TDP (General) 3rd Semester Exam., 2015

PHYSICS

(General)

THIRD PAPER

Full Marks : 40

Time : 2 hours

The figures in the margin indicate full marks for the questions

Answer *any* **two** questions from each Unit

UNIT—I

Answer any *two* questions : 10×2=20

1. *(a)* On what factors does the thermoelectric power in a thermocouple depend?

   (b) Show that total e.m.f. in a thermocouple is $dE = d\pi + (\sigma_A - \sigma_B)dT$, the symbols having their usual meaning.

   (c) What is thermoelectric diagram? How are Peltier coefficient and Thompson coefficient represented in thermoelectric diagram? 2+3+(1+2+2)=10

2. *(a)* Deduce the value of the self-inductance of a circular coil of radius a and n number of turns.

(b) What do you mean by mutual induction? Define the coefficient of mutual inductance Obtain an expression for the coefficient of mutual induction of two coaxial solenoids. 4+(1+1+4)=10

3. *(a)* Calculate the growth of charge in a capacitor of capacitance C connected in series with a battery of e.m.f. E and a resistance R. Draw a curve showing the variation of current with time in the above case.

(b) A telephone operates at 120 milliampere and has an inductance of 10 H and resistance 100 Ω. If a 24 V battery having negligible internal resistance is suddenly applied, calculate the operating time. (Consider, $\log_{10} 2 = 0 \cdot 3$)

(c) What is meant by inductive element in a circuit? (4+2)+3+1=10

UNIT—II

Answer any *two* questions : 10×2=20

4. *(a)* Find out RMS current and average power in AC circuit.

   (b) An alternating e.m.f. $E = E_0 \sin \omega t$ is applied to the ends of series circuit consisting of a resistor R, an inductance L and a capacitance C. Find the current through the circuit at any instant. What is the condition that the circuit will behave as a resistive circuit? (2+2)+(5+1)=10

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

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

   (c) State Pauli's exclusion principle. 6+2+2=10

6. *(a)* State and explain Bragg's law related to X-ray diffraction.

   (b) Calculate the interplanar spacing for a (321) plane in a simple cubic lattice whose lattice constant is $4 \cdot 2 \times 10^{-10}$ m.

   (c) What is Compton effect? What are the principles used to calculate Compton shift? 5+2+(1+2)=10

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TDP (General) 3rd Semester Exam., 2016

PHYSICS

(General)

THIRD PAPER

Full Marks : 40

Time : 2 hours

The figures in the margin indicate full marks for the questions

Answer *any* **two** questions from each Unit

UNIT—I

Answer any *two* questions : 10×2=20

1. *(a)* What is thermoelectric power?

(b) Applying thermodynamics to a thermocouple, establish the relation

$$\pi = T\frac{d\varepsilon}{dT}$$

where the symbols have their usual significances.

(c) The thermoelectric power against lead for iron at a temperature t °C is given by $(1734 - 4 \cdot 87t)\ \mu V / °C$ and that of copper by $(136 + 0 \cdot 96t)\ \mu V / °C$. Find the e.m.f. of a Cu-Fe couple with junctions at 20 °C and 200 °C. 1+4+5=10

2. (a) What is a solenoid? Find an expression for the coefficient of self-inductance of a long solenoid.

(b) What is mutual inductance? Find the mutual inductance between two parallel coaxial loops, having equal radius. (1+4)+(1+4)=10

3. (a) A d.c. source of voltage V is suddenly applied to a circuit consisting of a resistor R and an inductor L in series. Write down the instantaneous e.m.f. equation and hence, find the instantaneous current. Calculate the maximum energy stored in the inductor.

(b) Show that the quantity L/R has the dimension of time.

(c) A capacitor of capacity 500 pF is discharged through a resistance of 1000 megaohm. Find the time taken by half the charge on the capacitor to escape. (1+3+2)+1+3=10

UNIT—II

Answer any *two* questions : 10×2=20

4. *(a)* What are meant by 'power factor' and 'wattless current' in connection with a.c. circuit?

(b) A pure inductance of 300 millihenry is connected across a 220 volt-50 cycle AC source. Find the reactance of and the current through the inductance.

(c) Explain sharpness of resonance and bandwidth in connection with a series *L-C-R* circuit. (2+2)+2+(2+2)=10

5. *(a)* How were the isotopes identified in Thomson parabola method?

(b) Find the minimum wavelength of X-ray produced by an X-ray tube operated upon 1000 kV. Given $h = 6 \cdot 625 \times 10^{-34}$ J-s, $e = 1 \cdot 602 \times 10^{-19}$ C, $c = 3 \times 10^{8}$ m/s.

(c) Show in a diagram the normal Zeeman splitting of spectral line originating from transition between $l = 2$ and $l = 1$ levels.

(d) What are different compositions of the orbital angular momentum vectors for two electrons having angular momentum $l_1 = 1$ and $l_2 = 2$ respectively? 3+2+3+2=10

6. *(a)* Deduce Bragg's law of X-ray diffraction.

(b) Show that for a simple cubic lattice

$$d_{100} : d_{110} : d_{111} = \sqrt{6} : \sqrt{3} : \sqrt{2}$$

where d_{hkl} is the separation between adjacent (h.k.l.) parallel planes.

(c) Find out the expression for Compton shift.

3+3+4=10

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TDP (General) 3rd Semester Exam., 2017

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)* What do you mean by Thomson effect in thermoelectricity?

(b) Applying thermodynamics to a thermo-couple, establish the relation

$$\sigma = T\frac{d^2E}{dT^2}$$

The symbols have their usual meanings.

(c) A certain thermocouple with one junction at 0 °C has an e.m.f. given by

$$E = \{80t - 15000(1 - e^{-0\cdot0025t})\}\ \mu V$$

Determine the Peltier coefficient at 0 °C. Also find the difference of Thomson coefficient at 0 °C. 2+4+4=10

2. (a) Calculate the mutual inductance of two solenoids, one of which is wound outside of other.

(b) Write the laws of electromagnetic induction.

(c) An air-cored solenoid of diameter 1 cm and 1 m long has 1000 number of turns. Find the coefficient of self-induction. 4+3+3=10

3. (a) Derive an expression for the instantaneous value of the voltage across the capacitor when a d.c. voltage is applied to the capacitor in series with a resistance.

(b) If a capacitor of 4 μF be allowed to discharge through an inductance of 10 millihenries, calculate the natural frequency of the circuit.

(c) In an *L-C-R* series oscillatory circuit, $L = 0\cdot2$ henry, $C = 0\cdot0012$ μF. What is the maximum value of the resistance, so that the circuit may be oscillatory? 4+3+3=10

UNIT—II

4. (a) Why is a circuit consisting of a capacitor and an inductor in parallel often called a rejector circuit?

(b) Why is 220 volt a.c. is more dangerous than 220 volt d.c.?

(c) An alternating e.m.f. $E = E_0 \sin \omega t$ is applied to the circuit consisting of a resistor R and a coil of self-inductance L in series. Deduce an expression for the current in the circuit.

(d) What is Q factor? On what factor does it depend? 2+2+4+2=10

5. (a) Write the limitations of Bohr's theory.

(b) State and explain the significance of four quantum numbers. How are they interrelated?

(c) What are the properties of positive rays? 2+(4+2)+2=10

6. *(a)* Define atomic radius and Miller indices.

(b) Find the numbers of atoms per unit cell for—

(i) simple cubic lattice;

(ii) b.c.c. lattice;

(iii) f.c.c. lattice.

(c) The Bragg angle corresponding to first-order reflection from (111) plane in a crystal is 30°, when X-rays of wavelength 1·75Å are used. Calculate the interatomic spacing. (2+2)+3+3=10

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TDP (General) 3rd Semester Exam., 2018

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)* State the law of intermediate metal.

(b) Define Peltier coefficient. Find out its expression from thermodynamical considerations.

(c) For a copper-iron thermocouple, one junction of which is maintained at 0 °C and the other at t °C, the e.m.f. is given by $e = 10 \cdot 34t - \cdot 018t^2$ (in μV). Calculate the temperature of the hot junction for *(i)* maximum e.m.f. and *(ii)* zero e.m.f.

2+(1+4)+3=10

2. *(a)* Calculate the coefficient of self-induction for a long solenoid.

(b) What is meant by coefficient of coupling?

(c) A solenoid of length 50 cm and radius 3 cm has 20 turns per cm. A second coil of 1000 turns is wound upon the middle part of the solenoid. Calculate the mutual inductance of the coils. 4+2+4=10

3. *(a)* Derive the equation for the growth of electric current in a circuit with resistance and inductance in series. What is meant by the 'time constant' of such a circuit?

(b) Mention how the frequency of oscillation in *LCR* circuit with d.c. source of e.m.f., depends on the inductance and the capacitance.

(c) In a *C-R* circuit if $C = 2 \cdot 4\ \mu F$, $R = 0 \cdot 02$ megohm, in what time will the change in the capacitor attain half its final value? $[\log_e 2 = \cdot 6931]$. (4+2)+1+3=10

UNIT—II

4. *(a)* Define r.m.s. value of alternating current. What is meant by wattless current?

(Continued)

(b) Find the expression for power factor in an AC circuit.

(c) An alternating e.m.f. $E = E_0 \sin \omega t$ is applied to the ends of a circuit containing resistance R, self-inductance L and capacitance C. Calculate the current at any instant. (1+2)+3+4=10

5. (a) State and explain Pauli's exclusion principle.

(b) What is Zeeman effect? Explain.

(c) Describe the characteristics of vector atom model.

(d) Explain why an atomic shell with $n = 2$, cannot contain more than 8 electrons using the concept of Pauli's exclusion principle. 2+2+3+3=10

6. (a) What is Compton effect? Calculate the change of wavelength in this case.

(b) Derive Bragg's law regarding the diffraction of X-ray.

(c) Calculate the lattice constant of NaCl crystal. The density of NaCl is 2189 kg/m^3 and Avogadro's No. $N = 6 \cdot 02 \times 10^{23}$. (1+3)+3+3=10

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S–3/PHSG/03/19

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) 3rd Semester Exam., 2020
(Held in 2021)

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 Thomson coefficient. Explain positive and negative Thomson effect.

(b) At given junction temperatures, Bi-Sb pair will give the maximum thermo-e.m.f. Why?

(c) The e.m.f. in a thermocouple, one junction kept at 0°C, is given by $E = bt + ct^2$. Find the neutral temperature, and the Peltier and Thomson coefficients. (2+3)+2+3=10

2. *(a)* What is self-induction? Calculate the coefficient of self-induction of a circular coil of radius R and total number of turns N.

(b) On which factors does the coefficient of mutual induction between two circular coils depend?

(c) A solenoid 50 cm long and of radius 3 cm has 20 turns of wire per cm. A second coil of 1000 turns is wound upon the middle part of the solenoid. Calculate the mutual inductance of the coils and the self-inductance of the solenoid. (1+3)+2+4=10

3. *(a)* In an inductive circuit, current cannot grow to a steady value all at once. Why?

(b) A steady current is flowing in a circuit containing an inductor, a resistor and a battery in series. State the law of decay of current in the circuit if the battery is switched off suddenly. Show graphically the variation of current with time in the circuit. How the fall of current can be controlled?

(c) A capacitor is charged through a resistance of 2 mega ohms by a battery. It takes $\frac{1}{2}$ s for the charge to reach three quarter of its final value. What is the capacitance of the capacitor?

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

UNIT—II

4. (a) Define power factor and wattless current in a.c. circuit.

(b) Find the expression for current in an LC circuit when an alternating voltage is applied to it.

(c) Compare capacitative reactance and inductive reactance.

(d) In an a.c. circuit, average power is 40 watt, peak power is 80 watt. What is the phase difference between current and voltage? 2+4+2+2=10

5. (a) With a neat diagram, show the production of positive rays.

(b) On what factors specific charge of positive rays depends?

(c) What is normal Zeeman effect? How does the observational result differs in the case of longitudinal view and transverse view w.r.t. state of polarisation?

(d) State Pauli's exclusion principle. In what kind of particles the principle is valid? 3+1+(2+2)+2=10

6. (a) Distinguish between crystalline and amorphous solid.

(b) Draw the unit cell structure of NaCl, clearly indicating the position of Na^+ and Cl^-.

(c) X-ray is used to show crystalline structure but not ordinary light. Why?

(d) What are Bragg's planes in crystal?

(e) What is the basic assumption used in the calculation of Compton shift?

(f) Clearly write down the principle of determination of spacing of principal planes using Bragg's law.

2+2+1+2+1+2=10

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TDP (General) 3rd Semester Exam., 2021
(Held in 2022)

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)* Explain the variation of thermo e.m.f. with temperature for a thermocouple. In this graph, clearly indicate the neutral temperature and temperature of inversion.

(b) What are Peltier effect and Peltier coefficient? How is Peltier effect different from Joule effect?

(c) The e.m.f. of a thermocouple with junctions at 0 °C and t °C is given by $E = 16 \cdot 5t - 0 \cdot 04t^2$ μ-volt. Calculate *(i)* neutral temperature, *(ii)* temperature of inversion and *(iii)* thermoelectric power at 100 °C. (2+1)+(2+1)+(1+1+2)=10

2. (a) What is mutual induction? Calculate mutual inductance between two coaxial solenoids.

(b) Calculate the self-inductance of a solenoid having 700 turns and length 100 cm. The area of cross-section is 7 cm^2 and the relative permeability of the core is 1000.

(c) A circular coil P of 100 turns and radius 2 cm is placed coaxially at the centre of another circular coil Q of 1000 turns and radius 20 cm. Calculate the mutual inductance due to the coils. (1+4)+2+3=10

3. (a) Find an expression for charging of a capacitor of capacitance C through a series resistance R. Draw the nature of variation of charge and current during charging of capacitor. Define time constant of the circuit during charging.

(b) Considering growth of charge in a circuit with inductance, capacitance and resistance in series, draw the variation of instantaneous charge with time for the three cases of damped, critically damped and overdamped charging. (4+2+1)+3=10

UNIT—II

4. (a) A resistance R is connected in series with an inductance L and an a.c. voltage is applied. Calculate the expression for current in this case.

(b) Mention the losses in a transformer.

(c) What is choke coil?

(d) A coil is found to have impedance of 100 Ω and 110 Ω respectively for a.c. frequencies of 50 Hz and 60 Hz. Calculate the inductance of the coil. 4+2+2+2=10

5. (a) Mention the limitations of Bohr's theory.

(b) Discuss the theory of vector atom model.

(c) Define and explain the significance of all the quantum numbers of an electron in the orbit of an atom.

(d) What is positive ray? 2+3+4+1=10

6. *(a)* What is Compton effect? Calculate the expression for Compton shift.

(b) Can a photon be deflected by any electric field or magnetic field? Explain.

(c) Distinguish between crystalline and amorphous solids.

(d) Write down the Bragg's equation for crystal diffraction. (1+4)+2+2+1=10