TDP (General) 1st Semester Exam., 2019

PHYSICS

(General)

FIRST PAPER

Full Marks : 40

Time : 2 hours

The figures in the margin indicate full marks for the questions

Answer **four** questions, taking **one** from each Unit

UNIT—I

1. *(a)* State Green's theorem in plane and write its mathematical form.

(b) Evaluate $\vec{\nabla}\varphi$, where φ is scalar function given by $\varphi = \frac{1}{r}$.

(c) If $\vec{v} = \vec{\omega} \times \vec{r}$, then show that

$$\vec{\omega} = \frac{1}{2}\vec{\nabla} \times \vec{v}$$

where $\vec{\omega}$ is a constant vector. 2+4+4=10

2. *(a)* Calculate the moment of inertia of a solid cylinder about an axis through its centre and perpendicular to its length.

(b) What are generalized coordinates?

(c) A pendulum with a bob of mass m and length l, is suspended from a massless spring of spring constant k. The spring has only vertical motion. Find the Lagrangian and Lagrange's equation of motion. 3+2+(2+3)=10

UNIT—II

3. *(a)* The mass of the moon is about 8% of the mass of the earth and diameter is about 25% that of the earth. Find the acceleration due to gravity on the surface of the moon.

(b) Find an expression for the work done in stretching a wire and hence energy per unit volume of the wire.

(c) A wire of length 1 m, diameter 10^{-3} m is firmly fixed at its one end. If a couple of 0·5 N-m is applied to the other end of the wire and twisted the wire by an angle 45°, then find the modulus of rigidity of the material of the wire.

3+(3+1)+3=10

4. *(a)* Define surface tension of a liquid. Mention the factors that affecting the surface tension of a liquid.

(b) State Jurin's law and mention its limitations.

(c) Define terminal velocity. Find the terminal velocity of an oil-drop of density $1\,g/cm^3$ and radius 10^{-4} cm falling through air of density $0\cdot0013\,g/cm^3$, if the viscosity of the air is $1\cdot81\times10^{-4}$ c.g.s. unit.

(1+2)+(2+1)+(1+3)=10

UNIT—III

5. *(a)* In what respect, a real gas differs from an ideal gas?

(b) What is Boyle temperature?

(c) In a Carnot's engine, the temperature of source and sink are 227 °C and 102 °C respectively. If the engine consumes 600×10^5 cals per cycle, find its efficiency and work done per cycle.

(d) Define reversible and irreversible changes with example. 2+1+4+3=10

6. *(a)* Write van der Waals' equation of state for real gas.

(b) State second law of thermodynamics.

(c) Define Thomson effect and inversion temperature.

(d) What is entropy? Show that change in entropy in a Carnot's cycle is zero.

1+2+2+(1+4)=10

UNIT—IV

7. *(a)* State Fermat's principle. Using it establish Snell's law of refraction of light.

(b) Two convex lenses of focal lengths 10 cm and 20 cm are placed 5 cm apart in air. Find equivalent focal length.

(c) Name the cardinal points of a lens.

(1+4)+3+2=10

8. *(a)* Explain clearly Huygens' principle for propagation of light.

(b) Define double refraction.

(c) Discuss Fraunhofer diffraction pattern due to a single slit. Derive the condition for production of maxima and minima.

3+2+5=10

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(Continued)

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   3+2+5=10

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TDP (Honours) 3rd Semester Exam., 2019

PHYSICS
(Honours)

THIRD PAPER (Group—A)

Full Marks : 48

Time : 2 hours

The figures in the margin indicate full marks for the questions

Answer **four** questions, taking **two** from each Unit

UNIT—I

1. *(a)* State superposition theorem as applied to network analysis. Considering a simple resistive *T*-network and two DC sources, verify the validity of this theorem.

(b) Show that the self-inductance of solenoid of finite length is given as

$$L = \frac{\mu_0 N^2 A}{l^2}\left(\sqrt{a^2 + l^2} - a\right)$$

where symbols have their usual meanings. Also discuss the case when $l >> a$.

(c) Establish the differential form of Faraday's law in electromagnetic induction.

(d) An L-C-R circuit is critically damped with $L = 0{\cdot}2$ H and $R = 100$ ohms. What is the value of C? (1+3)+(3+1)+2+2=12

2. (a) In a thermoelectric circuit, discuss the origin of Peltier e.m.f.

(b) What is thermoelectric power diagram? Explain its significance.

(c) Using thermoelectric diagram, find the expression for total e.m.f. generated by a thermocouple.

(d) The e.m.f. equation of thermocouple is $E = at + bt^2$ in μV, where t is the temperature of the hot junction, the cold junction being at 0 °C. Given $a = 20\ \mu V/°C$, $b = -0{\cdot}0025\ \mu V/°C^2$. Find the temperature at which the Peltier coefficient is maximum and hence obtain the difference of the Thomson coefficients for the pair of metals of the thermocouple. 2+(2+2)+3+3=12

3. *(a)* What is the power factor in an AC circuit? What is its value for purely resistive and inductive circuits? What is wattless current?

(b) An air cored solenoid has a diameter of 2·5 cm and 500 turns wound over a length of 30 cm. Calculate the self-inductance of the solenoid and the self-linked flux, when the current in the solenoid is 2 A.

(c) A parallel *L-C* combination is in series with a resistance *R*. If a voltage $V_i \sin \omega t$ is applied to this circuit, calculate the voltage across the *L-C* combination. Show that this voltage reaches a maximum, when $\omega = \frac{1}{\sqrt{LC}}$. (Here L = inductor and C = capacitor.)

(d) How do you measure current in a circuit using a potentiometer?

(1+1+1)+2+(3+1)+3=12

UNIT—II

4. *(a)* Is it possible to utilize the huge internal energy of ocean to convert into external work? Justify your answer.

(b) Why a Carnot engine must be reversible in nature?

(c) Why is it not possible to get a 100% efficient Carnot engine?

(d) What necessitates the existence of entropy function?

(e) Calculate the change in the melting point of ice when it is subjected to pressure of 100 atmospheres. Given, density of ice = 0·917 g/cc, latent heat of ice = 336 J/g. 2+2+2+3+3=12

5. (a) "Substances having positive volume expansion coefficient generate heat on isothermal compression." Establish it from Maxwell's thermodynamic equation. Also discuss the anomalous expansion of water at 0 °C at normal atmospheric pressure.

(b) Even at sufficiently low temperature, why H_2, He show heating effect on throttling due to J-T expansion unlike other gases?

(c) What is radiation pressure? Show that the energy density of radiation inside a uniformly heated enclosure is given by $u = 4\pi K/c$, K = specific intensity of radiation and c = velocity of light.

(3+2)+2+(2+3)=12

(Continued)

6. *(a)* Derive Maxwell's law of velocity distribution of molecules for an ideal gas.

(b) What do you mean by self-diffusion of gas? Define the coefficient of diffusion and write down its mathematical form.

(c) Calculate the mean-free path, collision rate and molecular diameter of hydrogen, given $\eta = 85\times10^{-6}$ dyne/sq-cm, per unit velocity gradient $\bar{c} = 16\times10^{5}$ cm/s and $\rho = 0{\cdot}000089$ g/cc. 5+(2+2)+3=12

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TDP (General) 3rd Semester Exam., 2019

PHYSICS

(General)

THIRD PAPER

Full Marks : 40

Time : 2 hours

The figures in the margin indicate full marks for the questions

Answer **four** questions, taking **two** from each Unit

UNIT—I

1. *(a)* Define neutral temperature and thermo-electric power of a thermocouple.

(b) State and prove the law of intermediate temperatures.

(c) What is thermoelectric diagram? How are Peltier coefficient and Thomson coefficient represented in these diagrams? (1+1)+(1+2)+(1+2+2)=10

2. *(a)* Define mutual induction and coefficient of mutual induction. On what factors mutual induction depends? Calculate

the coefficient of mutual induction between two coaxial rings of radius R_1 and R_2 ($R_1 > R_2$) and current I_1 flowing through the ring of radius R_1.

(b) Mutual induction of two coils is 5 mH. If the current in one coil changes from 3 amp to 1 amp in 0·1 sec, then find the e.m.f. induced in the second.

(c) Why is self-inductance called electrical inertia? (1+1+2+3)+2+1=10

3. *(a)* A capacitor of capacitance C with initial charge q_0 is allowed to discharge through a resistance R. Show that the charge remaining after a time t is given by $q = q_0 e^{-t/RC}$. Find the variation of current with time during this discharge. Depict these variations of charge and current with time by a graph.

(b) The time constant of a coil is 2·5 millisec. On connecting a resistance of 80 Ω in series with the coil, the time constant is 0·5 millisec. Calculate the self-inductance and resistance of the coil. (4+1+2)+3=10

UNIT—II

4. *(a)* Find out the expression for current in an *L-R* circuit when an alternating e.m.f. $e = e_0 \sin \omega t$ is applied to it.

(b) Discuss the various losses in a real transformer.

(c) An electric lamp marked 100 volts DC consumes a current of 10 amperes. It is connected to a 200-volt 50-cycle per second AC mains. Calculate the inductance of the required choke.

4+3+3=10

5. *(a)* Explain with diagram, the method of analysis of positive rays.

(b) Write down the limitations of Bohr theory to explain the atomic spectra.

(c) What are the concepts of vector atom model? Define space-quantization.

6+2+(1+1)=10

6. *(a)* Why classical theory cannot explain Compton effect? Explain it on the basis of quantum theory.

(b) State and prove Bragg's law of X-ray diffraction.

(c) The spacing between principal planes of NaCl crystal is 2·82 Å. It is found that the first-order reflection of a beam of monochromatic X-rays occurs at an angle 10°. What is the wavelength of X-rays? (2+3)+3+2=10

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TDP (General) 5th Semester Exam., 2019

PHYSICS

(General)

FIFTH PAPER

Full Marks : 40

Time : 2 hours

The figures in the margin indicate full marks for the questions

Answer **four** questions, taking **two** from each Unit

UNIT—I

1. *(a)* What is pointing vector?

(b) Explain how Maxwell generalized Ampere's circuital law.

(c) Derive the expression for energy density in an electromagnetic wave. 2+3+5=10

2. *(a)* What is a metastable state? Write down its significance in case of LASER.

(b) What do you mean by graded-index fibre? Discuss its advantage over step-index fibre.

(c) Explain the terms spontaneous emission and stimulated emission.

(1+2)+(2+2)+(1½+1½)=10

3. (a) How can you design AND gate using NOR gate only?

(b) Write a basic programme to determine whether a given number is prime or not.

(c) What is the application of the basic statement 'LIST'?

(d) Write the difference between RAM and ROM. 2+4+2+2=10

UNIT—II

4. (a) Discuss the failure of classical theory in explaining black-body radiation phenomenon.

(b) Show how one can arrive at Bohr's quantization condition on the basis of de Broglie's hypothesis of matter waves.

(c) If E_k be the kinetic energy of a particle with rest mass m_0, prove that the de Broglie wavelength is given by

$$\lambda = \frac{hc}{\sqrt{E_k(E_k + 2m_0c^2)}}$$

4+3+3=10

5. *(a)* Show that electron diffraction through a narrow slit takes place in accordance with Heisenberg's uncertainty principle.

(b) Show that if uncertainty in the location of a particle is equal to the de Broglie wavelength associated with the particle, the uncertainty in its velocity is equal to its velocity.

(c) Establish Schrödinger's time independent one-dimensional wave equation from the classical differential equation of wave. 4+2+4=10

6. *(a)* Solve the Schrödinger's wave equation for a particle confined in a one-dimensional box.

(b) The wave function of a particle moving in a potential free region is given by $\psi(k) = A\cos kx$, where A and k are real constants. Is ψ an eigenstate of the operators $\hat{H}$ and $\hat{p}_x$? If so, find the corresponding eigenvalues.

(c) What is zero-point energy? 4+(2+2)+2=10

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