PHY101 (MAJOR/MINOR)

Student's Copy

2023

(NEP-2020)

(1st Semester)

PHYSICS (MAJOR/MINOR)

(Electricity Fundamentals)

Full Marks : 75

Time : 3 hours

The figures in the margin indicate full marks for the questions

(SECTION : A-OBJECTIVE)

(Marks: 10)

Tick (\checkmark) the correct answer in the brackets provided :

- 1. According to the continuity equation, the divergence of electric current density $(\vec{\nabla} \cdot \vec{J})$ equals
 - (a) the negative rate of change of the charge density ()
 - (b) the positive rate of change of the charge density (
 - (c) the product of the charge density and the volume ()
 - (d) the product of the total charge and the volume
- 2. When resistors are connected in parallel, the resistance of a circuit
 - (a) increases ()
 - (b) decreases ()
 - (c) remains the same ()
 - (d) None of the above ()

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1×10=10

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З.	Nor	ton's t	theorem replaces a complicated circuit	facing	a load	by a	in
	(a)	ideal	voltage source and parallel resistor	(-}*		
	(b)	ideal	current source and parallel resistor	()		
	(c)	ideal	voltage source and series resistor	()		
	(d)	ideal	current source and series resistor	()		

4. Faraday's law of electromagnetic induction is the relation between

- (a) induced flux and current ()
- (b) induced AC and flux ()
- (c) induced e.m.f. and flux ()
- (d) induced e.m.f. and magnetic induction ()

5. Biot and Savart's law is the relation given as

(a)
$$dB \propto \frac{r^2}{E.dl\sin\theta}$$
 ()
(b) $dB \propto \frac{E.dl\sin\theta}{r^2}$ ()
(c) $dB \propto \frac{r^2}{I.dl\sin\theta}$ ()
(d) $dB \propto \frac{I.dl\sin\theta}{r^2}$ ()

6. Lenz law is a consequence of the law of conservation of

(a)	charge	()	(b)	mass	()
(c)	energy	()	(d)	momentum		(

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- 7. In an alternating current, the direction of motion of current with time is periodically reversing. The average value over a complete cycle is
- (a) 0 (b) () () $(c) \pi$) $(d) 2\pi$ 8. The power factor of an AC circuit is equal to the (a) cosine of angle between voltage and current () (b) tangent of angle between voltage and current) (c) impedance/resistance ((d) apparent power/real power (9. The working of a dynamo is based on the principle of (a) heating effect of current) ((b) magnetic effect of current (and phasor diau (c) chemical effect of current (d) electromagnetic induction () 10. What is the primary function of a choke coil in an electrical circuit? (a) To store electrical energy (b) To limit the flow of AC current (c) To amplify DC voltage (۱ (d) To convert mechanical energy into electrical energy

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- (a) cosine of angle between voltage and current ()
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9. The working of a dynamo is based on the principle of

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(1)

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- (d) To convert mechanical energy into electrical energy ()

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(SECTION : B-SHORT ANSWERS)

(Marks: 15)

Answer *five* questions, taking at least *one* from each Unit :

Unit—I

1. State and explain Ohm's law in electrical network.

2. Explain with a circuit diagram the voltage division rule.

Unit—II

3. Obtain the Lorentz force equation for a moving charge.

4. Show that a circular coil-carrying current is equivalent to a magnetic dipole.

Unit—III

- 5. Define phasor and phasor diagram.
- 6. Explain single-phase and three-phase AC power supply.

Unit—IV

- 7. Explain how a galvanometer can be converted into a voltmeter of a given range.
- 8. Discuss the advantages and disadvantages of AC over DC.

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3×5=15

(SECTION : C-DESCRIPTIVE)

(Marks: 50)

Answer five questions, taking at least one from each Unit :

UNIT-I

1. (a) State and prove Thevenin's theorem.

- (b) State and explain with circuit diagram Kirchhoff's voltage law in electrical circuit.
- 2. (a) What is a Wheatstone bridge? Using Kirchhoff's law, obtain the balanced condition of Wheatstone bridge. 1+5=6
 - (b) Using Norton's theorem, find the current in 8Ω resistor in the network shown below :



Unit—II

- 3. (a) Using Biot-Savart law, obtain the expression of magnetic field at a point on the axis of a circular conductor having radius a carrying a current I. For a point P at the centre of a circular conductor, show that the magnetic field is μ₀I/2a, where μ₀ is the permeability of free space. 4+1=5
 - (b) State Ampere's circuital law and deduce the integral and differential forms of Ampere's law. 1+2+2=5

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5

1+6=7

10×5=50

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4

- 4. (a) Derive the expression for force on a straight conductor carrying current placed in a uniform magnetic field.
 - (b) State Faraday's laws of electromagnetic induction and obtain an expression of induced e.m.f. produced in a coil of N turns. 1+3=4
 - (c) Define mutual inductance and self-inductance. 1+1=2

Unit—III

- 5. (a) An alternating e.m.f. $E_0 \sin \omega t$ is applied to a series *L-C-R* circuit. Obtain the expression for impedance, phase-angle and current in the circuit at any instant. Also, deduce the expression for current at resonance.
 - (b) What do you mean by Q-factor? What does it measure?
- 6. (a) Define power of an AC circuit. Derive the expression for average power in an AC circuit. What will be the average power of a circuit having only an inductor with inductance L?
 - (b) Derive the relation between root mean square value and peak value of AC.

UNIT-IV

- 7. Discuss the principle, construction and working of a moving-coil galvanometer and hence derive the expression for current sensitivity and voltage sensitivity.
 7+3=10
- 8. Discuss the principle, construction and working of a transformer. Also explain the various types of energy losses which occur in a transformer.

7+3=10

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