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B.Sc. DEGREE (C.B.C.S.S.) EXAMINATION, OCTOBER 2011

Third Semester

Core Course—ELECTRICITY AND ELECTRODYNAMICS

(Common for the programmes (1) Physics Model I ; (2) Physics Model II ; (3) Physics EEM ; (4) Physics—Instrumentation)

Time : Three Hours Maximum Weight : 25

Non-programmable calculators and mathematical tables are permitted.

Part A (Objective Type)

Answer **all** *questions.*

Each bunch of four questions carries a weight of 1.

Bunch 1

Choose the most appropriate alternative.

1. A capacitor should have a dielectric with :
   (a) high permittivity. (b) low permittivity.
   (c) permittivity same as that of air. (d) permittivity which is neither high or low.
2. A sinusoidal current has an r.m.s. value of 10 V. Its peak-to-peak value is :
   (a) 7.07 V. (b) 14.14 V.
   (c) 6.37 V. (d) 0.628 V.
3. In an ac network, Thevenin's impedance and Norton's impedance are :
   (a) always the same. (b) generally the same.
   (c) sometimes the same. (d) always different.
4. A series resonant circuit has parameter 10 Ω, 1H and 0.1 F. It is excited by a voltage $v = 100 \sin \omega t$. At resonant frequency, the power dissipated in the circuit is :
   (a) 1000 W. (b) 707 W.
   (c) 500 W. (d) 414.14 W.

Bunch 2

Choose the most appropriate alternative.

5. In order to obtain maximum power from the load terminals of a circuit, the resistance across the load terminals should be :
   (a) equal to the circuit resistance when looked back from the two terminals.
   (b) less than the circuit resistance.
   (c) greater than the circuit resistance.
   (d) none of the above.

Turn over

6. The total electric field at a point, due to a number of charges is :
   (a) scalar sum of individual component fields at that point.
   (b) vector sum of individual component fields at that point.
   (c) scalar or vector sum of individual component fields at that point.
   (d) scalar or vector sum or product of individual component fields at that point.
7. The electric potential at a point P situated at distance r from a charge Q is :
   (a) directly proportional to r.
   (b) directly proportional to Q.
   (c) directly proportional to Q and inversely proportional to r.
   (d) inversely propotional to Q and directly propotional to r.
8. The relation between electric flux density D and electric field intensity E is :
   (a) $D = \epsilon E$. (b) $E = \epsilon D$.
   (c) $\epsilon = DE$. (d) $D = \epsilon E^2$.

Bunch 3

Choose the most appropriate alternative.

9. A parallel plate capacitor has air as dielectric. The electric field in the dielectric is E. If air is replaced by a dielectic of permittivity ϵ, the dielectric gets polarised to polarisation P. The additional energy stored in dielectric is :
   (a) $\frac{0.5P}{E}$. (b) 0.5PE.
   (c) PE. (d) $\frac{0.5P^2}{\epsilon}$.
10. Poisson's equation is :
   (a) $\nabla^2 V = -\frac{\rho}{\epsilon}$. (b) $\nabla^2 V = -\frac{\epsilon}{\rho}$.
   (c) $\nabla^2 V = \frac{\epsilon}{\rho}$. (d) $\nabla^2 V = \frac{\rho}{\epsilon}$.
11. The current through a pure capacitor is :
   (a) displacement current.
   (b) conduction current.
   (c) partly displacement and partly conduction current.
   (d) either conduction current or displacement current.

12. At a boundary of a dielectric and a conductor :

(a) normal component of flux density is zero.

(b) normal component of flux density is continuous.

(c) normal component of flux density is equal to surface charge density on the conductor.

(d) normal component of flux density may be zero or continuous.

Bunch 4

Choose the most appropriate alternative.

13. Wave impedance is :

(a) ratio of electric field component to magnetic field component at the same point of wave.

(b) ratio of magnetic field component to electric field component at the same point of wave.

(c) square root of the ratio of electric field component to magnetic field component at the same point of wave.

(d) product of electric and magnetic field components at the same point of wave.

14. For TE_{11} mode in a hollow rectangular waveguide :

(a) only $E_x = 0$. (b) only $E_z = 0$.

(c) only $H_x = 0$. (d) only $H_z = 0$.

15. If a coaxial line has a perfectly conducting solid tube as the outer conductor, then :

(a) both electric and magnetic fields are confined internally.

(b) electric field is confined internally.

(c) magnetic field is confined internally.

(d) neither electric nor magnetic field is confined internally.

16. At the boundary between two different media :

(a) electric field is continuous.

(b) electric field may change abruptly in direction.

(c) electric field may change abruptly in magnitude.

(d) electric field may change abruptly in both direction and magnitude.

$(4 \times 1 = 4)$

Part B (Short Answer Type)

Answer any **five** *questions.*
Each question carries a weight of 1.

17. What is the difference between r.m.s. and average values of a sine voltage ?

18. Explain the differences between ideal and practical voltage sources ? Give examples.

19. State and explain Gauss's law in differential form.

20. What do you mean by (a) permittivity ; (b) electric scalar potential ?

21. Define divergence and its physical meaning.
22. Write down Maxwell's equations.
23. What is uniform plane wave ? State its properties.
24. Write an expression for plane electromagnetic waves propagating in a dielectric media in a direction $\vec{r}$ with respect to origin.

$(5 \times 1 = 5)$

Part C (Short Essays/Problems)

Answer any **four** *questions.*
Each question carries a weight of 2.

25. Usign superposition theorem, determine the voltage drop and current across the resistor R_3 shown in Fig. 1.

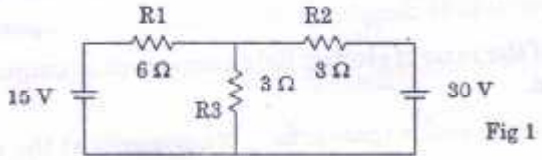

Fig 1

26. A TV antenna has a Thevenin voltage of 20 mV and a Thevenin resistance of 300 Ω. When the receiver is matched to the antenna, what is the power transferred to the receiver ?
27. A uniform line charge $\rho_L = 25$ nC/m. lies on the line $x = -3$ m. and $y = 4$ m. in free space. Calculate the electric field intensity at a point (2, 3, 15) m.
28. Derive the expression for $\vec{D}$ due to a point charge using Gauss's law.
29. Define workdone and obtain the line integral to calculate the workdone in moving a point charge Q in an electric field $\vec{E}$.
30. Derive Poynting theorem and give its significance.

$(4 \times 2 = 8)$

Part D (Essay Type Questions)

Answer any **two** *questions.*
Each question carries a weight of 4.

31. With neat diagrams, explain the construction and working of a wattmeter. Show the circuit connection diagram for power measurement.
32. State and explain the implications of Maxwell's equation in point form applicable for steady electric and magnetic field, convert these equations into integral form.
33. With neat diagrams, discuss the determination of the reflected and transmitted wave fields from the fields of a wave incident normally onto a plane boundary between two material media.

$(2 \times 4 = 8)$