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Prelims
Through
Questions

for

ESE 2021

Electronics & Telecommunication

Day 9 of 11

Q.361 - Q.410
(Out of 500 Questions)

Electronic Measurements & Instrumentation + Electromagnetics

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Q.361 A moving-coil instrument gives full-scale deflection of 10 mA, when a potential difference of 10 mV is applied across its terminals. To measure current upto 100 mA, the same instrument can be used by connecting a

(a) a shunt resistance of 0.1 Ω
(b) a series resistance of 0.1 Ω
(c) a shunt resistance of 0.01 Ω
(d) a series resistance of 0.01 Ω

361. (a)

$$R_{sh} = \frac{R_m}{m-1}$$

where,

$$m = \frac{I}{I_m} = \frac{100\times10^{-3}}{10\times10^{-3}} = 10$$

$$R_m = \frac{10\text{ mV}}{10\text{ mA}} = 1\,\Omega$$

$$R_{sh} = \frac{1}{10-1} \approx 0.1\,\Omega$$

Q.362 A Q-meter is supplied with an oscillator having a 500 mV output voltage while testing an unknown inductor, the voltage across the variable capacitor of the Q-meter measured by a digital voltmeter is obtained as 5 V, the Q-factor of the inductor is

(a) 1
(b) 10
(c) 20
(d) 5

362. (b)

Since Q-meter works on principle of resonance

$$V_L = V_C = QV$$

$$Q = \frac{V_C}{V} = \frac{5}{500\times10^{-3}} = 10$$

Q.363 Inductance of a coil having Q-value in the range of $(1 < Q < 10)$, can be best measured using

(a) Hay's bridge
(b) De-sauty's bridge
(c) Maxwell's bridge
(d) Carry-foster's bridge

363. (c)

Q.364 Precision is composed of two characteristics, one is the number of significant figures to which a measurement may be made, the other is

(a) Conformity
(b) Meter error
(c) Inertia effects
(d) Noise

364. (a)

Q.365 Which one of the following multi-range voltmeters has high and constant input impedance?
(a) Permanent magnet moving coil voltmeter
(b) Electronic voltmeter
(c) Moving iron voltmeter
(d) Dynamometer type voltmeter

365. (b)

Q.366 Three D.C. voltmeters are connected in series across a 120 V D.C. supply. The voltmeters are specified as follows:
Voltmeter A : 100 V, 2.5 mA
Voltmeter B : 100 V, 500 Ω/V
Voltmeter C : 10 mA, 30000 Ω
The voltages read by the meters *A*, *B* and *C* are respectively.
(a) 30, 40 and 50 V
(b) 40, 50 and 30 V
(c) 50, 40 and 30 V
(d) 40, 30 and 50 V

366. (b)

$$R_A = \frac{100}{2.5\text{ mA}} = 40\text{ k}\Omega$$
$$R_B = 100\text{ V} \times 500\ \Omega/\text{V} = 50\text{ k}\Omega$$
$$R_C = 30\text{ k}\Omega$$
$$I = \frac{120}{R_A + R_B + R_C} = \frac{120}{40+50+30} = 1\text{ mA}$$
$$V_A = 40\text{ k}\Omega \times 1\text{ mA} = 40\text{ V}$$
$$V_B = 50\text{ k}\Omega \times 1\text{ mA} = 50\text{ V}$$
$$V_C = 30\text{ k}\Omega \times 1\text{ mA} = 30\text{ V}$$

Q.367 Material used in the fabrication of swamping resistance of a PMMC instrument is
(a) Copper
(b) Aluminium
(c) Manganin
(d) Tungsten

367. (c)

Q.368 Due to the effect of inductance in the pressure coil, a dynamometer type wattmeter
(a) Reads low on lagging power factor and high on leading power factor
(b) Reads high on lagging power factor and low on leading power factor
(c) Reading is independent of the power factor
(d) Always reads lower than actual value

368. (b)
Due to the effect of inductance in the pressure coil, deflecting torque in a dynamometer type wattmeter varies as:
(i) For lagging power factor,
$T_d \propto VI\cos(\phi - \beta)$ $\{\cos(\phi - \beta) > \cos\phi\}$
So, wattmeter reads high.
(ii) For leading power factor
$T_d \propto VI\cos(\phi + \beta)$ $\{\cos(\phi + \beta) < \cos\phi\}$
Hence option (b) is correct.

Q.369 A $3\frac{1}{2}$ digit voltmeter having a resolution of 100 mV can be used to measure maximum voltage of
(a) 100 V (b) 200 V
(c) 250 V (d) 500 V

369. (a)

$$\because \quad \text{Resolution} = \frac{V_{FS}}{10^n}$$

where, n is the number of full digit.

$$V_{FS} = \text{Resolution} \times 10^n$$
$$= 100 \text{ mV} \times 10^3 = 100 \text{ V}$$

Q.370 Lissajous pattern shown in a double beam cathode-ray oscilloscope screen for two sinusoidal voltages of equal magnitude and of the same frequency but of phase shift of 30° is
(a) a circle
(b) an ellipse where major axis is in the first and third quadrant
(c) a straight line at 45° with horizontal
(d) an ellipse whose major axis is in the second and fourth quadrant

370. (b)

Q.371 The power across a 3-phase, 3-wire balanced load system is measured by two wattmeter method. One of the wattmeter reading is 500 W with accuracy of ±2.5% of full scale reading and the second wattmeter reading is 1250 W with accuracy of ±0.5% of reading. If both the wattmeters are having a full scale value of 1500 W each then the limiting error in the total power is
(a) ±0.5% (b) ±2%
(c) ±2.5% (d) ±3%

371. (c)

$$\text{Limiting error in the first wattmeter} = \pm\frac{2.5}{100}\times 1500 = \pm 37.5 \text{ W}$$

$$\text{Limiting error in the second wattmeter} = \pm\frac{0.5}{100}\times 1250 = \pm 6.25 \text{ W}$$

Total power = $P_1 + P_2$ = (500 ± 37.5) + (1250 ± 6.25) = 1750 ± 43.75

$$\text{Limiting error in total power} = \pm\frac{43.75}{1750}\times 100 = \pm 2.5\,\%$$

Q.372 A 100 mV full scale dual slope integrating type DVM has a reference voltage of 10 mV and conversion time of 50 ms. For an input of 5 mV, the conversion time is
(a) 25 msec (b) 50 msec
(c) 75 msec (d) 100 msec

372. (c)

For dual slope integrating type DVM

$$V_i \times T_1 = V_{ref} \times T_2$$

here, $V_{ref} = 10$ mV

$T_1 = 50$ msec

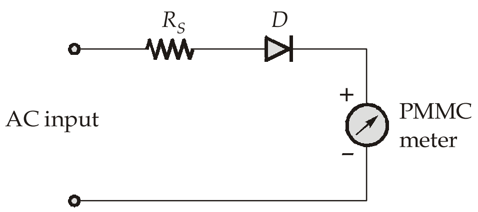
$V_i = 5$ mV

$T_2 = ?$

$$\therefore \quad T_2 = \frac{V_i}{V_{ref}} \times T_1 = \frac{5 \text{ mV}}{10 \text{ mV}} \times 50 \text{ msec} = 25 \text{ msec}$$

Conversion time $= T_1 + T_2 = 50 + 25 = 75$ msec

Q.373 An AC voltmeter uses the circuit shown below, where the PMMC meter has an internal resistance of 500 Ω and requires a D.C. current of 1 mA for full scale deflection. Assuming the diodes to be ideal, the value of R_S to obtain full scale deflection with 10 V (AC rms) applied to the input terminal would be



(a) 4.5 kΩ (b) 4 kΩ
(c) 5 kΩ (d) 0.5 kΩ

373. (b)

D.C. sensitivity of meter

$$S_{DC} = \frac{1}{I_{fsd}} = \frac{1}{1 \text{ mA}} = 1 \text{ k}\Omega/\text{V}$$

$$\therefore \quad S_{AC} = 0.45 \times S_{DC} = 0.45 \text{ k}\Omega/\text{V} = 450 \ \Omega/\text{V}$$

$$\therefore \quad R_S = V_{in(rms)} \times S_{AC} - R_m$$

$= 10 \times 450 - 500$

$= 4$ kΩ

Q.374 A (0 - 100) V voltmeter has a guaranteed accuracy of 1.2% on full-scale reading. The voltage measured by this instrument is equal to $3/4^{th}$ of its full scale value. Then the percentage limiting error on the measured value is equal to

(a) 1.2% (b) 1.6%
(c) 0.12% (d) 0.16%

374. (b)

Magnitude of the limiting error is,

$0.012 \times 100 \text{ V} = 1.2 \text{ V}$

Percentage error at a meter indication of $3/4^{th}$ of its full scale, i.e. 75 V is,

$$\% \varepsilon_r = \frac{1.2}{75} \times 100 = 1.6\%$$

Q.375 Consider the following statements:

1. Gross errors are mostly human errors.
2. Systematic errors are due to random variations in the system measurement.
3. Random errors are due to the effect of environment.

Which of the above statements is/are true?

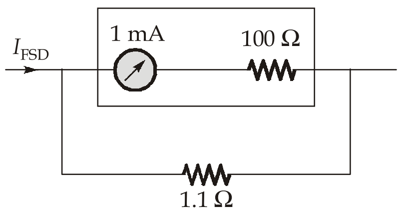
(a) 1 only
(b) 1 and 2 only
(c) 2 and 3 only
(d) 1, 2 and 3

375. (a)

Q.376 A 1 mA ammeter movement with an internal resistance of 100 Ω is shunted with 1.1 Ω resistance. Then this combination of ammeter is used to measure the maximum current range of

(a) 19.19 mA
(b) 90 mA
(c) 91.91 mA
(d) 99.91 mA

376. **(c)**



Given,

$$I_{MFSD} = 1 \text{ mA}$$
$$R_m = 100\ \Omega$$
$$R_{sh} = 1.1\ \Omega$$

We know that,

$$R_{sh} = \frac{R_m}{(M-1)}$$

where, $M = \dfrac{I_{FSD}}{I_{MFSD}}$

$$M - 1 = \frac{R_m}{R_{sh}} = \frac{100}{1.1} = 90.909$$
$$M = 91.909$$

$\therefore$
$$I_{FSD} = M \times I_{MFSD} = 91.909 \times 1 \text{ mA}$$
$$I_{FSD} \approx 91.91 \text{ mA}$$

Q.377 Consider the following statements regarding "electrodynamometer wattmeter":

1. it measures the average value of active power.
2. it has non-linear scale.
3. due to the effect of inductance in the pressure coil, it reads high on lagging power factor and low on leading power factor.

Which of the above statements are correct?

(a) 1 and 2 only
(b) 2 and 3 only
(c) 1 and 3 only
(d) 1, 2 and 3

377. **(c)**

Q.378 The clock frequency of a digital voltmeter is 500 kHz, the ramp voltage falls from 10 V to 0 V in 50 ms. Then the number of pulses counted by the counter is

(a) 250
(b) 2500
(c) 25000
(d) 250000

378. (c)

We know that,

Number of pulses = $500 \times 10^3 \times 50 \times 10^{-3}$ = 25000 pulses

Q.379 Consider the following statements regarding a strain gauge:

1. the strain is measured in terms of the change in the resistance.
2. dummy strain gauges are used for compensation of temperature changes.
3. the gauge factor of a strain gauge is the ratio of strain to per unit change in resistance.

Which of the above statements are correct?

(a) 1 and 2 only
(b) 2 and 3 only
(c) 1 and 3 only
(d) 1, 2 and 3

379. (a)

Q.380 Consider the following statements regarding a CRO:

1. Input resistance of CRO is nothing but the input resistance of vertical amplifier.
2. Bandwidth of CRO is nothing but the bandwidth of pre-amplifier.
3. Gain of CRO is nothing but the gain of horizontal amplifier.
4. Vertical amplifier is a push-pull amplifier.

Which of the above statements are true?

(a) 1 and 2 only
(b) 1 and 3 only
(c) 1, 2 and 4 only
(d) 2, 3 and 4 only

380. (c)

Q.381 Consider the following statements regarding "Bellows":

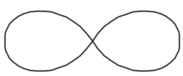
1. They are prone to errors due to shock and vibrations.
2. They are simple and rugged in construction.
3. They are capable of providing small force and low pressure range of measurements.

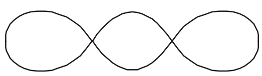
Which of the above statements are correct?

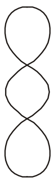
(a) 1 and 2 only
(b) 2 and 3 only
(c) 1 and 3 only
(d) 1, 2 and 3

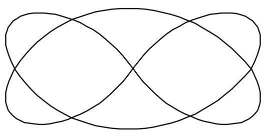
381. (a)

Q.382 Two sinusoidal signals with frequencies 'f_1' and '$3f_1$' are applied as X and Y inputs respectively to an oscilloscope. Which one of the following patterns could be observed on the screen?

(a) 

(b) 

(c) 

(d) 

382. (b)

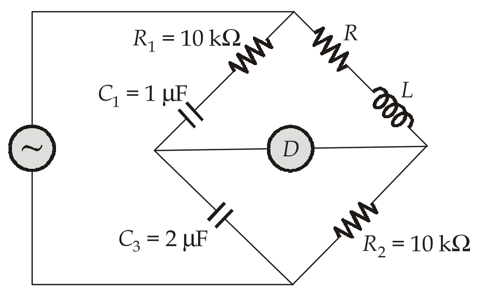
For closed Lissajous pattern,

$$\frac{f_y}{f_x} = \frac{\text{Number of Tangencies in Horizontal plane}}{\text{Number of Tangencies in Vertical plane}}$$

$$\frac{f_y}{f_x} = \frac{3f_1}{f_1} = \frac{3}{1}$$

Hence, option (b) is correct.

Q.383 A balanced Owen's bridge is shown below.



The values of R and L are respectively

(a) 20 kΩ and 20 H
(b) 200 kΩ and 200 H
(c) 20 kΩ and 200 H
(d) 200 kΩ and 20 H

383. (c)

At balance,

$$\left(R_1 + \frac{1}{j\omega C_1}\right)R_2 = (R + j\omega L)\frac{1}{j\omega C_3}$$

By equating real and imaginary parts, we get,

$$R = \frac{R_2 C_3}{C_1} = \frac{10^4 \times 2 \times 10^{-6}}{1 \times 10^{-6}} = 20\ \text{k}\Omega$$

$$L = R_1 R_2 C_3 = 10^4 \times 10^4 \times 2 \times 10^{-6} = 200\ \text{H}$$

Q.384 A circular disk of radius 4 m with a charge density $\rho_s = 12\sin\phi\ \text{mC/m}^2$ is enclosed by surface S. The net flux crosses the surface S will be

(a) 48 μC
(b) 12 μC
(c) 3 μC
(d) 0

384. (d)

Total charge enclosed,

$$Q = \int_0^{2\pi}\int_0^4 (12\sin\phi)\, r\, dr\, d\phi$$

$$= 0$$

Q.385 A dielectric material has relative permittivity of 9 and the loss tangent is 10^{-3} at 50 MHz, the conductivity of the medium will be

(a) 1.41×10^{-6} ℧/m
(b) 2.82×10^{-6} ℧/m
(c) 25.03×10^{-6} ℧/m
(d) 10.6×10^{-6} ℧/m

385. (c)

The loss tangent is given by,

$$\tan\delta = \frac{\sigma}{\omega\varepsilon}$$

$$10^{-3} = \frac{\sigma}{2\pi\times50\times10^{6}\times9\times8.854\times10^{-12}}$$

$$\sigma = 25.03 \times 10^{-6} \text{ ℧/m}$$

Q.386 A material has $\sigma = 0$ and $\varepsilon_r = 1$. The electric field intensity is given by

$$\vec{E} = 4\cos(10^{6}t - 0.01z)\hat{a}_y \text{ kV/m}$$

The value of μ_r is

(a) 3
(b) 6
(c) 9
(d) 12

386. (c)

$$v_p = \frac{\omega}{\beta} = \frac{10^6}{0.01} = 10^8$$

here, $$v_p = \frac{c}{\sqrt{\mu_r}} = \frac{3\times10^8}{\sqrt{\mu_r}}$$

∴ $$\mu_r = 3^2 = 9$$

Q.387 An air filled square waveguide with a = 1.2 cm has,

$$E_x = -10\sin\left(\frac{2\pi y}{a}\right)\sin(\omega t - 80z) \text{ V/m}$$

The cutoff frequency f_c is

(a) 12.5 GHz
(b) 25 GHz
(c) 40 GHz
(d) 80 GHz

387. (b)

∵ m = 0 and n = 2; TE_{02} mode.

For square waveguide, $a = b$,

∴ $$f_c = \frac{v_p}{a} = \frac{3\times10^{10}}{1.2} = 25 \text{ GHz}$$

Q.388 An air filled rectangular waveguide has dimension a = 2 cm and b = 1 cm. The range of frequencies over which the guide will operate single mode is

(a) 0 GHz < f < 15 GHz
(b) 7.5 GHz < f < ∞
(c) 7.5 GHz < f < 15 GHz
(d) 3.5 GHz < f < 7.5 GHz

388. **(c)**

Since the guide is air filled,

For dominant mode:

$$f_c = \frac{c}{2a} = \frac{3\times 10^{10}}{4} = 7.5\,\text{GHz}$$

The next higher mode will be either TE_{20} or TE_{01}, for both the modes,

$$f_c' = \frac{c}{2b} = \frac{3\times 10^{10}}{2} = 15\,\text{GHz}$$

Thus, the operating frequency range over which the guide will be single mode is,

$$7.5 \text{ GHz} < f < 15 \text{ GHz}$$

Q.389 A uniform plane wave in free space has electric field vector given by,

$$\vec{E} = 10e^{-j\beta x}\hat{a}_z + 15e^{-j\beta x}\hat{a}_y \text{ V/m}$$

The wave is said to be

(a) linearly polarized
(b) Right hand circularly polarized
(c) Left hand circularly polarized
(d) Left hand elliptically polarized

389. **(a)**

Since the two components have a fixed phase difference with respect to time and position, the wave has linear polarization.

Q.390 The relaxation time of a material with dielectric constant of $6\varepsilon_0$ is 54 sec. The conductivity of the material is

(a) 9.9×10^{-7} ℧/m
(b) 1.98×10^{-12} ℧/m
(c) 0.98×10^{-12} ℧/m
(d) 0.49×10^{-12} ℧/m

390. **(c)**

Relaxation time $\tau_r = \dfrac{\varepsilon}{\sigma}$

$\therefore$ $$\sigma = \frac{\varepsilon}{\tau_r} = \frac{6\times 8.854\times 10^{-12}}{54} = 0.983\times 10^{-12} \text{ ℧/m}$$

Q.391 A wave propagates from a dielectric medium to the interface with free space. If the angle of incidence is the critical angle of 20°, the relative permittivity of the medium is

(a) 0.116
(b) 0.0136
(c) 2.92
(d) 8.54

391. **(d)**

$$\sin\theta_i = \sqrt{\frac{\varepsilon_{r_2}}{\varepsilon_{r_1}}}$$

$$\sin 20^\circ = \frac{1}{\sqrt{\varepsilon_{r_1}}}$$

or $$\varepsilon_{r_1} = \frac{1}{\sin^2 20^\circ} = 8.54$$

Q.392 A small dipole of length 0.02λ is excited with a rms current of 4 A. The power radiated by the antenna is

(a) 0.40 W
(b) 8.04 W
(c) 1.60 W
(d) 5.05 W

392. (d)

Radiation resistance of the dipole is, $80\pi^2\left(\frac{dl}{\lambda}\right)^2$

$$= 80\pi^2\left(\frac{0.02\lambda}{\lambda}\right)^2$$

$$R_{rad} = 0.318\ \Omega$$

$\therefore$ Power radiated, $P_{rad} = I^2R_{rad} = 4^2 \times 0.318 = 5.05$ W

Q.393 In order to achieve a maximum unambiguous range of 160 km, the pulse repetition frequency will be

(a) 234.37 pulse/sec
(b) 468.75 pulse/sec
(c) 937.5 pulse/sec
(d) 1875 pulse/sec

393. (c)

$$R_{un} = \frac{c}{2f_p}$$

where, f_p = pulse repetition frequency

$$160 \times 10^3 = \frac{3\times10^8}{2\times f_p}$$

$$f_p = 937.5 \text{ Hz} = 937.5 \text{ pulse/sec}$$

Q.394 Consider a lossless transmission line with characteristic impedance Z_0 = 50 Ω. If the line is terminated with a load impedance of 80 Ω. The minimum input impedance of the line will be

(a) 80 Ω
(b) 50 Ω
(c) 31.25 Ω
(d) 15.26 Ω

394. (c)

$$|Z_{in}|_{min} = \frac{Z_0}{S}$$

where, $S = \frac{Z_L}{Z_0} = \frac{80}{50}$

$$|Z_{in}|_{min} = \frac{50}{80/50} = \frac{2500}{80} = 31.25\ \Omega$$

Q.395 In a uniform linear array, four isotropic radiating elements are spaced $\frac{\lambda}{4}$ apart. The progressive phase shift required for forming the main beam at 30° off the end fire array is

(a) $-\frac{\pi}{2}$ rad
(b) $-\frac{\pi}{4}$ rad
(c) $-\frac{\sqrt{3}\pi}{4}$ rad
(d) $-\frac{\sqrt{3}\pi}{2}$ rad

395. (c)

$$\psi = \beta d\cos\phi + \alpha$$

Here, $\phi = 30°$

$$d = \frac{\lambda}{4}$$

$$\beta = \frac{2\pi}{\lambda}$$

and $\psi = 0$ (for end fire array)

$\therefore$ $\alpha = -\beta d\cos\phi$

$$= -\frac{2\pi}{\lambda}\times\frac{\lambda}{4}\times\cos 30° = -\frac{\pi}{2}\times\cos 30°$$

$$= -\frac{\sqrt{3}\pi}{4}\text{rad}$$

Q.396 For an 2.4 m parabolic dish antenna the minimum distance required for far field measurement is given by 150 m. The approximate operating frequency of the antenna will be

(a) 1.63 GHz
(b) 2.45 GHz
(c) 3.9 GHz
(d) 8.7 GHz

396. (c)

$$\text{Far field distance} = \frac{2d^2}{\lambda}$$

$$150\text{ m} = \frac{2\times(2.4)^2}{\lambda}$$

$$\lambda = 0.0768 = 7.68\text{ cm}$$

$\therefore$ operating frequency, $f = \frac{c}{\lambda} = \frac{3\times10^8}{7.68\times10^{-2}} = 3.90\text{ GHz}$

Q.397 For a solenoidal vector field $\vec{F} = (x+3y)\hat{a}_x + (5y+2z)\hat{a}_y + (x-Qz)\hat{a}_z$, the value of Q must be

(a) 5
(b) 6
(c) 7
(d) 8

397. (b)

The vector will be solenoidal if its divergence is zero.

$$\vec{\nabla}\cdot\vec{F} = \frac{\partial}{\partial x}(x+3y) + \frac{\partial}{\partial y}(5y+2z) + \frac{\partial}{\partial z}(x-Qz) = 0$$

$$1 + 5 - Q = 0$$

or $Q = 6$

Q.398 For vector field $\vec{r} = x\hat{a}_x + y\hat{a}_y + z\hat{a}_z$,

1. $\nabla\cdot(\nabla\times\vec{r}) = 1$
2. $\nabla\times\vec{r} = 0$
3. $\nabla\cdot\vec{r} \neq 0$
4. $\nabla(\vec{r}\cdot\vec{r}) = \vec{r}$

Which of the above relations are true?

(a) 1 and 3
(b) 1 and 4
(c) 2, 3 and 4
(d) 2 and 3

398. (d)

$$\nabla\times\vec{r} = \begin{vmatrix} \hat{a}_x & \hat{a}_y & \hat{a}_z \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ x & y & z \end{vmatrix} = 0$$

$$\nabla\cdot\vec{r} = \frac{\partial}{\partial x}(x)+\frac{\partial}{\partial y}(y)+\frac{\partial}{\partial z}(z) = 3$$

$$\vec{r}\cdot\vec{r} = \left(x\hat{a}_x + y\hat{a}_y + z\hat{a}_z\right)\cdot\left(x\hat{a}_x + y\hat{a}_y + z\hat{a}_z\right) = x^2+y^2+z^2$$

$$\nabla(\vec{r}\cdot\vec{r}) = \frac{\partial}{\partial x}(x^2+y^2+z^2)\hat{a}_x + \frac{\partial}{\partial y}(x^2+y^2+z^2)\hat{a}_y + \frac{\partial}{\partial z}(x^2+y^2+z^2)\hat{a}_z$$

$$= 2x\hat{a}_x + 2y\hat{a}_y + 2z\hat{a}_z = 2\vec{r}$$

Q.399 In a free space $\vec{H}(z,t) = \frac{20}{\pi}\cos(\omega t - \beta z)\hat{a}_y$ A/m is given. The corresponding time averaged pointing vector will be

(a) $1.03\hat{a}_x$ kW/m^2
(b) $7.64\hat{a}_z$ kW/m^2
(c) $3.907\hat{a}_x$ kW/m^2
(d) $15.27\hat{a}_z$ kW/m^2

399. (b)

$$\vec{H} = \frac{20}{\pi}\cos(\omega t - \beta z)\hat{a}_y$$

$$\eta = 120\pi\ \Omega$$

$\because$
$$\vec{E} = \eta \times \vec{H} = 120\pi\times\frac{20}{\pi}\cos(\omega t - \beta z)\hat{a}_x$$

Thus,
$$\vec{P}_{avg} = \frac{1}{2}\text{Re}(\vec{E}\times\vec{H}^*) = \frac{1}{2}\left(\frac{20}{\pi}\times 120\times 20\right)\hat{a}_z\ \text{W/m}^2 = 7.64\hat{a}_z\ \text{kW/m}^2$$

Q.400 A current carrying circular loop, placed in the air, has loop current of 1 mA. If the loop radius is 2 cm, then the magnetic flux density at the center of the loop is

(a) π nWb/m^2
(b) 0.1π nWb/m^2
(c) 10π nWb/m^2
(d) 100π nWb/m^2

400. (c)

For a current carrying circular loop, at center,

$$B = \mu_0 H = \mu_0 \times \frac{I}{2r}$$

$$= \frac{4\pi\times 10^{-7}\times 1\times 10^{-3}}{2\times 2\times 10^{-2}}\ \text{Wb/m}^2 = 10\pi\ \text{nWb/m}^2$$

Q.401 In a particular conducting medium, the electric field is given by,

$$\vec{E} = 16e^{-0.05x}\sin(2\times 10^8 t - 0.05x)\hat{a}_y\ \text{V/m}$$

The skin depth is

(a) 20 m
(b) 2 m
(c) 0.5 m
(d) 0.05 m

401. (a)

$$\delta = \frac{1}{\alpha}$$

Here, $\alpha = 0.05$

$\therefore$ $\delta = \frac{1}{0.05} = 20 \text{ m}$

Q.402 In a copper conductor, the electromagnetic wave at 100 MHz penetrates to a depth of 7 μm. The wavelength of electromagnetic wave is

(a) 3 μm
(b) 7 μm
(c) 14 μm
(d) 44 μm

402. (d)

For conductors, $\delta = \frac{1}{\alpha} = \frac{1}{\beta}$

Here, $\beta = \frac{1}{\delta} = \frac{1}{7\mu\text{m}} = \frac{2\pi}{\lambda}$

$\therefore$ $\lambda = \frac{2\pi}{\beta} = 7 \times 2\pi \text{ μm} = 14\pi \text{ μm} \approx 44 \text{ μm}$

Q.403 A small dipole of length 0.1λ is excited by a sinusoidal signal with a peak current of 5 A. The total power radiated by such an antenna is

(a) 49.35 W
(b) 98.7 W
(c) 147.9 W
(d) 891.6 W

403. (b)

$$R_{\text{rad}} = 80\pi^2\left(\frac{dl}{\lambda}\right)^2 = 80\pi^2\left(\frac{0.1\lambda}{\lambda}\right)^2 = 0.8\pi^2\ \Omega$$

The power radiated $= \frac{1}{2}I_0^2 R_{rad} = \frac{1}{2}\times 5^2 \times 0.8\pi^2$

$= 25 \times 0.4\pi^2 \simeq 10 \times 9.87 = 98.7 \text{ W}$

Q.404 A 6 cm × 4 cm rectangular waveguide operating in TE_{32} mode at a frequency equal to $\sqrt{2}$ times the cut-off frequency. The operating frequency is

(a) 5 GHz
(b) 10 GHz
(c) 15 GHz
(d) 30 GHz

404. (c)

For TE_{32} mode,

$$f_c = \frac{c}{2\pi}\sqrt{\left(\frac{m\pi}{a}\right)^2 + \left(\frac{n\pi}{b}\right)^2} = \frac{3\times 10^{10}}{2\pi}\sqrt{\left(\frac{3\pi}{6}\right)^2 + \left(\frac{2\pi}{4}\right)^2}$$

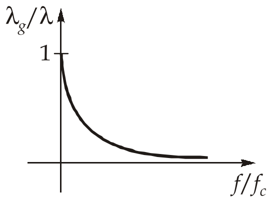
$$= \frac{3\times 10^{10}}{2\pi}\times\sqrt{\left(\frac{\pi}{2}\right)^2 + \left(\frac{\pi}{2}\right)^2} = \frac{3\times 10^{10}}{2\pi}\times\sqrt{2\left(\frac{\pi}{2}\right)^2}$$

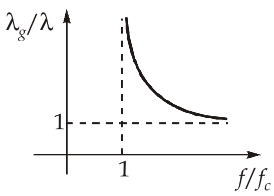
$$= \frac{3\times10^{10}}{2\sqrt{2}}\ \text{Hz}$$

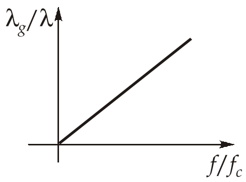
$$\because \qquad f = \sqrt{2}\, f_c$$

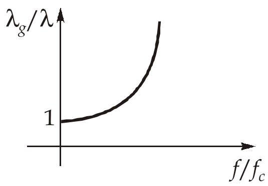
$$\therefore \qquad f = \frac{\sqrt{2}\times3\times10^{10}}{2\sqrt{2}} = \frac{3\times10^{10}}{2} = 15\ \text{GHz}$$

Q.405 An electromagnetic wave propagating at a frequency 'f' in free space has the wavelength λ. At the same frequency its wavelength in an airfilled rectangular waveguide is λ_g. If the cut-off frequency of the waveguide is f_c, then the plot (λ_g/λ) vs (f/f_c) is

(a)


(b)


(c)


(d)


405. (b)

As we know,

$$\lambda_g = \frac{\lambda}{\sqrt{1-\left(\frac{f_c}{f}\right)^2}}$$

$$\frac{\lambda_g}{\lambda} = \frac{1}{\sqrt{1-\left(\frac{f_c}{f}\right)^2}}$$

$$\frac{\lambda_g}{\lambda} = \sqrt{\frac{(f/f_c)^2}{(f/f_c)^2-1}}$$

Q.406 A transmission line, having primary constants R, L, C and G, has a characteristic impedance Z_0, which is purely resistive. Then

S_1: the line is definitely a lossless line.

S_2: the line is definitely a distortionless line.

Which of the above statements is/are true?

(a) S_1 only
(b) S_2 only
(c) Both S_1 and S_2
(d) Neither S_1 nor S_2

406. (b)

Characteristic impedance,

$$Z_0 = \sqrt{\frac{R + j\omega L}{G + j\omega C}}$$

For Z_0 to be purely resistive,

$$\angle Z_0 = \frac{1}{2}\left[\tan^{-1}\frac{\omega L}{R} - \tan^{-1}\frac{\omega C}{G}\right] = 0$$

$$\tan^{-1}\frac{\omega L}{R} = \tan^{-1}\frac{\omega C}{G}$$

or,

$$\frac{L}{R} = \frac{C}{G}$$

$$RC = LG \Rightarrow \text{Distortionless}$$

Direction (Q.407 to Q.410): The following items consists of two statements, one labelled as **Statement (I)** and the other labelled as **Statement (II)**. You have to examine these two statements carefully and select your answers to these items using the codes given below:

Codes:

(a) Both Statement (I) and Statement (II) are true and Statement (II) is the correct explanation of Statement (I).

(b) Both Statement (I) and Statement (II) are true but Statement (II) is not a correct explanation of Statement (I).

(c) Statement (I) is true but Statement (II) is false.

(d) Statement (I) is false but Statement (II) is true.

Q.407 Statement (I): It is possible to measure ac current on a D'Arsonval movement when a rectifier is used to produce unidirectional torque.

Statement (II): Rectifier converts ac into dc and the rectified current deflects the coil in the D'Arsonval meter.

407. (a)

Q.408 Statement (I): Piezoelectric transducers are self-generated type transducers.

Statement (II): Piezoelectric transducers have very good high frequency response.

408. (b)

Q.409 Statement (I): An antenna behaves as a resonant circuit, when the length of the antenna is integral multiple of $\lambda/2$.

Statement (II): An antenna of length $\lambda/2$ has a radiation pattern of two lobes.

409. (b)

To behave as a resonant circuit, the length of an antenna is an important factor and it should be equal to integral multiple of $\lambda/2$.

Q.410 Statement (I): A lossless transmission line is always a distortionless line.

Statement (II): A distortionless transmission line is always a lossless line.

410. (c)

■■■■