neat diagrams wherever necessary.

**iv) Given constants: $h=6.626 \times 10^{-34}$ J-s, $c=3 \times 10^8$ m/s, $e=1.602 \times 10^{-19}$ C,
Mass of electron = 9.1×10^{-31} kg, Mass of proton = 1.67×10^{-27} kg.
Boltzmann Constant = $K= 1.38 \times 10^{-23}$ J/K**

- 1. Attempt any five questions** 2x5=10
 - a) Draw a neat spectrum of black body radiations.
 - b) Define stopping potential in photoelectric effect.
 - c) State the four fundamental interactions in elementary particles.
 - d) Calculate the wavelength associated with a proton moving with a velocity of 10^5 m/s.
 - e) Find the shortest wavelength present in the radiations from an X-ray tube kept at potential of 50 kV?
 - f) State the principle of relativity and constancy of speed of light.
 - g) State relativistic energy momentum relation, where the symbols have usual meaning.

- 2. Attempt any five questions** 3x5=15
 - a) The uncertainty in the location of particle is equal to its de Broglie wavelength. Show that the uncertainty in its velocity is equal to its $v_x/4\pi$.
 - b) Green light has wavelength of about 700 nm, Through what potential difference must an electron be accelerated to have this wavelength?
 - c) Calculate the glancing angle at which electrons of 100 eV should fall on the lattice planes of a crystal to obtain a strong Bragg's reflection in the first order Given: d value = $2.15 \text{ \AA}$.
 - d) A stationary body explodes into two fragments each of mass 1 Kg, that move apart at speed 0.6c relative to original body. Find the mass of the original body?
 - e) Write a short note on the Higg's boson.
 - f) Draw a neat diagram of Thomson apparatus used in determination of e/m ratio of an electron.
 - g) Spacecraft alpha is moving at 0.9c with respect to earth. If the spacecraft Beta is to pass alpha at a relative speed of 0.5c in the same direction. What speed must beta have with respect to earth?

3. Attempt **any five** questions

- a) Explain in detail Davisson and Germer's electron diffraction experiment.
- b) Describe in detail electron diffraction "thought experiment" to prove Heisenberg's uncertainty principle.
- c) A beam of X-rays is scattered by a target, at 45° from the beam direction. If the scattered X-rays have a wavelength of 2.2 pm. i) What is the wavelength and the frequency of the x-rays in the direct beam? ii) Find the maximum kinetic energy of recoil electron?
- d) Derive Lorentz transformation equations. Express the equations in its inverse form.
- e) Explain working principle of electron Microscope with the help of neat schematic diagram.
- f) Write in detail the classification of elementary particles with suitable examples.
- g) Two twins Dick and Jane, each of 20 years age, Dick is at rest and Jane takes a round trip space voyage to a star with velocity $0.99c$ relative to Dick. Star is 10 light years distant away from earth. Determine the age of Dick and Jane after Jane finishes her journey.

16/11/2022

8/c

**Deccan Education Society's
Fergusson College (Autonomous), Pune-4
S. Y. B. Sc. (Semester IV)
Subject: Physics
(PHY2402) Measurement Techniques in Physics (2019 pattern)**

Time: 2 Hrs 30 minutes

Max. Marks: 50

Instruction to candidates:

- i) All questions are compulsory
- ii) Figures to the right indicate full marks
- iii) Use of statistical tables and scientific calculators is allowed.

Q.1 Attempt any five questions:

[2 x 5 =10]

- a) Define Poisson's ratio?
- b) What is role of buoyancy effect in the measurement of mass with an example.
- c) Explain Newton's law of cooling.
- d) What are the differences between the adiabatic and isothermal processes? Give relation for both the processes.
- e) Calculate the distance of the sun from the Earth if the time required for light to reach from the sun to Earth is 500 seconds.
(Given the speed of light is 3×10^8 m/s)
- f) Calculate the diameter of the moon if the distance of the moon from the Earth is 3.84×10^8 m, the angle made with diametrically opposite points on the moon from the Earth is 31 minutes.
- g) Define magnetic field, magnetic field intensity and magnetization and give SI unit of **B**, **H**, and magnetization **M**?

Q.2 Attempt any five questions:

[3 x 5 =15]

- a) With neat diagram explain the Astronomical method for measurement of a stellar object's diameter.

- b) What are the differences between Lloyd's single mirror and Fresnel's double mirror in terms of the condition of maxima and minima.
- c) Explain Callendar and Barne's method
- d) With a neat labeled diagram explain the procedure for rotation of the plane of polarization by Lorentz Saccharimeter.
- e) With a neat labeled diagram explain the procedure to measure the magnetic susceptibility of a solution.
- f) With a neat labeled diagram explain the procedure to measure self-inductance using the Anderson bridge.
- g) Explain the experiment to determine Stefan's constant using a black body radiation.

Q.3 Attempt any five questions:

[5 x 5 =25]

- a) Define Poisson's ratio. What is the modulus of rigidity if the value of the modulus of elasticity is 200 and Poisson's ratio is 0.25?
- b) With a neat diagram explain Ferguson's method for the determination of surface tension.
- c) With a neat diagram explain the method to measure surface tension from the measurement of bubbles.
- d) With a neat diagram explain Quincke's method.
- e) How to measure true mass if the balance has unequal lengths and pans are of unequal weights.
- f) With a neat diagram explain Wilhelmy's method for the measurement of surface tension.
- g) Explain average error, root means square error, and probable error.

28/11/2022 2:30pm

Deccan Education Society's					
FERGUSON COLLEGE (Autonomous) Pune-4					
T.Y. B.Sc, Semester: V					
PHYSICS					
Course Title: Mathematical Methods in Physics (PHY3501)					
(2019 Pattern) (2 Credits)					
Time: 2 hours 30 mins			Max. Marks: 50		
Instructions to the candidates:					
1) All questions are compulsory.					
2) Draw neat and labelled diagrams wherever necessary.					
3) Figures to the right indicate full marks.					
4) Use of logarithmic tables and pocket calculators is allowed.					
Q.1		Attempt ANY FIVE of the following questions.			(2 x 5 = 10)
	a)	Find the value of Jacobin (J) if $x + y = u$ and $x - 2y = v$			
	b)	Define circulation in terms of vector field. Give one example.			
	c)	If a force $\vec{F} = (x^2y)\vec{i} + xy\vec{j}$ displaces a particle in the xy plane from (0,0) to (1,4) along the curve $y = 4x^2$. Find the work done.			
	d)	If $\vec{V}$ is the velocity of liquid then $\oint \vec{V} \cdot \overline{d\vec{r}}$ is called as ---			
	e)	State Gauss's divergence theorem. Write its mathematical form.			
	f)	Write the value of scale factors in spherical and cylindrical coordinate system.			
	g)	What are curvilinear coordinate and coordinate surfaces. show with neat diagram.			
Q.2		Attempt ANY FIVE of the following questions.			(3 x 5 = 15)
	a)	Find Fourier cosine series of function $f(x) = \begin{matrix} 1 \text{ for } 0 < x < \frac{\pi}{2} \\ 0 \text{ for } \frac{\pi}{2} < x < \pi \end{matrix}$			
	b)	State Gauss's divergence theorem and find the value of $\iint_S \vec{F} \cdot \vec{n} \, ds$ where S is the surface of sphere $x^2 + y^2 + z^2 = 16$ and $\vec{F} = 3x\vec{i} + 4y\vec{j} + 5z\vec{k}$			
	c)	Evaluate $\iint_R xy \, dx dy$, where R is quadrant of circle $x^2 + y^2 = a^2$ where $x \geq 0, y \geq 0$			



	d)	Find the work done by a force $\vec{F} = (y)^2\vec{i} + x^2\vec{j}$ which displaces the particle from origin to a point $(\vec{i}+\vec{j})$	
	e)	Show that $\iint_S \vec{F} \cdot \vec{n} \, ds = \iiint_V \text{div } \vec{F} \, dv$	
	f)	Evaluate $\iiint_V \phi \, dv$ where $\phi = 45x^2y$ and V is the closed region bounded by the planes $4x+2y+z = 8$ and $x=0, y=0, z=0$.	
	g)	Obtain Fourier expression for $f(x) = x^3$ for $-\pi < x < \pi$	
Q.3		Attempt ANY FIVE of the following questions. (5 x 5 = 25)	
	a)	The acceleration of a particle at time t is given by $\vec{a} = 18 \cos 3t \vec{i} - 8 \sin 2t \vec{j} + 6t \vec{k}$. If the velocity $\vec{v}$ and $\vec{r}$ be zero at $t = 0$ and find $\vec{v}$ and $\vec{r}$ at any point t .	
	b)	Evaluate $\iint_S \vec{F} \cdot \vec{n} \, dS$, where $\vec{F} = 4xz\vec{i} - y^2\vec{j} + yz\vec{k}$ and S is the surface of cube bounded by $x = 0, x = 1, y = 0, y = 1, z = 0, z = 1$	
	c)	Using polar coordinate, evaluate $\int_0^\infty \int_0^\infty e^{-(x^2+y^2)} \, dx \, dy$	
	d)	Using divergence theorem show that $\iint_S \nabla(x^2 + y^2 + z^2) \cdot \vec{ds} = 6V$ where V is volume	
	e)	If $y = e^{-(i\omega t - kx)}$ then show that $\partial^2 y / \partial x^2 = (k^2/\omega^2) \partial^2 y / \partial t^2$	
	f)	Compute $\iiint \frac{dx \, dy \, dz}{(x+y+z)^3}$ if the region of integration is bounded by coordinate planes and plane $x+y+z=1$	
	g)	If $\vec{F} = f_1 \vec{e}_1 + f_2 \vec{e}_2 + f_3 \vec{e}_3$ then find curl of $\vec{F}$ in curvilinear coordinate system	

29/11/2022
O/C
2:30 pm

Deccan Education Society's
FERGUSSON COLLEGE (Autonomous), Pune-4
T. Y. B. Sc. Semester: V

PHYSICS
Solid State Physics (PHY3502)
(2019 Pattern) (2 Credits)

Time: 2 hours 30 mins

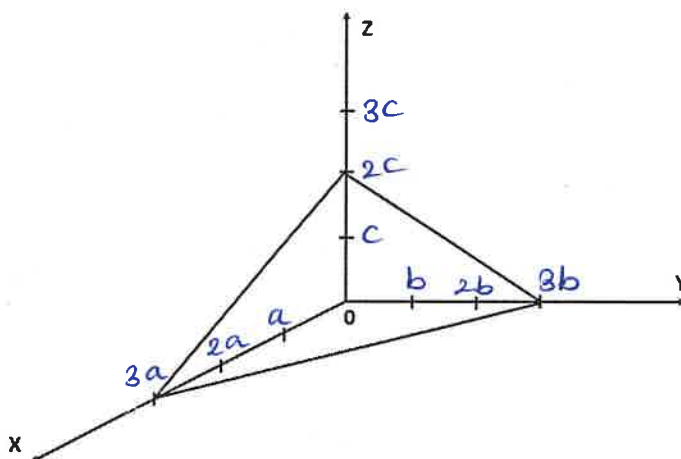
Max. Marks: 50

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Draw neat and labelled diagrams wherever necessary.
- 3) Figures to the right indicate full marks.
- 4) Use of logarithmic tables and pocket calculators is allowed.

Q.1 Attempt ANY FIVE of the following questions. (2 x 5 = 10)

- a) Define fold number. State fold number of a cubic unit cell in rotational symmetry operation?
- b) Determine the miller indices for the plane shown in figure



- c) A monochromatic beam of x-ray having a wavelength of $1.54 \text{ \AA}$ is incident on a crystal. The first-order maxima of the reflected x-rays are obtained at an angle of 7° . Calculate the glancing angle for the second-order reflection.
- d) Explain magnetization versus temperature curve for ferromagnetic materials.
- e) Explain how crystal can be used as a diffraction grating for x-rays?
- f) What is the difference between ferromagnetism and antiferromagnetism?
- g) What is critical temperature of superconductor.

Q.2 Attempt ANY FIVE of the following questions. (3 x 5 = 15)

- a) Calculate the number of atoms per unit cell of metal having a lattice parameter of 2.9 Å and density of 7.87 gm/cc. The atomic weight of the metal is 55.85 and the Avogadro constant is 6.022×10^{23} .
- b) Sketch $(\bar{2}10)$, (111) and (201) planes.
- c) An FCC crystal has an atomic radius of 1.246 Å. What are d_{200} , d_{220} and d_{111} spacing?
- d) A BCC crystal is used to measure the wavelength of some X-rays. The Bragg angle for first order reflection from the (110) plane is 20.2° . Find the wavelength of the X-ray, if the lattice parameter of the crystal is 3.15 Å.
- e) Draw the diagram of the CsCl crystal structure and explain it in detail.
- f) State and explain Bloch theorem.
- g) Explain B-H hysteresis loop.

Q.3 Attempt ANY FIVE of the following questions. (5 x 5 = 25)

- a) With help of a suitable diagram, explain the diamond cubic structure.
 - b) What is a reciprocal lattice? Obtain the expression for reciprocal lattice vectors $\vec{A}$, $\vec{B}$, and $\vec{C}$.
 - c) Explain the B-H hysteresis loop in ferromagnetic material on the basis of domain theory.
 - d) Discuss the motion of an electron in a cubical box and obtain an expression for its energy levels.
 - e) How many atoms per mm^2 surface area are there in (111) plane for copper which has FCC structure and lattice constant $a = 3.61 \times 10^{-10} \text{ m}$.
 - f) Show that FCC lattice is the reciprocal of the BCC lattice.
 - g) Explain Langevin theory for diamagnetic material and show that susceptibility is negative.
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30/11/2022 o/c
2:30 pm

Deccan Education Society's
FERGUSON COLLEGE (Autonomous) Pune-4
T.Y.B.Sc, Semester-V

PHYSICS
CLASSICAL MECHANICS (PHY3503)
(2019 Pattern) (2 Credits)

Max. Marks: 50

Time: 2 hours 30 mins

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Draw neat and labelled diagrams wherever necessary.
- 3) Figures to the right indicate full marks.
- 4) Use of logarithmic tables and pocket calculators is allowed.

Q.1 Attempt ANY FIVE of the following questions. (2 x 5 = 10)

- a) State Newton's laws of motion.
- b) Find the angle of projection at which range of the projectile is maximum.
- c) What is central force? Show that motion of a particle under central force is confined to a plane.
- d) What is meant by inelastic collision?
- e) What is meant by apsidal distance?
- f) What is meant by holonomic constraint?
- g) What is Coriolis force ?

Q.2 Attempt ANY FIVE of the following questions. (3 x 5 = 15)

- a) A rocket engine of mass 3×10^5 Kg having fuel of mass 2×10^5 kg can eject exhaust gases with velocity 3000m/s and at a rate of consumption of fuel 10^4 kg/s. Calculate the maximum vertical velocity attained by the rocket.
- b) The distance between sun and earth is suddenly reduced to half of its present distance. What will be the duration of year?

- c) Find the angle of projection when the horizontal range is $4\sqrt{3}$ times of its maximum height.
- d) Show that Hamiltonian of a system represents the total energy of the system.
- e) A particle of mass 1 g with velocity 2×10^3 m/s is incident on another particle of mass 2 g which is at rest. It is scattered along the direction making an angle of 45° with incident direction, while the particle of mass 2 g is recoiled with an angle 30° . Find the velocity of the particle of mass 1 g after collision.
- f) What are the types of constraints?
- g) Explain the effect of Coriolis force when a river flows on the surface of earth.

Q.3 Attempt ANY FIVE of the following questions. (5 x 5 = 25)

- a) Show that the path of charged particle moving with a uniform velocity in transverse electric field is parabola.
- b) How does a two body problem reduce to an equivalent one body problem?
- c) From D'Alembert's principle obtain Lagrange's equation of motion.
- d) Obtain the equation of height of rocket at an instant.
- e) Explain the conditions under which the orbit will be an ellipse, hyperbola, parabola and circle in an inverse square law of force.
- f) What is elastic collision? Describe two body elastic collisions in centre of mass system.
- g) Find the horizontal component of the Coriolis force acting on a body of mass 1.5 kg moving northward with a horizontal velocity of 100m/s, at 30° N latitude on earth.

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14/11/2022 o/c

Deccan Education Society's
FERGUSON COLLEGE (Autonomous) Pune-4
T.Y. B.Sc, Semester: VI
PHYSICS
Classical Electrodynamics (PHY3601)
(2019 Pattern) (2 Credits)

Time: 2 hours 30 mins

Max. Marks: 50

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Draw neat and labelled diagrams wherever necessary.
- 3) Figures to the right indicate full marks.
- 4) Use of logarithmic tables and pocket calculators is allowed.

Q.1 Attempt ANY FIVE of the following questions. (2 x 5 = 10)

- a) Determine the electric flux linked with a cube of side 'A' enclosing an electric dipole.
- b) What is meaning of polar and nonpolar molecule? Give one example of each.
- c) Write integral form of Ampere's Law.
- d) Why atomic polarizability of helium is less than hydrogen?
- e) What is significance of electric potential formalism in Electrostatics?
- f) Write the equation which interprets " Changing magnetic field induces electric field".
- g) A charge q is moving perpendicular to the direction of uniform magnetic field $\vec{B}$. What is force acting on charge q ?

Q.2 Attempt ANY FIVE of the following questions. (3 x 5 = 15)

- a) Determine electric field outside a charged nonconducting sphere of radius 'R' having total charge 'Q' on it.
- b) Write one advantage of method of images.
- c) Find the field $\vec{E} = xyz\hat{z}$, is conservative or nonconservative?

- d) Conducting circular loop is placed in a uniform magnetic field $B=0.04\text{T}$ with its plane perpendicular to the field. Somehow radius of the loop starts shrinking at constant rate of 2 mm/sec . Find the induced emf in the loop at the instant when radius is 2cm .
- e) Is diamagnetism a universal property? Comment.
- f) Avantika Express takes 14 hours to cover the distance of 1000km between Mumbai and Indore. The rails are separated by distance 100cm and vertical components of earth's magnetic field is $4 \times 10^{-5}\text{ T}$. Find the average emf induced across the width of the train.
- g) Explain one application of Lorentz law.

Q.3 Attempt ANY FIVE of the following questions. (5 x 5 = 25)

- a) Three charges q_1, q_2 and q_3 are situated at the vertices of equilateral triangle of side length 'a'. Find total energy required to assemble them.
- b) Determine the force acting on charge 'q' kept near to infinite grounded conducting plane.
- c) Describe the necessity of Maxwell's correction in Ampere's law.
- d) Describe the origin and meaning of motional emf. Draw suitable diagram for explanation.
- e) A steady current is flowing down a long cylindrical wire of radius 'a'. Find the magnetic field inside the wire if $|\vec{J}| \propto s$, where s is distance from the axis of cylinder.
- f) Determine the magnetic field at the centre of square carrying steady current I.
- g) Describe following terms:
 - i) Bound charges ii) Displacement vector

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15/11/2022 o/c

Deccan Education Society's
FERGUSON COLLEGE (Autonomous) Pune-4
Affiliated to Savitribai Phule Pune University

T.Y.B.Sc. (Semester : VI)
Subject: Physics
Paper Title: Quantum Mechanics
Paper Code: PHY3602
2019 Pattern (2 Credits)

[Time: 2:30 Hours]

[Max. Marks : 50]

Instructions to the candidates:

- All questions are compulsory.
 - Draw neat and labelled diagrams wherever necessary.
 - Figures to the right indicate full marks.
 - Use of logarithmic tables and pocket calculators is allowed.
-

1. Answer the following questions (Any Five).

[2 × 5] M

- Define wave packet with proper diagram.
- Give physical significance of wave function.
- Find the eigen value of e^{4x} for the operator $\frac{d^2}{dx^2}$.
- Define angular momentum operator and total energy operator.
- Find $[l_y, x]$.
- Normalise the given wave function $\psi(x) = Ae^{(-\frac{x}{2a} + ikx)}$.
- What is the smallest possible uncertainty in the position of particle moving with velocity of $3 \times 10^6 \text{ m/s}$, $\hbar = 1.055 \times 10^{-34} \text{ Js}$.

2. Answer the following questions (Any Five).

[3 × 5] M

- Derive the relation between group velocity and particle velocity.
- Show that $\frac{d}{dx} \langle P_x \rangle = \langle \frac{\partial V}{\partial x} \rangle$.
- Determine the current density if wave function is $\psi(x) = Ae^{-ikx}$.

d) Find the eigen function and eigen values of operator $(x^2 + \frac{d}{dx})$.

e) State the physical significance of equation of continuity.

f) Solve the $[L^2, L_y]$.

g) Obtain the independent Schrodinger wave equation.

3. Answer the following questions (Any Five).

[5 × 5] M

a) Show that eigen values of the Hermitian operator are real and momentum operator is the Hermitian operator.

b) A proton confined to move in one dimensional potential box of width 0.2nm. Find lowest possible energy of proton.

$$m_p = 1.67 \times 10^{-27} \text{Kg}, \hbar = 1.055 \times 10^{-34} \text{Js}.$$

c) Explain Davison and Germer experiment to prove wave nature of moving electron.

d) Apply Schrodinger's equation for particle in one dimensional well and obtain energy eigen value and eigen function of it.

e) Solve the steady-state Schrodinger's equations for the potential $V(x) = a$.

f) Explain the concept of parity, parity operator and its eigen values in detail.

g) Using the ground state wave function of the simple harmonic oscillator

$$\psi(x) = \sqrt{\left(\frac{a}{\pi}\right)} e^{-\frac{ax^2}{2}}. \text{ Find}$$

i) $\langle x \rangle$

ii) $\langle x^2 \rangle$.

16/11/2022.
2.30 pm

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Deccan Education Society's
FERGUSON COLLEGE (Autonomous) Pune-4
T.Y. B. Sc. Semester: VI

PHYSICS
Thermodynamics and Statistical Mechanics (PHY3603)
(2019 Pattern) (2 Credits)

Time: 2 hours 30 mins

Max. Marks: 50

Instruction to candidates:

- i) *All questions are compulsory.*
- ii) *Figures to the right indicate full marks.*
- iii) *Use of logarithmic tables and scientific calculators is allowed.*

Q.1 Attempt any FIVE questions:

(2 x 5 = 10)

- a) Define mean free path.
- b) In the random walk problem, what is the root mean square deviation?
- c) Explain the probability distribution curve using a suitable example.
- d) Explain the meaning of mean square deviation
- e) Explain the terms phase space and phase trajectory.
- f) Write any two basic postulates of statistical mechanics.
- g) What are bosons? Which statistic is used to study them?

Q.2 Attempt any FIVE questions:

(3 x 5 = 15)

- a) The viscosity of oxygen at N.T.P. is $1.96 \times 10^{-4} \text{ gm cm}^{-1} \text{ s}^{-1}$. Calculate the diameter of the molecule of a gas.
(Given: Boltzmann constant $K_B = 1.38 \times 10^{-16} \text{ ergs/K}$,
Avogadro's number $N_A = 6.023 \times 10^{23}$,
Molecular weight of oxygen = 32)
- b) The energy state of a particle moving in a rigid cubical box is specified by an equation $n_x^2 + n_y^2 + n_z^2 = \frac{2mL^2E}{\pi^2\hbar^2} = 14$. Determine the number of microstates accessible to the particle.
- c) A bag contains 10 red balls and 8 white balls. Two balls are drawn at random one after the other. What is the probability that both balls are red?
- d) If $p = q = \frac{1}{2}$ and total number of possibilities are $N = 200$.
Find a) mean value of n_1 i.e., $\bar{n}_1$ b) root mean square deviation

- e) Calculate the change in entropy when 10 grams of ice at 0 °C is converted into water at the same temperature.
(Given: Latent heat of ice = 80 Cal/gram)
- f) Derive the expression for mean value of energy in canonical distribution.
- g) Four molecules are to be distributed in two cells. Find possible number of macrostates and corresponding number of microstates.

Q.3 Attempt any FIVE questions:

(5 x 5 =25)

- a) For canonical ensemble, obtain the expression for $\bar{E}$ and $\overline{E^2}$ in terms of β and Z .
- b) What is transport phenomenon? Explain in brief viscosity, conductivity and self-diffusion on this basis.
- c) When a particle undergoes total number of steps ($N = 3$), draw different possibilities of steps. If $p = q = 1/2$, then find the probabilities corresponding to $n_1 = 0, 1, 2$ or 3.
- d) For random walk problem, show that mean displacement is,
 $\bar{m} = N(p - q)$
- e) Obtain the expression for Fermi-Dirac distribution law.
- f) What is Joule-Thomson effect? Prove that enthalpy remains constant in a throttling process.
- g) Derive Boltzmann entropy probability relation $S = k_B \ln \Omega(E)$, where, S is entropy and $\Omega(E)$ is the number of microstates in the entropy interval between E and $E + \delta E$, and k_B is Boltzmann constant.

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12/11/2022 o/c

**Deccan Education Society's
Fergusson College (Autonomous), Pune-4
T.Y.B.Sc. (Semester VI)
Physics
(PHY3604) Nuclear Physics (2019 pattern)**

Time: 2 hrs 30min

Max. Marks: 50

Instruction to candidates:

- i) All questions are compulsory
- ii) Figures to the right indicate full marks
- iii) Use of statistical tables and scientific calculators is allowed.

Constants:

- 1. Mass of proton, $m_p = 1.007825$ a.m.u.
- 2. Mass of neutron, $m_n = 1.008665$ a.m.u.
- 3. $1 \text{ a.m.u.} = 1.66 \times 10^{-27} \text{ kg} = 931.5 \text{ MeV}$
- 4. $1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$
- 5. Mass of electron, $m_e = 9.1 \times 10^{-31} \text{ kg}$
- 6. Avogadro's number, $N = 6.023 \times 10^{23} \text{ mol}^{-1}$
- 7. Boltzman constant, $k = 1.38 \times 10^{-23} \text{ joule/}^\circ\text{K}$
- 8. Plank's constant, $h = 6.625 \times 10^{-34} \text{ joule.sec}$

Q.1 Attempt any five questions:

[2 x 5 =10]

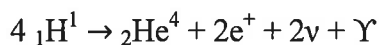
- a) Explain mass defect and binding energy.
- b) Explain quark model for protons.
- c) Define half life of radioactive substance.
- d) What is nuclear fission?
- e) Draw Feynman diagram for interaction between two nucleons.
- f) Define ideal equilibrium and secular (or permanent) equilibrium.
- g) What is dead time of the G. M. counter?

Q.2 Attempt any five questions:

[3 x 5 =15]

- a) Calculate the time required for 10% of a sample of thorium to disintegrate. Assume the half life of thorium to be 1.4×10^{10} years.
- b) A meson constructed from a quark and antiquark. Show that the quark structure $(u, \bar{d})$ give the correct charge number, spin and strangeness for π^+ meson.

- c) The sun radiate energy at the rate of 4×10^{23} kW. Assuming that the reaction



accounts for energy released, calculate (a) the number of protons fused per second and (b) the mass transformed into energy. (mass of helium = 4.002603 a.m.u., mass of positron = 5.4858×10^{-4} a.m.u.)

- d) Obtain the ratio of the nuclear radii of the lead ${}_{82}^{204}\text{Pb}$ and the silver isotope ${}_{47}^{107}\text{Ag}$.
- e) Find the approximate lengths of the first and last drift tubes, if 0.5 MeV protons are injected into a 50 MeV linear accelerator powered by 200 MHz radio – frequency supply. (mass of proton = 1.67×10^{-27} kg)
- f) Calculate the binding energy, binding energy per nucleon and packing fraction for helium. Given: mass of helium, ${}^4_2\text{He} = 4.00378$ a.m.u.
- g) Calculate the activity of (i) 1 gm of radium ${}^{226}_{88}\text{Ra}$, Half life = 1622 years; (ii) 3×10^{-9} kg of active gold, ${}^{200}_{79}\text{Au}$, Half life = 48 min.

Q.3 Attempt any five questions:

[5 x 5 =25]

- a) Obtain an expression for law of radioactive decay.
- b) Explain Meson theory of nuclear forces.
- c) What is nuclear fusion? Explain proton-proton and carbon cycle in the stars.
- d) Define packing fraction of the nucleus. How it determines the stability of the nucleus? Explain by packing fraction curve.
- e) Describe construction and working of linear accelerator.
- f) Discuss electric quadrupole moment of nucleus.
- g) What is nuclear reactor? State the essential components of the reactor. Explain power reactor with diagram

18/11/22

O/C

Deccan Education Society's
FERGUSON COLLEGE (Autonomous) Pune-4
Affiliated to Savitribai Phule Pune University
T.Y. B.Sc. (Semester: VI)
Subject: PHYSICS
Paper Title: Astronomy and Astrophysics
Paper Code: PHY3605
2019 Pattern (2 Credits)

[Time: 2hrs 30 min]

[Max. Marks : 50]

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Neat diagrams must be drawn wherever necessary.

Figures to the right side indicate full marks.

Q.1 Answer any five of the following:

10 mks

- a. The surface temperature of a star is 25,000K, at what wavelength is it emitting maximum radiation?
- b. What is the difference between annular eclipse and total solar eclipse?
- c. What is the peculiarity of "M" stars?
- d. What is meant by collecting power of a telescope? compare the collecting powers of 6 inch and 8 inch telescopes.
- e. How are Cepheid variables differentiated from other stars?
- f. What are peculiar galaxies?
- g. Where are Magellanic clouds found?

Q.2 Answer any **five** of the following:

15 mks

- a. Calculate the distance of Saturn from the Sun using Bodes law.
- b. Can you correlate the abundance of elements in the universe with fusion reactions in stars?
- c. An event is taking place in a city (45°W), at what time we in India (82.5°E) should log in to take part in the event?
- d. Is it possible to use optical telescopes as IR telescopes?
- e. What is Cosmology? which different cosmologies are you aware of?
- f. How is interesting abbot the quasar red shift?
- g. What is the difference between stars of 3^{rd} and 5^{th} magnitudes?

Q.3 Answer any **five** of the following:

25 mks

- a. Compares Red giants with brown dwarfs on the H-R diagram.
- b. How will you differentiate the spectra of "G" star with that of a "B" star? Give reasons.
- c. What is meant by Radio interferometry?
- d. Compare the fate of low and high mass stars.
- e. Explain the working of a CCD camera.
- f. What are the evidences of the Big Bang theory.
- g. What are AGN's, describe the various types that you know.

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**Deccan Education Society's
Fergusson College (Autonomous) Pune-4
T. Y. B. Sc SEM VI
Physics
Digital Electronics (PHY3605)
(Paper –V) (2016 Pattern)**

Time: 2 Hours

Max Marks: 50

Instructions: a) All questions are compulsory.
b) Figures to right indicate full marks.
c) Draw neat labelled diagrams wherever necessary.

- Q.1 Answer Any Five of the following questions:** (2x5=10)
- State De-Morgan's 1st and 2nd Theorem.
 - Convert C5E2 (Hexadecimal) into binary.
 - State Primary difference between JK and RS flip-flop.
 - What is switch control bounce?
 - Convert octal 257 to decimal equivalent.
 - Calculate the decimal equivalent of binary 1001.
 - What is flash memory?
- Q.2 Answer Any Five of the following questions:** (3x5=15)
- Compare the difference between TTL & CMOS.
 - Describe encoding with suitable example.
 - Name the four types of storage devices.
 - How many flip-flop's are required to produce a binary sequence representing decimal numbers 0 through 15?
 - What is flip-flop? Draw logic symbol and truth table for D-flip-flop.
 - Describe a 4-bit D/A converter system.
 - Explain Diode matrix as a ROM.
- Q.3 Answer Any Five of the following questions:** (5x5=25)
- Describe PISO and PIPO in detail.
 - Explain the concept of FAN-IN and FAN-OUT in detail.
 - Describe full adder in detail.
 - With suitable diagram explain edge triggered RS-flip-flop.
 - Explain single and dual slope technique for A/D conversion.
 - How many bits are required at the input of a converter if it is necessary to resolve voltage to 5 mv and the ladder has +10V full-scale?
 - Explain memory cell's, organization and addressing of memory cell's.
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**Deccan Education Society's
Fergusson College (Autonomous) Pune-4
T.Y.B.Sc. (Semester IV)
Physics
Computational Physics (PHY3606)
(2016 Pattern)**

Time: 2 Hours**Max Marks: 50****Instructions:** a) All questions are compulsory.

b) Figures to right indicate full marks.

c) Draw neat labelled diagrams whenever necessary

Q.1 Answer Any Five of the following questions:**(2x5=10)**

- a. Define i) True error ii) Truncation error
- b. Write a comparison between Bisection Newton Raphson and Secant Method.
- c. In Gauss elimination Method write a algorithm for eliminating x_1 from n-equation.
- d. Obtain the interpolation quadratic polynomial for the given data by using Newton's forward difference formula.

x	0	2	4	6
y	-3	5	21	45

- e. What do you mean error in error analysis? Mention its types.
- f. If $g(x)$ is continuous in $[a, b]$ then under what condition for iterative method $y=g(x)$ has unique solution in $[a, b]$?
- g. What are the error in Trapezoidal is and simpson's Rule of numerical integration?

Q.2 Answer Any Five of the following questions:**(3x5=15)**

- a. To find the root of $f(x)=0$, a scientist using the bisection method. At the beginning of iteration, the lower and upper guesses of the root are x_i and x_n . At the end of the iteration what will be the absolute relative approximate error in the estimated value of the root.
- b. Evaluate the order of convergence of Newton-Raphson Method.
- c. Solve the following system of equation by Gauss elimination method, correct to three decimal places.

$$28x+4z=32$$

$$X+3y+10z=24$$

$$2x+17y+4z=35$$

- d. Find the interpolation polynomial $f(x)$ by using Newton's forward difference interpolation formula and hence find the value of $f(5)$ for.

x	4	6	8	10
f(x)	1	3	8	16

- e. Using Simpson's 1/3 rule, evaluate $\int_0^{0.6} e^{-x^2} dx$ correct to three decimal places by a step size 0.1
- f. Given $3 \frac{dy}{dx} + 5y^2 = \sin x$, $y(0.3)=5$ and using a step size of $h=0.3$, find the value of $y(0.9)$ using the Range-Kutta 2nd order heun Method.

- g. Given $3\frac{dy}{dx} + 5y^2 = \sin x$, $y(0.3)=5$ and using a step size of $h=0.3$, find the value of $y(0.9)$ using Euler's Method.

Q.3 Answer Any Five of the following questions:

(5x5=25)

- Assuming an initial bracket $[1, 5]$, find value of root of equation $te^{-t} - 0.3=0$ at the end of 2nd iteration by using Bisection method.
 - Find the interpolation polynomial $f(x)$ by Lagrange formula and hence find $f(3)$ for $(0,2)$, $(1, 3)$, $(2, 12)$ and $(5, 147)$
 - Given $\frac{dy}{dx} = xy + y^2$, $y(0) = 1$, $y(0.1) = 1.1169$, $y(0.2) = 1.2773$ find $y(0.3)$ by R-k method of 4th order.
 - Find the approximate root of $xe^x=3$ by Newton's Raphson method correct to three decimal place.
 - Find the first and second derivatives for function tabulated below of $x=1.5$
- | | | | | | | |
|------|-------|-----|--------|------|--------|------|
| x | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 |
| f(x) | 3.375 | 7.0 | 13.625 | 24.0 | 38.875 | 59.0 |
- Find the value of $\log 2^{1/3}$ from $\int_0^1 \frac{x^2}{1+x^3} dx$ using Simpson's 1/3 Rule with $h=0.25$.
 - The velocity of a body is given by
 $v(t) = 2t \quad 1 \leq t \leq 5$
 $= 5t^2 + 3 \quad 5 < t \leq 14$ when 't' is given in seconds and 'v' is given in m/s use the two segment trapezoidal rule to find the distance covered by a body from $t=2$ to $t=9$ seconds.

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Deccan Education Society's
FERGUSON COLLEGE (Autonomous) Pune-4
T.Y. B.Sc, Semester: VI
PHYSICS
Energy Studies (PHY3606)
(2019 Pattern) (2 Credits)

Time: 2 hours 30 mins

Max. Marks: 50

Instructions to the candidates:

- 1) All questions are compulsory.*
- 2) Draw neat and labelled diagrams wherever necessary.*
- 3) Figures to the right indicate full marks.*
- 4) Use of logarithmic tables and pocket calculators is allowed.*

Q.1 Attempt ANY FIVE of the following questions. (2 x 5 = 10)

- a) What is thermochemical conversion of biomass gasification?
- b) State main components of flat plate collectors.
- c) What is wind energy?
- d) What is electrical vehicle (EV) and its types?
- e) Define solar constant.
- f) State any two advantages of photo voltaic system.
- g) Write two factors affecting bio-degradation.

Q.2 Attempt ANY FIVE of the following questions. (3 x 5 = 15)

- a) Define Fill Factor (FF) and maximum conversion efficiency.
- b) Explain the methods for obtaining energy from Biomass.
- c) The radius of sun surface is 6.960×10^8 m and the mean earth-sun distance is 4.5×10^{11} m. Find the angular divergence.
- d) With neat diagram explain in brief p-n junction solar cell.
- e) What is Fuel cell? Explain it.

Q.2 f) Assuming Sun as a black body whose temperature is 5762 K, calculate the solar flux.

Given: Radius of the Sun surface: 6.96×10^8 m.

Stefan-Boltzman constant: $5.67 \times 10^{-8} \text{ W/m}^2\text{K}^4$

Mean Earth-Sun distance: 1.5×10^{11} m.

g) Describe solar water heater.

Q.3 Attempt ANY FIVE of the following questions. (5 x 5 = 25)

a) Explain the term: solar radiation at the earth's surface.

b) Explain the applications of Gasifiers.

c) Differentiate Lithium Ion battery and Sodium Ion battery.

d) Calculate efficiency of solar cell using the following data.

Given: $V_{OC}=400$ mV, $I_{SC}= 40$ mA, $FF=0.7$, Input power of the cell= 6×10^{-2} W

e) Write short note on:

i) Solar cooker

ii) Solar dryer

f) The solar radiation intensity leaving the surface of the sun is $5.961 \times 10^7 \text{ W/m}^2$ and radius of sun surface is 6.960×10^8 m. If the sun emits radiation epically then determine the radiant flux crossing the surface.

g) Sate the disadvantages of floating drum and fixed domed type plant.

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**Deccan Education Society's
Fergusson College(Autonomous), Pune – 04.
T.Y.B.Sc. Semester VI
Physics
Astronomy and Astrophysics (PHY 3607)
2016 Pattern**

Time : $2\frac{1}{2}$ Hours

Max Marks: 50

Instructions: a) All questions are compulsory.
b) Figures to the right indicates full marks.
c) Draw the diagrams wherever necessary.

- Q. 1. Solve any five: (10 Marks)**
- a) An object in space is receding at a speed of 50,000 Km/s, what will be the shift in its spectra if the $\lambda_{\max}$ is at 5800Å.
 - b) What is the difference between a Transit and an Eclipse?
 - c) What is meant by the Chandrasekhar limit?
 - d) How bright is a 4th magnitude star from 6th magnitude star?
 - e) Compare grating and prism spectroscopes.
 - f) Why do we not use telescopes under highest magnification?
 - g) What is the difference between a Neutron star and a pulsar.
- Q. 2. Solve any five: (15 Marks)**
- a) What is a protostar? When is it formed?
 - b) What is meant by Solar maxima and minima?
 - c) How are Radio telescopes different from optical ones.
 - d) Nocturnal animals have large pupils in their eyes, How will you relate that to astronomical telescopes?
 - e) Explain why Annular Eclipse is a very rare event.
 - f) Differentiate between spectra of "A" and "F" star.
 - g) What is the difference between Doppler and gravitational red shift?
- Q. 3. Solve any five: (25 Marks)**
- a) What is the significance of the HR diagram in Astronomy?
 - b) Write a short note on X-ray telescope.
 - c) What are the evidences of the Big Bang theory?
 - d) What are Cepheid variables.
 - e) What are AGN's, give a few examples.
 - f) What is a Quasar Red shift?
 - g) What information is obtained from stellar spectra?

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**Deccan Education Society's
Fergusson College (Autonomous) Pune-4
T.Y.B.Sc. Semester VI
Physics Paper VI
RENEWABLE ENERGY SOURCES (PHY3608)
(Paper I) (2016 Pattern)**

Time: 2 Hours**Max Marks: 50***Instructions: a) All questions are compulsory.**b) Neat and labelled diagrams must be drawn wherever necessary**c) Figures to right indicate full marks.***Q.1 Answer Any Five of the following questions:****(2x5=10)**

- a. What is biomass?
- b. State the principle of solar dryer.
- c. State any two application of solar cell.
- d. Define gasifier.
- e. What are non-conventional sources of energy?
- f. State types of rotors used in wind machine.
- g. State the photovoltaic principle.

Q.2 Answer Any Five of the following questions:**(3x5=15)**

- a. Describe solar water heater.
- b. Explain the methods for obtaining energy from Biomass.
- c. With neat diagram explain in brief p-n junction solar cell.
- d. State energy balance equation for the collector.
- e. Assuming Sun as a black body whose temperature is 5762 K, calculate the solar flux.
Given : Radius of sun surface : 6.96×10^8 m
Stefan-Boltzman constant : $5.67 \times 10^{-8} \text{ W/m}^2\text{K}^4$
Mean Earth-Sun distance : 1.5×10^{11} m
- f. What is energy audit?
- g. Define Fill Factor (FF) and maximum conversion efficiency.

Q.3 Answer Any Five of the following questions:**(5x5=25)**

- a. The solar radiation intensity leaving the surface of the sun is $5.961 \times 10^7 \text{ W/m}^2$ and radius of sun surface is 6.96×10^8 m. If the sun emits radiation equally then determine the radiant flux crossing the surface.
State the advantages of floating drum and fixed domed type plant.
- b. State the advantages of floating drum and fixed domed type plant.
- c. Describe box type solar cooker with neat diagram.
- d. Give the structure and characteristics of sun. Draw spectral distribution of extra-terrestrial radiation.
- e. Describe gasification of biomass by downdraft gasifier.
- f. Calculate the input power of solar cell using following data:
Given: $V_{oc} = 400\text{mV}$, $I_{sc} = 40\text{mA}$, $FF = 0.7$, and efficiency (η) = 12%.
- g. Explain vertical axis type wind mill.

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**Deccan Education Society's
Fergusson College (Autonomous), Pune-4**

**T.Y.B.Sc. (Semester VI)
Subject: PHY 3611: Digital Electronics
(2019 pattern)**

Time: 2.30Hrs

Max. Marks: 50

Instruction to candidates:

- i) All questions are compulsory
- ii) Figures to the right indicate full marks
- iii) Use of statistical tables and scientific calculators is allowed.

Q.1 Attempt any five questions: [2 x 5 =10]

- a) Write the Binary equivalent of decimal 257?
- b) Find the Decimal equivalent of binary 1010.
- c) State main difference between fixed point and floating point representation
- d) What is possible edge triggering?
- e) State the primary difference between D and RS flip-flop.
- f) What is Switch contact bounce?
- g) What are the advantage of the Continuous type A to D converter and counter type A to D converter?

Q.2 Attempt any five questions: [3 x 5 =15]

- a) Explain Binary System with suitable example.
- b) What is ASCII Code?
- c) Describe Fan-In and Fan-out.
- d) With Suitable Diagram explain JK flip-flop.
- e) Explain in detail IC 7490.
- f) Find the output voltage from a 5-bit ladder that has a digital input of 11010 (assume 0=0V, 1=10V).
- g) What is the operational difference between SRAM and DRAM?

Q.3 Attempt any five questions: [5 x 5 =25]

- a) Prove that $A(A'+C)(A'B+C)(A'BC+C')=0$
- b) Explain K-map in detail with Suitable examples.

- c) What are counters? Describe asynchronous counter in detail.
- d) Explain the counter method of A to D converter.
- e) Draw and Explain the timing diagram of a typical memory write operation.
- f) Explain a BJT based memory Cell.
- g) Describe in detail Multiplexer with the help of block diagram; Also draw the logic circuit diagram of 2to 1 multiplexer.

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Deccan Education Society's					
FERGUSON COLLEGE (Autonomous) Pune-4					
T.Y. B. Sc, Semester: VI					
PHYSICS					
Course Title: C programming (PHY3612)					
(2019 Pattern) (2 Credits)					
Time: 2 hours 30 mins				Max. Marks: 50	
Instructions to the candidates:					
1) All questions are compulsory.					
2) Draw neat and labelled diagrams wherever necessary.					
3) Figures to the right indicate full marks.					
4) Use of logarithmic tables and pocket calculators is allowed.					
Q.1		Attempt ANY FIVE of the following questions.			(2 x 5 = 10)
	a)	What are advantages of Algorithm.			
	b)	Draw symbol of (1) process (2) Input/output (3) subroutine (4) module call			
	c)	What is token in C programming? Write any four tokens.			
	d)	If p=20, q=50 ; C = (p > q)? p:q, then what is value of C?			
	e)	What are standard input/output functions used in C programming?			
	f)	What is difference between do and for loop statement?			
	g)	What are the ways for passing Array element to a function.			
Q.2		Attempt ANY FIVE of the following questions.			(3 x 5 = 15)
	a)	What is output of void main() {int a; a = mul (10,20); printf(“%d\n”, a); }			
	b)	Write syntax for drawing (i)circle (ii)ellipse (iii) line and (iv) arc.			
	c)	Write a program to display your name using string constant.			

	d)	What are different rules for giving variable names.	
	e)	With suitable example explain incremental and decremental operator.	
	f)	What are different types of data. Give one example each.	
	g)	If i= 2, j = 4, k = 6, interpret the following.(i) i<j (ii) i+j >= k (iii) k !=6	
Q.3		Attempt ANY FIVE of the following questions. (5 x 5 = 25)	
	a)	Write flowchart to find factorial of 10.	
	b)	What are characteristics of algorithm? What are advantages and disadvantages of algorithm.	
	c)	Write C program to calculate area of circle and triangle.	
	d)	If float x =12.3456 then write output of following (i) printf(“%7.4f”,x); (ii) printf(“%7.2f”,x); (iii) printf(“%f”,x); (iv) printf(“%10.2e”, x); (v) printf(“%e”,x);	
	e)	Explain switch statement. Write C programme using switch statement.	
	f)	What are library functions? Write program to find square root of 100 using sqrt function.	
	g)	Write C program to find roots of $ax^2 + bx + c = 0$	

19-12-22

10.30 am

Deccan Education Society's
FERGUSON COLLEGE (Autonomous) Pune-4
Affiliated to Savitribai Phule Pune University
FYBSc (Semester: I)
Subject: Physics
Paper Title: Mechanics and Properties of Matter
Paper Code: PHY1101
2019 Pattern (2 Credits)

[Time: 2.5 Hours]

[Max. Marks : 50]

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Neat diagrams must be drawn wherever necessary.
- 3) Figures to the right side indicate full marks.
- 4) Use of logarithmic tables and scientific calculators are allowed

Que 1: Attempt any **five** of the following (2 M each)

- a. Write the formula for moment of inertia of a circular ring of mass M and radius R about a tangent perpendicular to its plane.
- b. State the working principle of gyroscope.
- c. If radius of circular orbit of a planet around a star is doubled what will happen to its period of revolution.
- d. What do you mean by the term "compressibility" in fluids?
- e. How does an external pressure and temperature affect the viscosity of fluids?
- f. Define the term 'Elastic Hysteresis'.
- g. State the difference between streamline flow and turbulent flow.

Que 2. Attempt any **five** of the following (3 M each)

- a. Elaborate briefly three Kepler's laws of planetary motion.
- b. The mass of the planet Venus is 0.814 times that of the earth (5.98×10^{24} kg) and its radius is equal to 0.967 of that of the earth (6.38×10^6 m). Calculate the velocity of escape from it. Given $G = 6.67 \times 10^{-11} \text{ N-m}^2/\text{kg}^2$.
- c. If four particles of mass 3 Kg each are sitting on vertices of a square of 2 m, find magnitude of resultant gravitational force on any one of them because of the other masses.
- d. The inter-molecular distance between two atoms of Hydrogen (H_2) molecule is $0.77 \text{ \AA}$ and the mass of H-atom is 1.67×10^{-27} Kg. Calculate the moment of inertia of H_2 molecule.
- e. A wire of area of cross-section 3 mm^2 and original length 50 cm is fixed at one end and mass of 2.1 kg is hung from the other end. Find the elastic potential energy store in the wire. Given Young's modulus of wire, $Y = 1.9 \times 10^{11} \text{ N/m}^2$ and acceleration due to gravity, $g = 9.81 \text{ m/s}^2$.

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- f. Obtain the equation of flow rate of fluid through Venturimeter.
- g. A capillary tube of 0.5 mm bore stands vertically in a wide vessel containing a liquid of surface tension 0.03 N/m. The liquid wets the tube and has density $0.8 \times 10^3 \text{ kg/m}^3$ and acceleration due to gravity of 9.81 m/s^2 . Calculate the rise of liquid in the tube.

Que 3: Attempt any **five** of the following (5 M each)

- a.) A flywheel which can turn about horizontal axis is set in motion by a 2 kg weight hanging from a thin string that passes round the axle held in position at height of 100 cm. After the wheel has made 1 revolution, the string is detached from the axle and the weight drops off. Then wheel makes 20 revolutions in 8 sec before being to rest by friction. The radius of the axle is 1 cm. Assuming the work done against friction in each revolution is always the same, calculate the moment of Inertia of the flywheel about its axel.
 - b.) How much energy is required to lift the 9000 kg Suyoz-vehicle from the Earth's surface to the height 400 km above the surface? Given that the mass of the Earth = $5.98 \times 10^{24} \text{ kg}$ and its radius = $6.37 \times 10^6 \text{ m}$. (Gravitational constant, $G = 6.67 \times 10^{-11} \text{ N m}^2/\text{kg}^2$)
 - c.) Calculate moment of inertia of a solid sphere of mass M and radius R about a chord whose perpendicular distance from center of sphere is $\frac{3}{5} R$ (Hint: use expression for M.I. of sphere about its diameter)
 - d.) A bar of length 1 cm, breadth 1.2 cm and depth 1.4 cm is clamped horizontally at one end and a weight of 2 Kg is applied at the other end. Neglecting the weight of the bar calculate depression of the loaded end if Young's modulus of the material of the rod is $Y = 9.78 \times 10^8 \text{ N/m}^2$ and acceleration due to gravity, $g = 9.81 \text{ m/s}^2$.
 - e.) Derive an expression which shows the relationship between Young's modulus, Bulk modulus and Poisson's ratio.
 - f.) Derive a Poiseuille's equation for a flow of liquid through horizontal capillary tube.
 - g.) Calculate the length of the wire that will break under its own weight when suspended vertically. Given- breaking stress = $9.8 \times 10^8 \text{ N/m}^2$, density of wire = 10^4 Kg/m^3 and acceleration due to gravity $g = 9.8 \text{ m/s}^2$.
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2:30 pm

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Deccan Education Society's
FERGUSON COLLEGE (Autonomous) Pune-4
Affiliated to Savitribai Phule Pune University

F.Y.B.Sc. (Semester : I)
Subject: Physics
Paper Title: Mechanics and Properties of matter
Paper Code: PHY1101
2019 Pattern (2 Credits)

[Time: 2:30 Hours]

[Max. Marks : 50]

Instructions to the candidates:

- All questions are compulsory.
 - Draw neat and labelled diagrams wherever necessary.
 - Figures to the right indicate full marks.
 - Use of logarithmic tables and pocket calculators is allowed.
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1. Answer the following questions (Any Five).

[2 × 5] M

- a) State perpendicular axis theorem.
- b) State Newton's law of gravitation and write dimension of gravitational constant.
- c) If modulus of rigidity $\eta = 8 \times 10^{11} \text{ N/m}^2$ and Young's modulus $Y = 20 \times 10^{11} \text{ N/m}^2$ for iron, calculate its Poisson's ratio.
- d) Define intensity of gravitational field.
- e) State Newton's law of viscous flow of a fluid. What is co-efficient of viscosity?
- f) Calculate radius of gyration of a solid sphere rotating about its diameter if its radius is 6 cm.
- g) What is the critical velocity of a fluid? Write the formula for critical velocity..

2. Answer the following questions (Any Five).

[3 × 5] M

- a) What is the magnitude of gravitational field intensity at a point in a gravitational field where a mass of 3 Kg experiences a force of 5 N due to the field.

- b) The flat surface of a hemisphere of radius r is cemented to one flat surface of a cylinder of radius r and length L . If the total mass is M , then find the moment of inertia of a combination about the axis of the cylinder.
- c) Calculate the self energy of the sun, taking its mass to be equal to 2×10^{30} Kg and its radius to be very nearly 7×10^8 metre. ($G = 6.67 \times 10^{-11}$ N-m/kg²).
- d) Find the greatest length of the wire that can hang vertically without breaking. Breaking stress for steel = 7.9×10^9 dynes/sq.cm. Density of steel = 7.9 gm/c.c.
- e) In an experiment the diameter of the rod was 1.26 cm and distance between the knife edges 0.7 m. On putting a load of 0.9 kg at the mid-point, the depression was 0.025 cm. Find the Young's modulus of elasticity of the material rod.
- f) A gas bubble of diameter 2 cm rises steadily through a solution of density 1.75 gm/cc at the rate of 0.35 cm/sec. Calculate the coefficient of viscosity of the solution. (Neglect density of the gas)
- g) A hollow steel sphere has its inner and outer radii 5 cm and 12 cm respectively. Calculate its moment of inertia about a diameter. Density of steel is 7.8×10^3 kgm⁻³.

3. Answer the following questions (Any Five).

[5 × 5] M

- a) Derive the expression for the moment of inertia of a spherical shell about its diameter.
- b) State and prove Bernoulli's principle. Explain its application in lifting airplanes.
- c) What is a gyrostat? Explain its working and mention some of its applications.
- d) Explain the method of determination of Y (Young's modulus) by bending of a uniformly loaded beam.
- e) Explain streamline flow and turbulent flow. What should be the value of Reynolds number for the flow to be turbulent?
- f) Obtain expression for moment of inertia of annular ring of mass M and inner and outer radii r and R respectively.
- g) Obtain the expression for gravitational self energy of a galaxy.

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2:30pm

Deccan Education Society's
FERGUSON COLLEGE (Autonomous) Pune-4

F. Y. B. Sc., Semester : I

PHYSICS

PHY1102: Heat and Thermodynamics

2019 Pattern (2 Credits)

Time: 2 Hours 30 minutes

Max. Marks : 50

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Draw neat and labelled diagrams wherever necessary.
- 3) Figures to the right indicate maximum marks.

Q1 Answer ANY FIVE of the following.

2×5=10

- a) A Carnot's engine absorbs 10^4 calories of heat from a reservoir at 627°C and rejects heat to a sink at 27°C . What is the efficiency? How much work does it perform? (1 calorie = 4.2 joule).
- b) Define: i) critical temperature and ii) critical pressure.
- c) What are Virial coefficients?
- d) Define the coefficient of performance.
- e) Find the efficiency of the Carnot's engine working between the steam point and the ice point.
- f) Calculate the change in entropy when 20 gm of ice at 0°C is converted into water at the same temperature. (Latent heat of ice = 80 cal/gm)
- g) Find the temperature on Fahrenheit scale corresponding to -40°C .

Q2 Answer ANY FIVE of the following.

3×5=15

- a) Calculate the work done when one mole of an ideal gas expands isothermally at 27°C to double its original volume. ($R=8.3\text{ J/K mol}$)
- b) A thermocouple with test junction at $t^\circ\text{C}$ on gas thermometer scale and reference junction at ice point gives emf as, $E = 0.25t - 5 \times 10^{-4}t^2\text{mV}$, The millivoltmeter is calibrated at ice and steam points. What is the reading on this thermometer when the gas thermometer reads 60°C ?
- c) Find the change in entropy in van der Waal's equation of state.
- d) What are essential requisites of good thermometer?
- e) State the first law of thermodynamics and give its physical importance.

- f) Differentiate between Diesel engine and Otto engine.
- g) One-gram molecule of a monatomic ($\gamma = 5/3$) perfect gas at 27°C is adiabatically compressed in a reversible process from an initial pressure of 1 atmosphere to a final pressure of 50 atmosphere. Calculate the resulting difference in temperature.

Q3 Answer ANY FIVE of the following.

5×5=25

- a) Derive the expression for Clausius- Clapeyron first equation. Explain its importance.
 - b) Explain the construction and working of the gas filled thermometer.
 - c) Derive an expression for efficiency of a Diesel engine.
 - d) When lead is melted at atmospheric pressure, (the melting point is 600 K), the density decreases from 11.01 to 10.65 gm/cm³ and the latent heat of fusion is 34.5 J/gm. What is the melting point at a pressure of 100 atmospheres?
 - e) Derive an expression for critical constants P_c , V_c , T_c and show that for gas obeying van der Waals equation, $\frac{RT_c}{P_c V_c} = \frac{8}{3}$.
 - f) Describe a Carnot's engine and show that its efficiency is a function of working temperature only.
 - g) Prove that for an ideal gas, during adiabatic process:
 - i. $PV^\gamma = \text{constant}$
 - ii. $TV^{\gamma-1} = \text{constant}$
 - iii. $\frac{P^{\gamma-1}}{T^\gamma} = \text{constant}$
-

14/11/2022 O/C

Deccan Education Society's
Fergusson College (Autonomous) Pune 411004

F. Y. B. Sc. Semester II

Physics Paper I

PHY1201 : Introduction to Mathematical Physics

Time : 2:30 Hours

Maximum Marks 50

Instructions to Candidates:

- a) All questions are compulsory.
- b) Figures to the right indicate full marks
- c) Use of log table and calculator is permitted.

Question1. Answer any five.

10 marks

- a) What is complex plane?
- b) Using Euler's Formula show that $\cos(\theta) = \frac{e^{i\theta} + e^{-i\theta}}{2}$.
- c) For complex number $z = 7 + i8$, find mod z .
- d) Define partial differential equation.
- e) Show that $dF = (y^2 + y + 2xy)dx + (x^2 + x + 2xy)dy$ is exact differential equation.
- f) Define the gradient of scalar field.
- g) Prove that $\sinh(i\theta) = i \sin(\theta)$

Question 2. Answer any five.

15 marks

- a) Express the complex number $3+4i$ into (i) polar and (ii) exponential form.
- b) If $F = f(x,y) = 2x^3y + y^3$ find $\frac{\partial f}{\partial x}, \frac{\partial f}{\partial y}, \frac{\partial^2 f}{\partial x^2}, \frac{\partial^2 f}{\partial y^2}$.
- c) If $z = x + iy$, interpret the equation geometrically: $|z + 3| = 2 |z - 3|$.
- d) Find the unit vector normal to the surface $x^2 + 3y^2 + 2z^2 = 6$ at point $(2,0,1)$
- e) If $\phi = 3x^2y + y^3z^2$, find grad ϕ at $(2,2,2)$.

- f) Draw a neat label circuit diagram for growth of current in an inductive RC circuit. Derive the equation for the same.
- g) What do you mean by implicit and explicit function?

Question 3. Answer any five.

25 marks

- a) If $z = \frac{1 + \sqrt{3}i}{2}$ find the value of z^3 .
- b) Show that the curl of gradient of scalar field $\phi = 0$.
- c) Show that $\vec{\nabla} \times (\phi \vec{A}) = \phi (\vec{\nabla} \times \vec{A}) + (\nabla \phi) \times \vec{A}$
- d) With neat diagram explain the physical significance of curl of a vector field.
- e) If $u = x + y + z$, $v = x^2 + y^2 + z^2$ and $w = xy + yz + zx$ prove that grad u , grad v and grad w are coplanar vectors.
- f) Using Argand diagram explain subtraction of two complex numbers.
- g) Prove that $\text{grad}(\phi + \psi) = \text{grad}(\phi) + \text{grad}(\psi)$

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15/11/2022 O/C

Deccan Education Society's
FERGUSON COLLEGE (Autonomous) Pune-4
F.Y. B.Sc, Semester: II

PHYSICS
Electricity and Magnetism (PHY1202)
(2019 Pattern) (2 Credits)

Time: 2 hours 30 mins

Max. Marks: 50

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Draw neat and labelled diagrams wherever necessary.
- 3) Figures to the right indicate full marks.
- 4) Use of logarithmic tables and pocket calculators is allowed.

Q.1 Attempt ANY FIVE of the following questions. (2 x 5 = 10)

- a) Classify the following given molecules into polar and non-polar molecules CH_4 , CCl_4 , C_6H_6 , H_2O , $\text{C}_6\text{H}_5\text{Cl}$ and CS_2 .
- b) What is the maximum allowed value of resistance in LCR circuit for oscillatory charge?
- c) Why permanent magnets can not be made from paramagnetic substances?
- d) Define the dielectric constant of a material.
- e) What is meaning of time constant in LR circuit?
- f) Draw waveform of voltage and current in AC RC circuit.
- g) Why power factor for inductor and capacitor is zero?

Q.2 Attempt ANY FIVE of the following questions. (3 x 5 = 15)

- a) A charge of $4 \times 10^{-8} \text{ C}$ is distributed uniformly on the surface of a sphere of radius 1cm. Find the electric field at a point 2cm away from the centre.
- b) A parallel plate capacitor is formed by two plates, each of area 100 cm^2 , separated by distance 1mm. A dielectric material of dielectric constant 5 and dielectric strength $1.9 \times 10^7 \text{ Vm}^{-1}$ is filled between the plates. Find the maximum charge that can be stored on the capacitor without causing any dielectric breakdown.
- c) A long solenoid is formed by winding 40 turns per cm. What current is necessary to produce a magnetic field of 40mT inside the solenoid?
- d) The maximum value of permeability of an alloy is 0.126 TmA^{-1} . Find maximum relative permeability and susceptibility.
(Given $\mu_0 = 4\pi \times 10^{-7} \text{ TmA}^{-1}$)
- e) An LCR series circuit with $L=100\text{mH}$, $C=100\mu\text{F}$, $R=120\Omega$ is connected to AC source of emf $E=(30\text{V}) \sin(100\text{sec}^{-1})t$. Find the resonant frequency of the circuit.
- f) A resistor with resistance $10\text{M}\Omega$ is connected in series with a capacitor of capacitance $1 \mu\text{F}$ and a battery with emf 12 V. Before the switch is closed at $t=0$, The capacitor is uncharged.
 1. What is time constant?
 2. What fraction of final charge is there on plate at time $t=46 \text{ sec}$?

- g) The minimum capacitance of a variable capacitor in a radio is 4.18pF . What is inductance of coil to be connected to this capacitor to get frequency of LC circuit 1600KHz ?

Q.3

Attempt ANY FIVE of the following questions. (5 x 5 = 25)

- a) Determine the electric field due to an uniformly charged non-conducting sphere with radius R , as a function of distance r .
- b) Derive Gauss's law for dielectrics.
- c) Derive the equation of discharging of a capacitor through an inductor in a series LC circuit.
- d) A coil of resistance 60 ohm and inductance 3 henry is connected in series with a condenser of $4\text{ }\mu\text{F}$ and an ac supply of 200V , 50 cps . Calculate i) The impedance in the circuit, ii) The phase difference between current and voltage, iii) The potential difference across the inductance coil, iv) The p.d. across the capacitor. Give the vector diagram for the current and p.d. acting across the components of the circuit.
- e) What is a solenoid? Determine the magnetic field at a point inside the solenoid.
- f) An inductor of 3H and resistance 6Ω is connected to the terminals of a battery of emf 12V and of negligible internal resistance. Calculate
- i) The initial rate of increase of current in the circuit,
 - ii) The rate of increase of current at the instant when the current in the circuit is 1A ,
 - iii) The instantaneous value of current 0.2sec after the circuit is closed
 - iv) The final steady state current
 - v) The power input to the inductor at the instant when the current is 0.5A .
- g) Compare diamagnetic, paramagnetic and ferromagnetic materials.
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30-11-22
10:30

G/C

Deccan Education Society's

Fergusson College (Autonomous) Pune-4

S.Y.B.Sc. (Physics)

Semester III

Oscillations, Waves and Sound (PHY-2301)

(Paper-1) (2016 Pattern)

Time: 2Hours

Max Marks:50

Instructions: a) All questions are compulsory and carry equal marks.

b) Neat and labelled diagrams must be drawn wherever necessary.

c) Figures to right indicate full marks.

d) Use of non-programmable calculator is allowed.

Q.1 Answer Any Five of the following questions:

(2×5=10 marks)

a) What is reverberation time?

b) Define Energy density of wave. Give its S.I. unit.

c) What is meant by half-width of resonance curve? On which factors half width depends?

d) A capacitor of $0.4\mu\text{F}$, an inductor of 80 mH and a resistor of 400 ohms are joined in series. Can the electrical circuit be oscillatory?

e) Define linear simple harmonic motion.

f) Distinguish between forced oscillations and damped oscillations.

g) The equation of longitudinal wave motion is expressed by $y = y_0 \sin 2\pi(0.1x - 34t)$. Where x and t are measured in metres and seconds respectively. Find the wave velocity.

Q.2 Answer Any Five of the following questions:

(3×5=15 marks)

a) A particle of mass 0.2 Kg moves simple harmonically according to the law $x = 0.08 \sin(20\pi t + \pi/4)$. Find the velocity of the particle, its acceleration and the acting force as well as amplitudes of respective quantities.

b) Write note on: Logarithmic decrement. Show that ratio of successive amplitude is constant.

c) An alternating emf of peak value 200 volt is applied across the series combination of an inductor of inductance 20 mH , a capacitor of capacitance $2\mu\text{F}$ and resistance of 50Ω . Determine resonant frequency, quality factor and bandwidth.

d) A fixed source emits sound of frequency 1000 Hz . What is the frequency as heard by the listener.

(i) at rest (ii) moving towards the source at constant speed of 20 m/s and (iii) moving away from the source at the same rate (at constant speed of 20 m/s).

e) What is Intensity of wave? Show that intensity of wave at a point is directly proportional to the square of the amplitude of a particle situated at the point.

f) Discuss the phenomenon of sharpness of resonance and show how it depends on the damping factor.

g) For damped harmonic oscillator, its amplitude reduced to $(1/10)^{\text{th}}$ of its value after 100 oscillations. If its time period be 1.15 second, calculate the damping constant $(R/2M)$. If the observed value of the 1st amplitude of the oscillator be 2 cm, what would be its value in the absence of damping?

Q.3 Answer Any Five of following questions:

(5×5=25 marks)

a) Derive the general equation for path of a particle for composition of two mutually perpendicular SHMs in the frequency ratio 1:2.

What will be the resultant motion of the particle when (1) $\phi=0$ or $\phi=\pi$. (2) when $\phi=\pi/2$, $\sin\phi=1$. Also represent its motion diagrammatically.

b) A body of mass 2Kg executes damped SHM under a restoring force 10 N/m and a damping force 4N/m sec^{-1} . Find the displacement time equation if the initial displacement is 4m and initial velocity is -4m/sec .

c) Explain in detail power and Bandwidth of forced oscillations.

d) Derive the expression for differential equation of a transverse wave. Give expression for velocity of transverse wave on the string.

e) Explain Doppler effect in light. If source of light moving away from stationary observer, what will be the change in wavelength $(d\lambda)=?$

f) What is blue shift and red shift? What is their significance?

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Deccan Education Society's
FERGUSSON COLLEGE (Autonomous) Pune-4
S.Y. B.Sc, Semester: III

PHYSICS
Principles and Applications of Optics (PHY2302)
(2019 Pattern) (2 Credits)

Time: 2 hours 30 mins

Max. Marks: 50

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Draw neat and labelled diagrams wherever necessary.
- 3) Figures to the right indicate full marks.
- 4) Use of logarithmic tables and pocket calculators is allowed.

Q.1 Attempt ANY FIVE of the following questions. (2 x 5 = 10)

- a) What is relation between optical path difference and geometrical path difference?
- b) Why Newton's rings are circular?
- c) In nonreflecting single layer of a lens coating is to be done on the lens of refractive index 1.78. Determine the refractive index of coating material required to produce zero reflection of light for light of wavelength 550nm.
- d) Due to which phenomenon resolving power of an optical instrument is limited?
- e) What is Zone plate?
- f) Write one application of Brewster's law.
- g) A dot is marked on a white paper and viewed through calcite crystal from the top. How many images are expected to be seen and why?

Q.2 Attempt ANY FIVE of the following questions. (3 x 5 = 15)

- a) If in a Newton's ring arrangement, the air is replaced by a liquid of refractive index 1.3, in what proportion would the diameters of the ring changes?
- b) In an experiment with Michelson interferometer the micrometer readings for maximum contrast were found to be 0.6939mm and 0.9884mm. If the mean wavelength for the two components of the line be $5893\text{\AA}$, determine the difference between the two wavelengths.

- c) A collimated beam of mercury light at 546.1nm is normally incident on a slit 0.015 cm wide. Lens of focal length 60cm is placed behind the slit. A diffraction pattern is formed on a screen placed in the focal plane of the lens. Determine the distance between the central maxima and first minima.
- d) Calculate resolving power of a telescope whose objective lens has a diameter of 508 cm and wavelength 6000 Å.
- e) Zone plate has the radius of first ring 0.05cm if plane waves 5000 Å falls on the plate where should the screen be placed so that the light is focused to a bright spot?
- f) Light of wavelength 580 nm is incident on a slit having a width of 0.300 mm. The viewing screen is 2.00 m from the slit. Find the width of the central bright fringe.
- g) Two polarizing plates have polarizing directions parallel so as to transmit maximum intensity of light. Through what angle must either plate be turned if the intensity of transmitted beam is one third of the intensity of incident beam.

Q.3 Attempt ANY FIVE of the following questions. (5 x 5 = 25)

- a) How Michelson interferometer is used to determine the separation between two wavelengths very close together? Explain.
- b) A beam of monochromatic light of wavelength 5.82×10^{-7} m falls normally on a wedge film with the wedge angle 20 arc seconds. If the refractive index of glass is 1.5, find the number of dark fringe per cm of wedge length.
- c) Intensity distribution of diffraction pattern due to double slit ,each slit of width 'a' separated by 'd=3a' is given by

$$I = 4I_0 \frac{\sin^2 \alpha}{\alpha^2} \cos^2 \beta$$
 where I_0 is intensity and $\alpha = \frac{\pi a \sin \theta}{\lambda}$, $\beta = \frac{\pi d \sin \theta}{\lambda}$ are diffraction parameters, λ is wavelength of incident light. Plot the intensity distribution.
- d) What are half period zones? Determine the amplitude due to large wavefront at a point in front.
- e) How circularly polarized light can be analysed?
- f) Obtain condition for constructive and destructive interference of light transmitted from uniform thickness film.
- g) Obtain expression for thickness of QWP and HWP in terms of wavelength of incident light and refractive indices of E ray and O ray. Calculate the thickness of a half wave plate and quarter wave plate for light of wavelength 600nm. (Given $\mu_e = 1.544$ and $\mu_o = 1.533$).

15/11/2022

Ok

Deccan Education Society's
FERGUSON COLLEGE (Autonomous) Pune-4
S.Y.B.Sc, Semester-IV

PHYSICS
Introductory Quantum Physics and Special Theory of Relativity
(PHY2401)
(2019 Pattern) (2 Credits)

Time: 2 hours 30 mins

Max. Marks: 50

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Draw neat and labelled diagrams wherever necessary.
- 3) Figures to the right indicate full marks.
- 4) Use of logarithmic tables and pocket calculators is allowed.
- 5) mass of electron = 9.11×10^{-31} kg, charge of electron = 1.6×10^{-19} C and Planck's constant = 6.62×10^{-34} J.s.

Q.1 Attempt ANY FIVE of the following questions. (2 x 5 = 10)

- a) Write Einstein's postulates of special theory of relativity.
- b) Write Heisenberg's Uncertainty principle.
- c) What are quarks?
- d) Define black body radiation.
- e) Calculate the de-Broglie wavelength of an electron moving with a kinetic energy of 10 eV.
- f) What are bosons?
- g) Explain in short, pair production.

Q.2 Attempt ANY FIVE of the following questions. (3 x 5 = 15)

- a) X-rays of wavelength 10.0 pm are scattered from a target.
 - i) Find the wavelength of the x-rays scattered through 45° .
 - ii) Find the maximum wavelength present in the scattered x-rays.
 - iii) Find the maximum kinetic energy of the recoil electrons.
- b) Show that pair production cannot occur in empty space.
- c) Derive the formula for time dilation using the inverse Lorentz transformation.

- d) A certain particle has a lifetime of 10^{-7} s when measured at rest. How far does it go before decaying if it's speed is $0.99c$ when it is created?
- e) A hydrogen atom is 5.3×10^{-11} m in radius. Use the uncertainty principle to estimate the minimum energy an electron can have in its atom.
- f) Write the classification of elementary particles.
- g) Show that $\Delta L \Delta \theta \geq \hbar/2$ and $\Delta E \Delta t \geq \hbar/2$

Q.3 Attempt ANY FIVE of the following questions. (5 x 5 = 25)

- a) Describe the Michelson Morley experiment and explain the physical significance of negative result.
- b) Explain in brief discoveries of an electron, proton and neutron.
- c) Explain the working of an electron microscope.
- d) Discuss in detail the Y-ray microscope to illustrate the uncertainty principle.
- e) What is Compton effect? Explain the experimental verification of Compton theory.
- f) Calculate the glancing angle at which an electron of energy 100 eV must be incident on the lattice planes of the metal crystal to give a strong Bragg reflection in the first order.
Use the following data:
Lattice spacing = $2.15 \text{ \AA}$, mass of electron = 9.11×10^{-31} kg,
electron charge = 1.6×10^{-19} C and Planck's constant = 6.62×10^{-34} Js.
- g) Two twins Dick and Jane, each of 20 years age, Dick is at rest and Jane takes a round trip space voyage to a star with a velocity $0.98c$ relative to Dick. Star is 15 light years distant from earth. Determine the age of Dick and Jane after Jane finishes her journey.

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15/11/2022 01c

Deccan Education Society's
Fergusson College (Autonomous), Pune-4
End Semester Examination (ESE)
S. Y. B. Sc. (Physics) Semester IV (2016 Pattern)
Paper I: PHY 2401: Introductory Quantum Physics and Relativity

Time: 2 Hrs

Max. Marks: 50

Instruction to candidates:

i) All questions are compulsory.

ii) Figures to the right indicate full marks.

iii) Draw neat diagrams wherever necessary.

**iv) Given constants: $h=6.626 \times 10^{-34}$ J-s, $c=3 \times 10^8$ m/s, $e=1.602 \times 10^{-19}$ C,
Mass of electron = 9.1×10^{-31} kg, Mass of proton = 1.67×10^{-27} kg.
Boltzmann Constant = $K= 1.38 \times 10^{-23}$ J/K**

1. Attempt any five questions 2x5=10
 - a) Draw a neat spectrum of black body radiations.
 - b) Define stopping potential in photoelectric effect.
 - c) State the four fundamental interactions in elementary particles.
 - d) Calculate the wavelength associated with a proton moving with a velocity of 10^5 m/s.
 - e) Find the shortest wavelength present in the radiations from an X-ray tube kept at potential of 50 kV?
 - f) State the principle of relativity and constancy of speed of light.
 - g) State relativistic energy momentum relation, where the symbols have usual meaning.

2. Attempt any five questions 3x5=15
 - a) The uncertainty in the location of particle is equal to its de Broglie wavelength. Show that the uncertainty in its velocity is equal to its $v_x/4\pi$.
 - b) Green light has wavelength of about 700 nm, Through what potential difference must an electron be accelerated to have this wavelength?
 - c) Calculate the glancing angle at which electrons of 100 eV should fall on the lattice planes of a crystal to obtain a strong Bragg's reflection in the first order Given: d value = $2.15 \text{ \AA}$.
 - d) A stationary body explodes into two fragments each of mass 1 Kg, that move apart at speed 0.6c relative to original body. Find the mass of the original body?
 - e) Write a short note on the Higg's boson.
 - f) Draw a neat diagram of Thomson apparatus used in determination of e/m ratio of an electron.
 - g) Spacecraft alpha is moving at 0.9c with respect to earth. If the spacecraft Beta is to pass alpha at a relative speed of 0.5c in the same direction. What speed must beta have with respect to earth?

3. Attempt **any five** questions

- a) Explain in detail Davisson and Germer's electron diffraction experiment.
- b) Describe in detail electron diffraction "thought experiment" to prove Heisenberg's uncertainty principle.
- c) A beam of X-rays is scattered by a target, at 45° from the beam direction. If the scattered X-rays have a wavelength of 2.2 pm. i) What is the wavelength and the frequency of the x-rays in the direct beam? ii) Find the maximum kinetic energy of recoil electron?
- d) Derive Lorentz transformation equations. Express the equations in its inverse form.
- e) Explain working principle of electron Microscope with the help of neat schematic diagram.
- f) Write in detail the classification of elementary particles with suitable examples.
- g) Two twins Dick and Jane, each of 20 years age, Dick is at rest and Jane takes a round trip space voyage to a star with velocity $0.99c$ relative to Dick. Star is 10 light years distant away from earth. Determine the age of Dick and Jane after Jane finishes her journey.

16/11/2022

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**Deccan Education Society's
Fergusson College (Autonomous), Pune-4
S. Y. B. Sc. (Semester IV)
Subject: Physics
(PHY2402) Measurement Techniques in Physics (2019 pattern)**

Time: 2 Hrs 30 minutes

Max. Marks: 50

Instruction to candidates:

- i) All questions are compulsory
- ii) Figures to the right indicate full marks
- iii) Use of statistical tables and scientific calculators is allowed.

Q.1 Attempt any five questions:

[2 x 5 =10]

- a) Define Poisson's ratio?
- b) What is role of buoyancy effect in the measurement of mass with an example.
- c) Explain Newton's law of cooling.
- d) What are the differences between the adiabatic and isothermal processes? Give relation for both the processes.
- e) Calculate the distance of the sun from the Earth if the time required for light to reach from the sun to Earth is 500 seconds.
(Given the speed of light is 3×10^8 m/s)
- f) Calculate the diameter of the moon if the distance of the moon from the Earth is 3.84×10^8 m, the angle made with diametrically opposite points on the moon from the Earth is 31 minutes.
- g) Define magnetic field, magnetic field intensity and magnetization and give SI unit of **B**, **H**, and magnetization **M**?

Q.2 Attempt any five questions:

[3 x 5 =15]

- a) With neat diagram explain the Astronomical method for measurement of a stellar object's diameter.

- b) What are the differences between Lloyd's single mirror and Fresnel's double mirror in terms of the condition of maxima and minima.
- c) Explain Callendar and Barne's method
- d) With a neat labeled diagram explain the procedure for rotation of the plane of polarization by Lorentz Saccharimeter.
- e) With a neat labeled diagram explain the procedure to measure the magnetic susceptibility of a solution.
- f) With a neat labeled diagram explain the procedure to measure self-inductance using the Anderson bridge.
- g) Explain the experiment to determine Stefan's constant using a black body radiation.

Q.3 Attempt any five questions:

[5 x 5 =25]

- a) Define Poisson's ratio. What is the modulus of rigidity if the value of the modulus of elasticity is 200 and Poisson's ratio is 0.25?
- b) With a neat diagram explain Ferguson's method for the determination of surface tension.
- c) With a neat diagram explain the method to measure surface tension from the measurement of bubbles.
- d) With a neat diagram explain Quincke's method.
- e) How to measure true mass if the balance has unequal lengths and pans are of unequal weights.
- f) With a neat diagram explain Wilhelmy's method for the measurement of surface tension.
- g) Explain average error, root means square error, and probable error.

28/11/2022 2:30pm

Deccan Education Society's					
FERGUSON COLLEGE (Autonomous) Pune-4					
T.Y. B.Sc, Semester: V					
PHYSICS					
Course Title: Mathematical Methods in Physics (PHY3501)					
(2019 Pattern) (2 Credits)					
Time: 2 hours 30 mins				Max. Marks: 50	
Instructions to the candidates:					
1) All questions are compulsory.					
2) Draw neat and labelled diagrams wherever necessary.					
3) Figures to the right indicate full marks.					
4) Use of logarithmic tables and pocket calculators is allowed.					
Q.1		Attempt ANY FIVE of the following questions.			(2 x 5 = 10)
	a)	Find the value of Jacobin (J) if $x + y = u$ and $x - 2y = v$			
	b)	Define circulation in terms of vector field. Give one example.			
	c)	If a force $\vec{F} = (x^2y)\vec{i} + xy\vec{j}$ displaces a particle in the xy plane from (0,0) to (1,4) along the curve $y = 4x^2$. Find the work done.			
	d)	If $\vec{V}$ is the velocity of liquid then $\oint \vec{V} \cdot d\vec{r}$ is called as ---			
	e)	State Gauss's divergence theorem. Write its mathematical form.			
	f)	Write the value of scale factors in spherical and cylindrical coordinate system.			
	g)	What are curvilinear coordinate and coordinate surfaces. show with neat diagram.			
Q.2		Attempt ANY FIVE of the following questions.			(3 x 5 = 15)
	a)	Find Fourier cosine series of function $f(x) = \begin{matrix} 1 \text{ for } 0 < x < \frac{\pi}{2} \\ 0 \text{ for } \frac{\pi}{2} < x < \pi \end{matrix}$			
	b)	State Gauss's divergence theorem and find the value of $\iint_S \vec{F} \cdot \vec{n} ds$ where S is the surface of sphere $x^2 + y^2 + z^2 = 16$ and $\vec{F} = 3x\vec{i} + 4y\vec{j} + 5z\vec{k}$			
	c)	Evaluate $\iint_R xy dx dy$, where R is quadrant of circle $x^2 + y^2 = a^2$ where $x \geq 0, y \geq 0$			

	d)	Find the work done by a force $\vec{F} = (y)^2\vec{i} + x^2\vec{j}$ which displaces the particle from origin to a point $(\vec{i}+\vec{j})$	
	e)	Show that $\iint_S \vec{F} \cdot \vec{n} \, ds = \iiint_V \text{div } \vec{F} \, dv$	
	f)	Evaluate $\iiint_V \phi \, dv$ where $\phi = 45x^2y$ and V is the closed region bounded by the planes $4x+2y+z = 8$ and $x=0, y=0, z=0$.	
	g)	Obtain Fourier expression for $f(x) = x^3$ for $-\pi < x < \pi$	
Q.3		Attempt ANY FIVE of the following questions. (5 x 5 = 25)	
	a)	The acceleration of a particle at time t is given by $\vec{a} = 18 \cos 3t \vec{i} - 8 \sin 2t \vec{j} + 6t \vec{k}$. If the velocity $\vec{v}$ and $\vec{r}$ be zero at $t = 0$ and find $\vec{v}$ and $\vec{r}$ at any point t .	
	b)	Evaluate $\iint_S \vec{F} \cdot \vec{n} \, dS$, where $\vec{F} = 4xz\vec{i} - y2\vec{j} + yz\vec{k}$ and S is the surface of cube bounded by $x = 0, x = 1, y = 0, y = 1, z = 0, z = 1$	
	c)	Using polar coordinate, evaluate $\int_0^\infty \int_0^\infty e^{-(x^2+y^2)} \, dx \, dy$	
	d)	Using divergence theorem show that $\iint_S \nabla(x^2 + y^2 + z^2) \cdot \vec{ds} = 6V$ where V is volume	
	e)	If $y = e^{-(i\omega t - kx)}$ then show that $\partial^2 y / \partial x^2 = (k^2/\omega^2) \partial^2 y / \partial t^2$	
	f)	Compute $\iiint \frac{dx \, dy \, dz}{(x+y+z)^3}$ if the region of integration is bounded by coordinate planes and plane $x+y+z=1$	
	g)	If $\vec{F} = f_1 \vec{e}_1 + f_2 \vec{e}_2 + f_3 \vec{e}_3$ then find curl of $\vec{F}$ in curvilinear coordinate system	

29/11/2022
O/C
2:30 pm

**Deccan Education Society's
FERGUSSON COLLEGE (Autonomous), Pune-4
T. Y. B. Sc. Semester: V**

**PHYSICS
Solid State Physics (PHY3502)
(2019 Pattern) (2 Credits)**

Time: 2 hours 30 mins

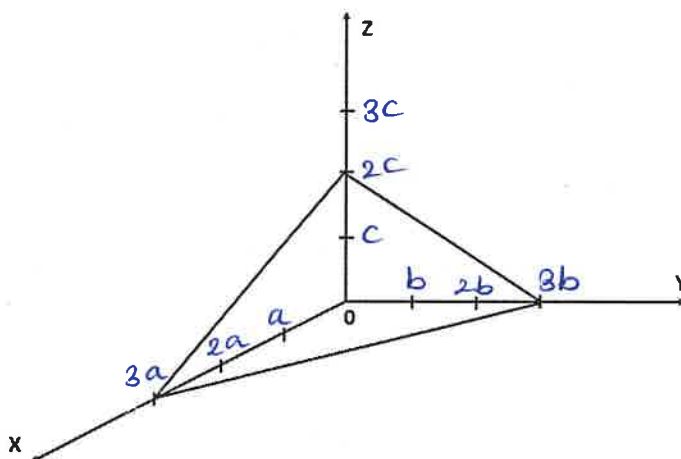
Max. Marks: 50

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Draw neat and labelled diagrams wherever necessary.
- 3) Figures to the right indicate full marks.
- 4) Use of logarithmic tables and pocket calculators is allowed.

Q.1 Attempt ANY FIVE of the following questions. (2 x 5 = 10)

- a) Define fold number. State fold number of a cubic unit cell in rotational symmetry operation?
- b) Determine the miller indices for the plane shown in figure



- c) A monochromatic beam of x-ray having a wavelength of $1.54 \text{ \AA}$ is incident on a crystal. The first-order maxima of the reflected x-rays are obtained at an angle of 7° . Calculate the glancing angle for the second-order reflection.
- d) Explain magnetization versus temperature curve for ferromagnetic materials.
- e) Explain how crystal can be used as a diffraction grating for x-rays?
- f) What is the difference between ferromagnetism and antiferromagnetism?
- g) What is critical temperature of superconductor.

Q.2 Attempt ANY FIVE of the following questions. (3 x 5 = 15)

- a) Calculate the number of atoms per unit cell of metal having a lattice parameter of 2.9 Å and density of 7.87 gm/cc. The atomic weight of the metal is 55.85 and the Avogadro constant is 6.022×10^{23} .
- b) Sketch $(\bar{2}10)$, (111) and (201) planes.
- c) An FCC crystal has an atomic radius of 1.246 Å. What are d_{200} , d_{220} and d_{111} spacing?
- d) A BCC crystal is used to measure the wavelength of some X-rays. The Bragg angle for first order reflection from the (110) plane is 20.2° . Find the wavelength of the X-ray, if the lattice parameter of the crystal is 3.15 Å.
- e) Draw the diagram of the CsCl crystal structure and explain it in detail.
- f) State and explain Bloch theorem.
- g) Explain B-H hysteresis loop.

Q.3 Attempt ANY FIVE of the following questions. (5 x 5 = 25)

- a) With help of a suitable diagram, explain the diamond cubic structure.
 - b) What is a reciprocal lattice? Obtain the expression for reciprocal lattice vectors $\vec{A}$, $\vec{B}$, and $\vec{C}$.
 - c) Explain the B-H hysteresis loop in ferromagnetic material on the basis of domain theory.
 - d) Discuss the motion of an electron in a cubical box and obtain an expression for its energy levels.
 - e) How many atoms per mm^2 surface area are there in (111) plane for copper which has FCC structure and lattice constant $a = 3.61 \times 10^{-10} \text{ m}$.
 - f) Show that FCC lattice is the reciprocal of the BCC lattice.
 - g) Explain Langevin theory for diamagnetic material and show that susceptibility is negative.
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30/11/2022 o/c
2:30 pm

Deccan Education Society's
FERGUSON COLLEGE (Autonomous) Pune-4
T.Y.B.Sc, Semester-V

PHYSICS
CLASSICAL MECHANICS (PHY3503)
(2019 Pattern) (2 Credits)

Max. Marks: 50

Time: 2 hours 30 mins

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Draw neat and labelled diagrams wherever necessary.
- 3) Figures to the right indicate full marks.
- 4) Use of logarithmic tables and pocket calculators is allowed.

Q.1 Attempt ANY FIVE of the following questions. (2 x 5 = 10)

- a) State Newton's laws of motion.
- b) Find the angle of projection at which range of the projectile is maximum.
- c) What is central force? Show that motion of a particle under central force is confined to a plane.
- d) What is meant by inelastic collision?
- e) What is meant by apsidal distance?
- f) What is meant by holonomic constraint?
- g) What is Coriolis force ?

Q.2 Attempt ANY FIVE of the following questions. (3 x 5 = 15)

- a) A rocket engine of mass 3×10^5 Kg having fuel of mass 2×10^5 kg can eject exhaust gases with velocity 3000m/s and at a rate of consumption of fuel 10^4 kg/s. Calculate the maximum vertical velocity attained by the rocket.
- b) The distance between sun and earth is suddenly reduced to half of its present distance. What will be the duration of year?

- c) Find the angle of projection when the horizontal range is $4\sqrt{3}$ times of its maximum height.
- d) Show that Hamiltonian of a system represents the total energy of the system.
- e) A particle of mass 1 g with velocity 2×10^3 m/s is incident on another particle of mass 2 g which is at rest. It is scattered along the direction making an angle of 45° with incident direction, while the particle of mass 2 g is recoiled with an angle 30° . Find the velocity of the particle of mass 1 g after collision.
- f) What are the types of constraints?
- g) Explain the effect of Coriolis force when a river flows on the surface of earth.

Q.3 Attempt ANY FIVE of the following questions. (5 x 5 = 25)

- a) Show that the path of charged particle moving with a uniform velocity in transverse electric field is parabola.
- b) How does a two body problem reduce to an equivalent one body problem?
- c) From D'Alembert's principle obtain Lagrange's equation of motion.
- d) Obtain the equation of height of rocket at an instant.
- e) Explain the conditions under which the orbit will be an ellipse, hyperbola, parabola and circle in an inverse square law of force.
- f) What is elastic collision? Describe two body elastic collisions in centre of mass system.
- g) Find the horizontal component of the Coriolis force acting on a body of mass 1.5 kg moving northward with a horizontal velocity of 100m/s, at 30° N latitude on earth.

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14/11/2022 o/c

Deccan Education Society's
FERGUSON COLLEGE (Autonomous) Pune-4
T.Y. B.Sc, Semester: VI
PHYSICS
Classical Electrodynamics (PHY3601)
(2019 Pattern) (2 Credits)

Time: 2 hours 30 mins

Max. Marks: 50

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Draw neat and labelled diagrams wherever necessary.
- 3) Figures to the right indicate full marks.
- 4) Use of logarithmic tables and pocket calculators is allowed.

Q.1 Attempt ANY FIVE of the following questions. (2 x 5 = 10)

- a) Determine the electric flux linked with a cube of side 'A' enclosing an electric dipole.
- b) What is meaning of polar and nonpolar molecule? Give one example of each.
- c) Write integral form of Ampere's Law.
- d) Why atomic polarizability of helium is less than hydrogen?
- e) What is significance of electric potential formalism in Electrostatics?
- f) Write the equation which interprets "Changing magnetic field induces electric field".
- g) A charge q is moving perpendicular to the direction of uniform magnetic field $\vec{B}$. What is force acting on charge q ?

Q.2 Attempt ANY FIVE of the following questions. (3 x 5 = 15)

- a) Determine electric field outside a charged nonconducting sphere of radius 'R' having total charge 'Q' on it.
- b) Write one advantage of method of images.
- c) Find the field $\vec{E} = xyz\hat{z}$, is conservative or nonconservative?

- d) Conducting circular loop is placed in a uniform magnetic field $B=0.04\text{T}$ with its plane perpendicular to the field. Somehow radius of the loop starts shrinking at constant rate of 2 mm/sec . Find the induced emf in the loop at the instant when radius is 2cm .
- e) Is diamagnetism a universal property? Comment.
- f) Avantika Express takes 14 hours to cover the distance of 1000km between Mumbai and Indore. The rails are separated by distance 100cm and vertical components of earth's magnetic field is $4 \times 10^{-5}\text{ T}$. Find the average emf induced across the width of the train.
- g) Explain one application of Lorentz law.

Q.3 Attempt ANY FIVE of the following questions. (5 x 5 = 25)

- a) Three charges q_1, q_2 and q_3 are situated at the vertices of equilateral triangle of side length 'a'. Find total energy required to assemble them.
- b) Determine the force acting on charge 'q' kept near to infinite grounded conducting plane.
- c) Describe the necessity of Maxwell's correction in Ampere's law.
- d) Describe the origin and meaning of motional emf. Draw suitable diagram for explanation.
- e) A steady current is flowing down a long cylindrical wire of radius 'a'. Find the magnetic field inside the wire if $|\vec{j}| \propto s$, where s is distance from the axis of cylinder.
- f) Determine the magnetic field at the centre of square carrying steady current I.
- g) Describe following terms:
 - i) Bound charges ii) Displacement vector

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15/11/2022 o/c

Deccan Education Society's
FERGUSON COLLEGE (Autonomous) Pune-4
Affiliated to Savitribai Phule Pune University

T.Y.B.Sc. (Semester : VI)
Subject: Physics
Paper Title: Quantum Mechanics
Paper Code: PHY3602
2019 Pattern (2 Credits)

[Time: 2:30 Hours]

[Max. Marks : 50]

Instructions to the candidates:

- All questions are compulsory.
 - Draw neat and labelled diagrams wherever necessary.
 - Figures to the right indicate full marks.
 - Use of logarithmic tables and pocket calculators is allowed.
-

1. Answer the following questions (Any Five).

[2 × 5] M

- Define wave packet with proper diagram.
- Give physical significance of wave function.
- Find the eigen value of e^{4x} for the operator $\frac{d^2}{dx^2}$.
- Define angular momentum operator and total energy operator.
- Find $[l_y, x]$.
- Normalise the given wave function $\psi(x) = Ae^{(-\frac{x}{2a} + ikx)}$.
- What is the smallest possible uncertainty in the position of particle moving with velocity of $3 \times 10^6 \text{ m/s}$, $\hbar = 1.055 \times 10^{-34} \text{ Js}$.

2. Answer the following questions (Any Five).

[3 × 5] M

- Derive the relation between group velocity and particle velocity.
- Show that $\frac{d}{dx} \langle P_x \rangle = \langle \frac{\partial V}{\partial x} \rangle$.
- Determine the current density if wave function is $\psi(x) = Ae^{-ikx}$.

d) Find the eigen function and eigen values of operator $(x^2 + \frac{d}{dx})$.

e) State the physical significance of equation of continuity.

f) Solve the $[L^2, L_y]$.

g) Obtain the independent Schrodinger wave equation.

3. Answer the following questions (Any Five).

[5 × 5] M

a) Show that eigen values of the Hermitian operator are real and momentum operator is the Hermitian operator.

b) A proton confined to move in one dimensional potential box of width 0.2nm. Find lowest possible energy of proton.

$$m_p = 1.67 \times 10^{-27} \text{Kg}, \hbar = 1.055 \times 10^{-34} \text{Js}.$$

c) Explain Davison and Germer experiment to prove wave nature of moving electron.

d) Apply Schrodinger's equation for particle in one dimensional well and obtain energy eigen value and eigen function of it.

e) Solve the steady-state Schrodinger's equations for the potential $V(x) = a$.

f) Explain the concept of parity, parity operator and its eigen values in detail.

g) Using the ground state wave function of the simple harmonic oscillator

$$\psi(x) = \sqrt{\left(\frac{a}{\pi}\right)} e^{-\frac{ax^2}{2}}. \text{ Find}$$

i) $\langle x \rangle$

ii) $\langle x^2 \rangle$.

16/11/2022.
2.30 pm

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Deccan Education Society's
FERGUSON COLLEGE (Autonomous) Pune-4
T.Y. B. Sc. Semester: VI

PHYSICS
Thermodynamics and Statistical Mechanics (PHY3603)
(2019 Pattern) (2 Credits)

Time: 2 hours 30 mins

Max. Marks: 50

Instruction to candidates:

- i) *All questions are compulsory.*
- ii) *Figures to the right indicate full marks.*
- iii) *Use of logarithmic tables and scientific calculators is allowed.*

Q.1 Attempt any FIVE questions:

(2 x 5 = 10)

- a) Define mean free path.
- b) In the random walk problem, what is the root mean square deviation?
- c) Explain the probability distribution curve using a suitable example.
- d) Explain the meaning of mean square deviation
- e) Explain the terms phase space and phase trajectory.
- f) Write any two basic postulates of statistical mechanics.
- g) What are bosons? Which statistic is used to study them?

Q.2 Attempt any FIVE questions:

(3 x 5 = 15)

- a) The viscosity of oxygen at N.T.P. is $1.96 \times 10^{-4} \text{ gm cm}^{-1} \text{ s}^{-1}$. Calculate the diameter of the molecule of a gas.
(Given: Boltzmann constant $K_B = 1.38 \times 10^{-16} \text{ ergs/K}$,
Avogadro's number $N_A = 6.023 \times 10^{23}$,
Molecular weight of oxygen = 32)
- b) The energy state of a particle moving in a rigid cubical box is specified by an equation $n_x^2 + n_y^2 + n_z^2 = \frac{2mL^2E}{\pi^2\hbar^2} = 14$. Determine the number of microstates accessible to the particle.
- c) A bag contains 10 red balls and 8 white balls. Two balls are drawn at random one after the other. What is the probability that both balls are red?
- d) If $p = q = \frac{1}{2}$ and total number of possibilities are $N = 200$.
Find a) mean value of n_1 i.e., $\bar{n}_1$ b) root mean square deviation

- e) Calculate the change in entropy when 10 grams of ice at 0 °C is converted into water at the same temperature.
(Given: Latent heat of ice = 80 Cal/gram)
- f) Derive the expression for mean value of energy in canonical distribution.
- g) Four molecules are to be distributed in two cells. Find possible number of macrostates and corresponding number of microstates.

Q.3 Attempt any FIVE questions:

(5 x 5 =25)

- a) For canonical ensemble, obtain the expression for $\bar{E}$ and $\overline{E^2}$ in terms of β and Z .
- b) What is transport phenomenon? Explain in brief viscosity, conductivity and self-diffusion on this basis.
- c) When a particle undergoes total number of steps ($N = 3$), draw different possibilities of steps. If $p = q = 1/2$, then find the probabilities corresponding to $n_1 = 0, 1, 2$ or 3.
- d) For random walk problem, show that mean displacement is,
 $\bar{m} = N(p - q)$
- e) Obtain the expression for Fermi-Dirac distribution law.
- f) What is Joule-Thomson effect? Prove that enthalpy remains constant in a throttling process.
- g) Derive Boltzmann entropy probability relation $S = k_B \ln \Omega(E)$, where, S is entropy and $\Omega(E)$ is the number of microstates in the entropy interval between E and $E + \delta E$, and k_B is Boltzmann constant.

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12/11/2022 o/c

**Deccan Education Society's
Fergusson College (Autonomous), Pune-4
T.Y.B.Sc. (Semester VI)
Physics
(PHY3604) Nuclear Physics (2019 pattern)**

Time: 2 hrs 30min

Max. Marks: 50

Instruction to candidates:

- i) All questions are compulsory
- ii) Figures to the right indicate full marks
- iii) Use of statistical tables and scientific calculators is allowed.

Constants:

- 1. Mass of proton, $m_p = 1.007825$ a.m.u.
- 2. Mass of neutron, $m_n = 1.008665$ a.m.u.
- 3. $1 \text{ a.m.u.} = 1.66 \times 10^{-27} \text{ kg} = 931.5 \text{ MeV}$
- 4. $1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$
- 5. Mass of electron, $m_e = 9.1 \times 10^{-31} \text{ kg}$
- 6. Avogadro's number, $N = 6.023 \times 10^{23} \text{ mol}^{-1}$
- 7. Boltzman constant, $k = 1.38 \times 10^{-23} \text{ joule/}^\circ\text{K}$
- 8. Plank's constant, $h = 6.625 \times 10^{-34} \text{ joule.sec}$

Q.1 Attempt any five questions:

[2 x 5 =10]

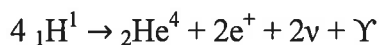
- a) Explain mass defect and binding energy.
- b) Explain quark model for protons.
- c) Define half life of radioactive substance.
- d) What is nuclear fission?
- e) Draw Feynman diagram for interaction between two nucleons.
- f) Define ideal equilibrium and secular (or permanent) equilibrium.
- g) What is dead time of the G. M. counter?

Q.2 Attempt any five questions:

[3 x 5 =15]

- a) Calculate the time required for 10% of a sample of thorium to disintegrate. Assume the half life of thorium to be 1.4×10^{10} years.
- b) A meson constructed from a quark and antiquark. Show that the quark structure $(u, \bar{d})$ give the correct charge number, spin and strangeness for π^+ meson.

- c) The sun radiate energy at the rate of 4×10^{23} kW. Assuming that the reaction



accounts for energy released, calculate (a) the number of protons fused per second and (b) the mass transformed into energy. (mass of helium = 4.002603 a.m.u., mass of positron = 5.4858×10^{-4} a.m.u.)

- d) Obtain the ratio of the nuclear radii of the lead ${}_{82}^{204}\text{Pb}$ and the silver isotope ${}_{47}^{107}\text{Ag}$.
- e) Find the approximate lengths of the first and last drift tubes, if 0.5 MeV protons are injected into a 50 MeV linear accelerator powered by 200 MHz radio – frequency supply. (mass of proton = 1.67×10^{-27} kg)
- f) Calculate the binding energy, binding energy per nucleon and packing fraction for helium. Given: mass of helium, ${}_2^4\text{He} = 4.00378$ a.m.u.
- g) Calculate the activity of (i) 1 gm of radium ${}_{88}^{226}\text{Ra}$, Half life = 1622 years; (ii) 3×10^{-9} kg of active gold, ${}_{79}^{200}\text{Au}$, Half life = 48 min.

Q.3 Attempt any five questions:

[5 x 5 =25]

- a) Obtain an expression for law of radioactive decay.
- b) Explain Meson theory of nuclear forces.
- c) What is nuclear fusion? Explain proton-proton and carbon cycle in the stars.
- d) Define packing fraction of the nucleus. How it determines the stability of the nucleus? Explain by packing fraction curve.
- e) Describe construction and working of linear accelerator.
- f) Discuss electric quadrupole moment of nucleus.
- g) What is nuclear reactor? State the essential components of the reactor. Explain power reactor with diagram

18/11/22

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Deccan Education Society's
FERGUSON COLLEGE (Autonomous) Pune-4
Affiliated to Savitribai Phule Pune University
T.Y. B.Sc. (Semester: VI)
Subject: PHYSICS
Paper Title: Astronomy and Astrophysics
Paper Code: PHY3605
2019 Pattern (2 Credits)

[Time: 2hrs 30 min]

[Max. Marks : 50]

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Neat diagrams must be drawn wherever necessary.

Figures to the right side indicate full marks.

Q.1 Answer any five of the following:

10 mks

- a. The surface temperature of a star is 25,000K, at what wavelength is it emitting maximum radiation?
- b. What is the difference between annular eclipse and total solar eclipse?
- c. What is the peculiarity of "M" stars?
- d. What is meant by collecting power of a telescope? compare the collecting powers of 6 inch and 8 inch telescopes.
- e. How are Cepheid variables differentiated from other stars?
- f. What are peculiar galaxies?
- g. Where are Magellenic clouds found?

Q.2 Answer any **five** of the following:

15 mks

- a. Calculate the distance of Saturn from the Sun using Bodes law.
- b. Can you correlate the abundance of elements in the universe with fusion reactions in stars?
- c. An event is taking place in a city (45°W), at what time we in India (82.5°E) should log in to take part in the event?
- d. Is it possible to use optical telescopes as IR telescopes?
- e. What is Cosmology? which different cosmologies are you aware of?
- f. How is interesting abbot the quasar red shift?
- g. What is the difference between stars of 3^{rd} and 5^{th} magnitudes?

Q.3 Answer any **five** of the following:

25 mks

- a. Compares Red giants with brown dwarfs on the H-R diagram.
- b. How will you differentiate the spectra of "G" star with that of a "B" star? Give reasons.
- c. What is meant by Radio interferometry?
- d. Compare the fate of low and high mass stars.
- e. Explain the working of a CCD camera.
- f. What are the evidences of the Big Bang theory.
- g. What are AGN's, describe the various types that you know.

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**Deccan Education Society's
Fergusson College (Autonomous) Pune-4
T. Y. B. Sc SEM VI
Physics
Digital Electronics (PHY3605)
(Paper –V) (2016 Pattern)**

Time: 2 Hours

Max Marks: 50

Instructions: a) All questions are compulsory.
b) Figures to right indicate full marks.
c) Draw neat labelled diagrams wherever necessary.

- Q.1 Answer Any Five of the following questions:** (2x5=10)
- State De-Morgan's 1st and 2nd Theorem.
 - Convert C5E2 (Hexadecimal) into binary.
 - State Primary difference between JK and RS flip-flop.
 - What is switch control bounce?
 - Convert octal 257 to decimal equivalent.
 - Calculate the decimal equivalent of binary 1001.
 - What is flash memory?
- Q.2 Answer Any Five of the following questions:** (3x5=15)
- Compare the difference between TTL & CMOS.
 - Describe encoding with suitable example.
 - Name the four types of storage devices.
 - How many flip-flop's are required to produce a binary sequence representing decimal numbers 0 through 15?
 - What is flip-flop? Draw logic symbol and truth table for D-flip-flop.
 - Describe a 4-bit D/A converter system.
 - Explain Diode matrix as a ROM.
- Q.3 Answer Any Five of the following questions:** (5x5=25)
- Describe PISO and PIPO in detail.
 - Explain the concept of FAN-IN and FAN-OUT in detail.
 - Describe full adder in detail.
 - With suitable diagram explain edge triggered RS-flip-flop.
 - Explain single and dual slope technique for A/D conversion.
 - How many bits are required at the input of a converter if it is necessary to resolve voltage to 5 mv and the ladder has +10V full-scale?
 - Explain memory cell's, organization and addressing of memory cell's.
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18/11/22

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**Deccan Education Society's
Fergusson College (Autonomous) Pune-4
T.Y.B.Sc. (Semester IV)
Physics
Computational Physics (PHY3606)
(2016 Pattern)**

Time: 2 Hours**Max Marks: 50****Instructions:** a) All questions are compulsory.

b) Figures to right indicate full marks.

c) Draw neat labelled diagrams whenever necessary

Q.1 Answer Any Five of the following questions:**(2x5=10)**

- a. Define i) True error ii) Truncation error
- b. Write a comparison between Bisection Newton Raphson and Secant Method.
- c. In Gauss elimination Method write a algorithm for eliminating x_1 from n-equation.
- d. Obtain the interpolation quadratic polynomial for the given data by using Newton's forward difference formula.

x	0	2	4	6
y	-3	5	21	45

- e. What do you mean error in error analysis? Mention its types.
- f. If $g(x)$ is continuous in $[a, b]$ then under what condition for iterative method $y=g(x)$ has unique solution in $[a, b]$?
- g. What are the error in Trapezoidal is and simpson's Rule of numerical integration?

Q.2 Answer Any Five of the following questions:**(3x5=15)**

- a. To find the root of $f(x)=0$, a scientist using the bisection method. At the beginning of iteration, the lower and upper guesses of the root are x_i and x_n . At the end of the iteration what will be the absolute relative approximate error in the estimated value of the root.
- b. Evaluate the order of convergence of Newton-Raphson Method.
- c. Solve the following system of equation by Gauss elimination method, correct to three decimal places.

$$28x+4z=32$$

$$X+3y+10z=24$$

$$2x+17y+4z=35$$

- d. Find the interpolation polynomial $f(x)$ by using Newton's forward difference interpolation formula and hence find the value of $f(5)$ for.

x	4	6	8	10
f(x)	1	3	8	16

- e. Using Simpson's 1/3 rule, evaluate $\int_0^{0.6} e^{-x^2} dx$ correct to three decimal places by a step size 0.1
- f. Given $3 \frac{dy}{dx} + 5y^2 = \sin x$, $y(0.3)=5$ and using a step size of $h=0.3$, find the value of $y(0.9)$ using the Range-Kutta 2nd order heun Method.

- g. Given $3\frac{dy}{dx} + 5y^2 = \sin x$, $y(0.3)=5$ and using a step size of $h=0.3$, find the value of $y(0.9)$ using Euler's Method.

Q.3 Answer Any Five of the following questions:

(5x5=25)

- Assuming an initial bracket $[1, 5]$, find value of root of equation $te^{-t} - 0.3=0$ at the end of 2nd iteration by using Bisection method.
 - Find the interpolation polynomial $f(x)$ by Lagrange formula and hence find $f(3)$ for $(0,2)$, $(1, 3)$, $(2, 12)$ and $(5, 147)$
 - Given $\frac{dy}{dx} = xy + y^2$, $y(0) = 1$, $y(0.1) = 1.1169$, $y(0.2) = 1.2773$ find $y(0.3)$ by R-k method of 4th order.
 - Find the approximate root of $xe^x=3$ by Newton's Raphson method correct to three decimal place.
 - Find the first and second derivatives for function tabulated below of $x=1.5$
- | | | | | | | |
|------|-------|-----|--------|------|--------|------|
| x | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 |
| f(x) | 3.375 | 7.0 | 13.625 | 24.0 | 38.875 | 59.0 |
- Find the value of $\log 2^{1/3}$ from $\int_0^1 \frac{x^2}{1+x^3} dx$ using Simpson's 1/3 Rule with $h=0.25$.
 - The velocity of a body is given by
 $v(t) = 2t \quad 1 \leq t \leq 5$
 $= 5t^2 + 3 \quad 5 < t \leq 14$ when 't' is given in seconds and 'v' is given in m/s use the two segment trapezoidal rule to find the distance covered by a body from $t=2$ to $t=9$ seconds.

19/11/22 o/c

Deccan Education Society's
FERGUSSON COLLEGE (Autonomous) Pune-4
T.Y. B.Sc, Semester: VI
PHYSICS
Energy Studies (PHY3606)
(2019 Pattern) (2 Credits)

Time: 2 hours 30 mins

Max. Marks: 50

Instructions to the candidates:

- 1) All questions are compulsory.*
- 2) Draw neat and labelled diagrams wherever necessary.*
- 3) Figures to the right indicate full marks.*
- 4) Use of logarithmic tables and pocket calculators is allowed.*

Q.1 Attempt ANY FIVE of the following questions. (2 x 5 = 10)

- a) What is thermochemical conversion of biomass gasification?
- b) State main components of flat plate collectors.
- c) What is wind energy?
- d) What is electrical vehicle (EV) and its types?
- e) Define solar constant.
- f) State any two advantages of photo voltaic system.
- g) Write two factors affecting bio-degradation.

Q.2 Attempt ANY FIVE of the following questions. (3 x 5 = 15)

- a) Define Fill Factor (FF) and maximum conversion efficiency.
- b) Explain the methods for obtaining energy from Biomass.
- c) The radius of sun surface is 6.960×10^8 m and the mean earth-sun distance is 4.5×10^{11} m. Find the angular divergence.
- d) With neat diagram explain in brief p-n junction solar cell.
- e) What is Fuel cell? Explain it.

Q.2 f) Assuming Sun as a black body whose temperature is 5762 K, calculate the solar flux.

Given: Radius of the Sun surface: 6.96×10^8 m.

Stefan-Boltzman constant: $5.67 \times 10^{-8} \text{ W/m}^2\text{K}^4$

Mean Earth-Sun distance: 1.5×10^{11} m.

g) Describe solar water heater.

Q.3 Attempt ANY FIVE of the following questions. (5 x 5 = 25)

a) Explain the term: solar radiation at the earth's surface.

b) Explain the applications of Gasifiers.

c) Differentiate Lithium Ion battery and Sodium Ion battery.

d) Calculate efficiency of solar cell using the following data.

Given: $V_{OC}=400$ mV, $I_{SC}= 40$ mA, $FF=0.7$, Input power of the cell= 6×10^{-2} W

e) Write short note on:

i) Solar cooker

ii) Solar dryer

f) The solar radiation intensity leaving the surface of the sun is $5.961 \times 10^7 \text{ W/m}^2$ and radius of sun surface is 6.960×10^8 m. If the sun emits radiation epically then determine the radiant flux crossing the surface.

g) Sate the disadvantages of floating drum and fixed domed type plant.

19/11/22 o/c

**Deccan Education Society's
Fergusson College(Autonomous), Pune – 04.
T.Y.B.Sc. Semester VI
Physics
Astronomy and Astrophysics (PHY 3607)
2016 Pattern**

Time : $2\frac{1}{2}$ Hours

Max Marks: 50

Instructions: a) All questions are compulsory.
b) Figures to the right indicates full marks.
c) Draw the diagrams wherever necessary.

- Q. 1. Solve any five: (10 Marks)**
- a) An object in space is receding at a speed of 50,000 Km/s, what will be the shift in its spectra if the $\lambda_{\max}$ is at 5800Å.
 - b) What is the difference between a Transit and an Eclipse?
 - c) What is meant by the Chandrasekhar limit?
 - d) How bright is a 4th magnitude star from 6th magnitude star?
 - e) Compare grating and prism spectroscopes.
 - f) Why do we not use telescopes under highest magnification?
 - g) What is the difference between a Neutron star and a pulsar.
- Q. 2. Solve any five: (15 Marks)**
- a) What is a protostar? When is it formed?
 - b) What is meant by Solar maxima and minima?
 - c) How are Radio telescopes different from optical ones.
 - d) Nocturnal animals have large pupils in their eyes, How will you relate that to astronomical telescopes?
 - e) Explain why Annular Eclipse is a very rare event.
 - f) Differentiate between spectra of "A" and "F" star.
 - g) What is the difference between Doppler and gravitational red shift?
- Q. 3. Solve any five: (25 Marks)**
- a) What is the significance of the HR diagram in Astronomy?
 - b) Write a short note on X-ray telescope.
 - c) What are the evidences of the Big Bang theory?
 - d) What are Cepheid variables.
 - e) What are AGN's, give a few examples.
 - f) What is a Quasar Red shift?
 - g) What information is obtained from stellar spectra?

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**Deccan Education Society's
Fergusson College (Autonomous) Pune-4
T.Y.B.Sc. Semester VI
Physics Paper VI
RENEWABLE ENERGY SOURCES (PHY3608)
(Paper I) (2016 Pattern)**

Time: 2 Hours**Max Marks: 50***Instructions: a) All questions are compulsory.**b) Neat and labelled diagrams must be drawn wherever necessary**c) Figures to right indicate full marks.***Q.1 Answer Any Five of the following questions:****(2x5=10)**

- a. What is biomass?
- b. State the principle of solar dryer.
- c. State any two application of solar cell.
- d. Define gasifier.
- e. What are non-conventional sources of energy?
- f. State types of rotors used in wind machine.
- g. State the photovoltaic principle.

Q.2 Answer Any Five of the following questions:**(3x5=15)**

- a. Describe solar water heater.
- b. Explain the methods for obtaining energy from Biomass.
- c. With neat diagram explain in brief p-n junction solar cell.
- d. State energy balance equation for the collector.
- e. Assuming Sun as a black body whose temperature is 5762 K, calculate the solar flux.
Given : Radius of sun surface : 6.96×10^8 m
Stefan-Boltzman constant : $5.67 \times 10^{-8} \text{ W/m}^2\text{K}^4$
Mean Earth-Sun distance : 1.5×10^{11} m
- f. What is energy audit?
- g. Define Fill Factor (FF) and maximum conversion efficiency.

Q.3 Answer Any Five of the following questions:**(5x5=25)**

- a. The solar radiation intensity leaving the surface of the sun is $5.961 \times 10^7 \text{ W/m}^2$ and radius of sun surface is 6.96×10^8 m. If the sun emits radiation equally then determine the radiant flux crossing the surface.
State the advantages of floating drum and fixed domed type plant.
 - b. State the advantages of floating drum and fixed domed type plant.
 - c. Describe box type solar cooker with neat diagram.
 - d. Give the structure and characteristics of sun. Draw spectral distribution of extra-terrestrial radiation.
 - e. Describe gasification of biomass by downdraft gasifier.
 - f. Calculate the input power of solar cell using following data:
Given: $V_{oc} = 400\text{mV}$, $I_{sc} = 40\text{mA}$, $FF = 0.7$, and efficiency (η) = 12%.
 - g. Explain vertical axis type wind mill.
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**Deccan Education Society's
Fergusson College (Autonomous), Pune-4**

**T.Y.B.Sc. (Semester VI)
Subject: PHY 3611:Digital Electronics
(2019 pattern)**

Time: 2.30Hrs

Max. Marks: 50

Instruction to candidates:

- i) All questions are compulsory
- ii) Figures to the right indicate full marks
- iii) Use of statistical tables and scientific calculators is allowed.

Q.1 Attempt any five questions: [2 x 5 =10]

- a) Write the Binary equivalent of decimal 257?
- b) Find the Decimal equivalent of binary 1010.
- c) State main difference between fixed point and floating point representation
- d) What is possible edge triggering?
- e) State the primary difference between D and RS flip-flop.
- f) What is Switch contact bounce?
- g) What are the advantage of the Continuous type A to D converter and counter type A to D converter?

Q.2 Attempt any five questions: [3 x 5 =15]

- a) Explain Binary System with suitable example.
- b) What is ASCII Code?
- c) Describe Fan-In and Fan-out.
- d) With Suitable Diagram explain JK flip-flop.
- e) Explain in detail IC 7490.
- f) Find the output voltage from a 5-bit ladder that has a digital input of 11010 (assume 0=0V, 1=10V).
- g) What is the operational difference between SRAM and DRAM?

Q.3 Attempt any five questions: [5 x 5 =25]

- a) Prove that $A(A'+C)(A'B+C)(A'BC+C')=0$
- b) Explain K-map in detail with Suitable examples.

- c) What are counters? Describe asynchronous counter in detail.
- d) Explain the counter method of A to D converter.
- e) Draw and Explain the timing diagram of a typical memory write operation.
- f) Explain a BJT based memory Cell.
- g) Describe in detail Multiplexer with the help of block diagram; Also draw the logic circuit diagram of 2to 1 multiplexer.

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Deccan Education Society's					
FERGUSON COLLEGE (Autonomous) Pune-4					
T.Y. B. Sc, Semester: VI					
PHYSICS					
Course Title: C programming (PHY3612)					
(2019 Pattern) (2 Credits)					
Time: 2 hours 30 mins				Max. Marks: 50	
Instructions to the candidates:					
1) All questions are compulsory.					
2) Draw neat and labelled diagrams wherever necessary.					
3) Figures to the right indicate full marks.					
4) Use of logarithmic tables and pocket calculators is allowed.					
Q.1		Attempt ANY FIVE of the following questions.			(2 x 5 = 10)
	a)	What are advantages of Algorithm.			
	b)	Draw symbol of (1) process (2) Input/output (3) subroutine (4) module call			
	c)	What is token in C programming? Write any four tokens.			
	d)	If p=20, q=50 ; C = (p > q)? p:q, then what is value of C?			
	e)	What are standard input/output functions used in C programming?			
	f)	What is difference between do and for loop statement?			
	g)	What are the ways for passing Array element to a function.			
Q.2		Attempt ANY FIVE of the following questions.			(3 x 5 = 15)
	a)	What is output of void main() {int a; a = mul (10,20); printf(“%d\n”, a); }			
	b)	Write syntax for drawing (i)circle (ii)ellipse (iii) line and (iv) arc.			
	c)	Write a program to display your name using string constant.			

	d)	What are different rules for giving variable names.	
	e)	With suitable example explain incremental and decremental operator.	
	f)	What are different types of data. Give one example each.	
	g)	If i= 2, j = 4, k = 6, interpret the following.(i) i<j (ii) i+j >= k (iii) k !=6	
Q.3		Attempt ANY FIVE of the following questions. (5 x 5 = 25)	
	a)	Write flowchart to find factorial of 10.	
	b)	What are characteristics of algorithm? What are advantages and disadvantages of algorithm.	
	c)	Write C program to calculate area of circle and triangle.	
	d)	If float x =12.3456 then write output of following (i) printf(“%7.4f”,x); (ii) printf(“%7.2f”,x); (iii) printf(“%f”,x); (iv) printf(“%10.2e”, x); (v) printf(“%e”,x);	
	e)	Explain switch statement. Write C programme using switch statement.	
	f)	What are library functions? Write program to find square root of 100 using sqrt function.	
	g)	Write C program to find roots of $ax^2 + bx + c = 0$	

