2016

(April)

PHYSICS

(Elective/Honours)

SECOND PAPER

(Electromagnetism, Electronics—I)

Marks : 56

Time : 3 hours

The figures in the margin indicate full marks for the questions

Answer Question No. **1** and *any* **four** from the rest

1. *(a)* State Gauss' law. Apply this law to calculate the electric field of a charged infinite plane. 1+2½=3½

(b) What is an electrical image? Use the method of electrical images to find the electric field at a point near a conducting plane. 1+3½=4½

(c) Two drops of water having a charge of 3×10^{-9} coulomb each and a surface potential of 500 volts combine to form a single drop. Calculate the surface potential of the single drop. 4

2. *(a)* Find the magnetic field at a point on the axis of the solenoid. Then obtain the magnetic field *(i)* when the solenoid is very long, *(ii)* at a point on the end of the solenoid. 3+1+1=5

(b) Define gyromagnetic ratio and susceptibility. 1½+1½=3

(c) Discuss the magnetic behaviour of steel and soft iron in terms of hysterisis loops. 1½+1½=3

3. *(a)* Discuss the growth and decay of electric current in CR circuit. What is the time constant of the circuit? 4+1=5

(b) Explain the terms resonance and power factor in a.c. electrical circuits. 1½+1½=3

(c) A coil of resistance 20 Ω and inductance 0·5 H is switched to direct current 200 V supply. Calculate the rate of increase of current at the instant of closing the switch. 3

4. *(a)* Explain what is meant by mutual and self-inductances. Derive the relation

$$M = \sqrt{L_1 L_2}$$

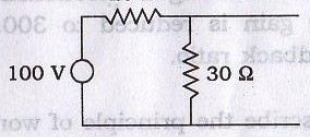
where the symbols have their usual significance. 1+1+3=5

(b) Write down Maxwell's equations in free space. 2

(c) A step-up transformer works on 220 V and gives 2 amperes to an external circuit. The turns ratio between primary and secondary coils is 2:25. Assuming 100% efficiency, find the secondary voltage, primary current and power delivered. 4

5. *(a)* State Thevenin's theorem and prove it for a two-terminal network. 2+4=6

(b) Find the open-circuit voltage and Thevenin resistance for a terminal network shown in the diagram below : 3



(c) Explain the meaning of hybrid parameters. 2

6. *(a)* Draw a circuit diagram for static characteristics of a CE *p-n-p* transistor. What is output characteristics? Explain the meaning of cut-off region, saturation region and active region from this characteristics. 2+2+1½=5½

(b) Explain the terms load line and Q-point. 1½+1½=3

(c) The current gain of a transistor in a CE circuit is 49. Calculate the CB current gain. Find the base current when the emitter current is 3 mA. 2½

7. (a) What is a multistage transistor amplifier? Draw and describe the circuit of a two-stage RC-coupled CE amplifier. 1+2+2=5

(b) What is Barkhausen criterion for sustained oscillations? 2

(c) What is feedback ratio in feedback amplifiers? An amplifier has a gain of 400. When negative feedback is applied, the gain is reduced to 300. Find the feedback ratio. 1½+2½=4

8. (a) Describe the principle of working of an operational amplifier (OP-AMP). Explain the common-mode rejection ratio. What is the advantage of OP-AMP? 2½+1½+1=5

(b) Explain NAND and NOR logic gates with circuit diagrams. Write down the truth table for both. 2+2+2=6

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[PHY 02 (T)]

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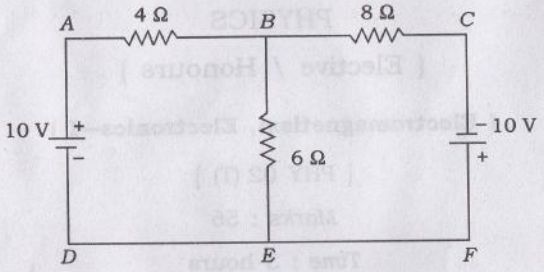
Answer Question No. **1** and *any* **four** from the rest

1. *(a)* Find the self-inductance of a air-type solenoid 40 cm long and radius 4 cm having 200 turns. 2

(b) A 2 V battery of negligible internal resistance is applied to a coil of inductance 1 henry and of resistance 1 ohm. Calculate the time required by the current to attain a value half that in the steady state or maximum value. 3

(c) Calculate the power factor of a 50 cycles/sec a.c. circuit in which an inductance of 0·1 H and 10 Ω resistance are connected in series. 3

(d) Calculate the current through the 6 Ω resistance using superposition theorem in the circuit given below : 4



2. (a) Obtain an expression for the potential and intensity of electric field due to a uniformly charged disc of radius (a) at a finite distance (x) from it. Show that the disc behaves as a point charge for $x >> a$. 4+2=6

(b) State Biot-Savart law and give its vector form. Using this law, obtain an expression for the intensity of magnetic field due to a straight current carrying conductor. 1+1+3=5

3. (a) Establish the relationship between the magnetic dipole moment and the angular momentum. Define gyromagnetic ratio. 4+1=5

(b) Discuss the growth and decay of current in an L-R circuit. What is the time constant of the circuit? 4+2=6

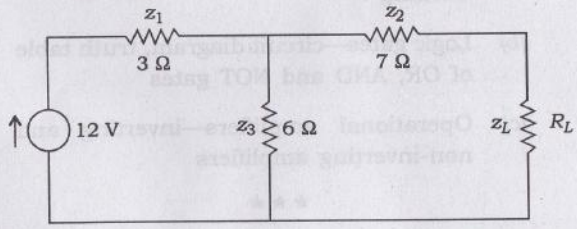
4. (a) Explain star and delta connections in three-phase power supply. 2+2=4

(b) Express Faraday's law of electro-magnetic induction in integral and differential form. 2+2=4

(c) What is Maxwell's displacement current? Discuss its need in modifying Ampere's circuital law. 2+1=3

5. (a) State superposition theorem and prove it with the help of a simple two-mesh network. 1+3=4

(b) Convert the linear network given below into Thevenin's equivalent network and then into Norton's equivalent network, and show that the power delivered to the load resistance in both the cases is same. 3½+3½=7



6. *(a)* Explain the working of a half-wave rectifier with the help of a simple circuit. Define ripple factor and show that its value is 1·21 for a half-wave rectifier. 3+1+2=6

(b) Explain current amplification factor in common base and common emitter configuration, and establish the relation between them (α, β). 2+2+1=5

7. *(a)* Discuss the principle of feedback amplifiers. Give three important advantages of negative feedback amplifiers. 3+(1½×3)=7½

(b) Draw a net circuit diagram of a two-stage *R-C* coupled CE amplifier and give a qualitative description. 2+1½=3½

8. Write short notes on any *two* of the following : 5½×2=11

(a) Transformer—construction, theory and working

(b) Logic gates—circuit diagram, truth table of OR, AND and NOT gates

(c) Operational amplifiers—inverting and non-inverting amplifiers

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2018

(April)

PHYSICS

(Elective/Honours)

(Electromagnetism, Electronics—I)

[PHY-02 (T)]

Marks : 56

Time : 3 hours

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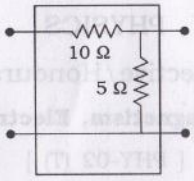
Answer Question No. **1** and *any* **four** from the rest

1. *(a)* Find the electric potential on the surface of a nucleus having mass number 64, atomic number 30. Taking charge on proton to be $1{\cdot}6\times10^{-19}$ C and radius of proton $1{\cdot}2\times10^{-15}$ m. 3

(b) A conductor of length 64 cm is bent into a square and a current of 4 A is passed through it. Find the magnetic field at the centre of the square. 3

(c) A straight solenoid of length 1 m has 50 turns in the primary and 200 turns in the secondary. If the area of cross-section of the solenoid is 4×10^{-4} sq m, find its mutual inductance. 3

(d) Find the h-parameters of the circuit as shown in the figure below : 3



2. (a) State and prove Gauss' theorem in electrostatics and hence show that the total flux over a surface due to a charge lying outside is zero. 1+4+2=7

(b) Obtain an expression for the potential due to a uniformly charged their spherical shell at an external point. 4

3. (a) A point charge $+q$ is placed at a distance d from the centre of an earthed conductor of radius R. Apply the method of electrical images to calculate the field on the sphere. 4

(b) Derive an expression for Gauss' law in the presence of a dielectric. Also discuss the integral form of Gauss' law. 4+3=7

4. (a) An alternating e.m.f. $E_0 \sin \omega t$ is applied to the ends of a circuit containing resistance R, self-inductance L and capacitance C. Calculate the impedance of the circuit, phase angle and the current at any instant. 4+1+2=7

(b) What is the quality factor for an AC circuit? Prove that quality factor

$$Q = \frac{1}{R}\sqrt{\frac{L}{C}}$$

1+3=4

5. (a) What do you mean by mutual inductance? On what factors does mutual induction depend? 2+2=4

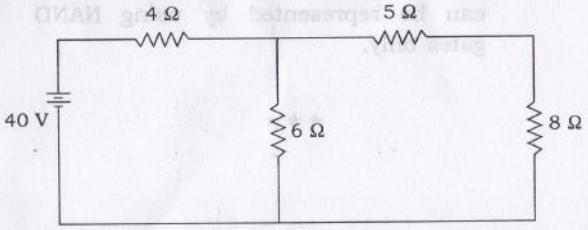
(b) State Faraday's law of electromagnetic induction. Prove that Faraday's law of electromagnetic induction can be expressed in the differential form

$$\vec{\nabla} \times \vec{E} = \frac{\partial \vec{B}}{\partial t}$$

and hence give the physical significance of the equation. 1+4+2=7

6. (a) State and explain Thevenin's theorem. 1+5=6

(b) Using Norton's theorem, find the current through the 8 Ω resistor in the network shown in the figure below : 5



7. *(a)* Describe with the help of a block diagram the working principle of a feedback amplifier. Derive an expression for the overall transfer gain. When does a feedback amplifier become oscillatory? 2+2+1=5

(b) What is a clipper circuit? Draw the circuit of a diode clipper which 'clips' the upper half of an input sin-wave lying above a reference voltage. 1+2=3

(c) Draw and describe in brief about a two-stage *R-C* coupled amplifier in CE mode. 3

8. *(a)* Write down the characteristics of an ideal Op-Amp. What are inverting and non-inverting terminals of an Op-Amp? Discuss the concept of virtual ground in Op-Amp. 3+2+2=7

(b) Show that OR, AND, NOR, NOT gates can be represented by using NAND gates only. 4

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