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T.B.C. : B-HUF-P-VEA

Test Booklet Series

Serial No.

0065685

## TEST BOOKLET

### ELECTRONICS & TELECOMMUNICATION ENGINEERING



Paper—I

**Time Allowed : Two Hours**

**Maximum Marks : 200**

#### INSTRUCTIONS

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5. You have to mark your responses **ONLY** on the separate Answer Sheet provided. See directions in the Answer Sheet.
6. All items carry equal marks.
7. Before you proceed to mark in the Answer Sheet the response to various items in the Test Booklet, you have to fill in some particulars in the Answer Sheet as per instructions sent to you with your Admission Certificate.
8. After you have completed filling in all your responses on the Answer Sheet and the examination has concluded, you should hand over to the Invigilator **only the Answer Sheet**. You are permitted to take away with you the Test Booklet.
9. Sheets for rough work are appended in the Test Booklet at the end.
10. **Penalty for wrong answers :**  
THERE WILL BE PENALTY FOR WRONG ANSWERS MARKED BY A CANDIDATE.
  - (i) There are four alternatives for the answer to every question. For each question for which a wrong answer has been given by the candidate, **one-third** of the marks assigned to that question will be deducted as penalty.
  - (ii) If a candidate gives more than one answer, it will be treated as **wrong answer** even if one of the given answers happens to be correct and there will be same penalty as above to that question.
  - (iii) If a question is left blank, i.e. no answer is given by the candidate, there will be **no penalty** for that question.

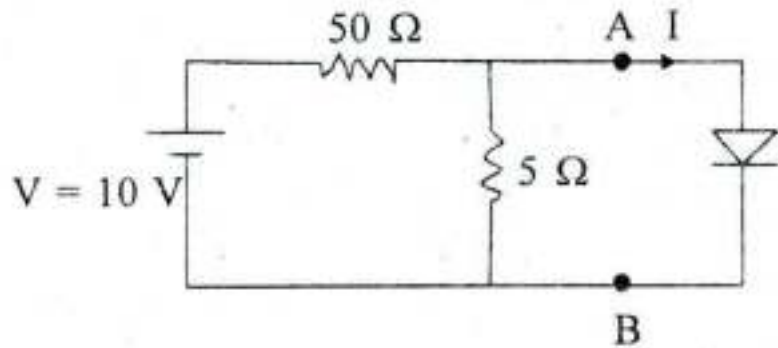
**DO NOT OPEN THIS TEST BOOKLET UNTIL YOU ARE ASKED TO DO SO**

1. Which one of the following helps experimental confirmation of the Crystalline state of matter ?
- Shock compression
  - Photo emission
  - Conductivity measurements
  - X-ray diffraction
2. The electrical conductivity of pure semiconductor is :
- Proportional to temperature
  - Increases exponentially with temperature
  - Decreases exponentially with temperature
  - Not altered with temperature
3. Consider the following statements pertaining to the resistance of a conductor :
- Resistance can be simply defined as the ratio of voltage across the conductor to the current through the conductor. This is, in fact, Georg Ohm's law
  - Resistance is a function of voltage and current
  - Resistance is a function of conductor geometry and its conductivity
- Which of the above statements are correct?
- 1 and 2 only
  - 2 and 3 only
  - 1 and 3 only
  - 1, 2 and 3
4. The ratio of ionic radii of Cations i.e.  $r_C$  and that of Anions i.e.  $r_A$  for stable and unstable ceramic crystal structure, is :
- Less than unity
  - Greater than unity
  - Unity
  - Either lesser or greater than unity
5. Which one of the following statements is correct?
- For insulators the band-gap is narrow as compared to semiconductors
  - For insulators the band-gap is relatively wide whereas for semiconductors it is narrow
  - The band-gap is narrow in width for both the insulators and conductors
  - The band-gap is equally wide for both conductors and semiconductors
6. In an extrinsic semiconductor the conductivity significantly depends upon :
- Majority charge carriers generated due to impurity doping
  - Minority charge carriers generated due to thermal agitation
  - Majority charge carriers generated due to thermal agitation
  - Minority charge carriers generated due to impurity doping
7. Necessary condition for photo-electric emission is :
- $h\nu \geq e\phi$
  - $h\nu \geq mc$
  - $h\nu \geq e\phi^2$
  - $h\nu \geq \frac{1}{2} mc$

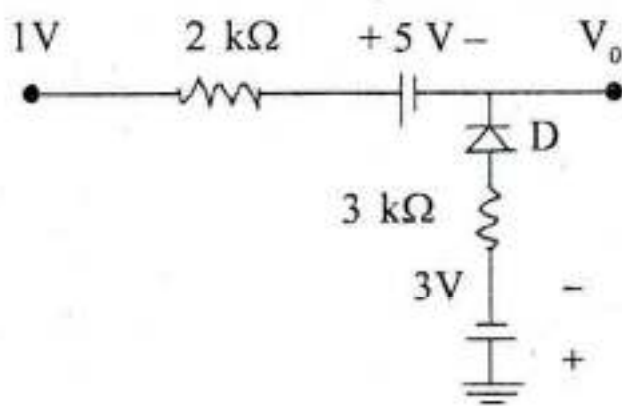
8. In some substances when an electric field is applied the substance becomes polarized. The electrons and nuclei assume new geometrical positions and the mechanical dimensions are altered. This phenomenon is called :
- Electrostriction
  - Hall-Effect
  - Polarization
  - Magnetization
9. In ferromagnetic materials, the net magnetic moment created due to magnetization by an applied field is :
- Normal to the applied field
  - Adds to the applied field
  - In line with magneto motive force
  - Subtracts from the applied field
10. At what temperatures domains lose their ferromagnetic properties ?
- Above ferromagnetic Curie temperature
  - Below paramagnetic Curie temperature
  - Above  $4^\circ \text{K}$
  - At room temperature
11. Which of the following materials does not have paramagnetic properties ?
- Rare earth elements (with incomplete shell)
  - Transition elements
  - Magnesium oxide
- Select the correct answer from the codes given below :
- 1 only
  - 2 only
  - 3 only
  - 1 and 2
12. In a superconducting magnet, wires of superconducting material are embedded in the thick copper matrix, because while the material is in the superconducting state :
- The leakage current passes through copper part
  - Copper part helps in conducting heat away from the superconductor
  - Copper part helps in overcoming the mechanical stress
  - Copper acts as an insulating cover for superconductor
13. The crystal structure of some Ceramic materials may be thought of being composed of electrically charged Cations and Anions, instead of Atoms, and as such :
- The Cations are negatively charged, because they have given up their valence electrons to Anions which are positively charged.
  - The Cations are positively charged, because they have given up their valence electrons to Anions which are negatively charged.
  - The Cations are positively charged, because they have added one electron to their valence electrons borrowing from Anions which are negatively charged.
  - The Cations are negatively charged, as they are non-metallic whereas Anions are positively charged being metallic.

14. Manganin alloy used for making resistors for laboratory instruments contains :
- Copper, Aluminium and Manganese
  - Copper, Nickel and Manganese
  - Aluminium, Nickel and Manganese
  - Chromium, Nickel and Manganese
15. A rolled-paper capacitor of value  $0.02 \mu\text{F}$  is to be constructed using two strips of aluminium of width 6 cm, and, wax impregnated paper of thickness 0.06 mm whose relative permittivity is 3. The length of foil strips should be :
- 0.3765 m
  - 0.4765 m
  - 0.5765 m
  - 0.7765 m
16. A Ge sample at room temperature has intrinsic carrier concentration,  $n_i = 1.5 \times 10^{13} \text{ cm}^{-3}$  and is uniformly doped with acceptor of  $3 \times 10^{16} \text{ cm}^{-3}$  and donor of  $2.5 \times 10^{15} \text{ cm}^{-3}$ . Then, the minority charge carrier concentration is :
- $0.918 \times 10^{10} \text{ cm}^{-3}$
  - $0.818 \times 10^{10} \text{ cm}^{-3}$
  - $0.918 \times 10^{12} \text{ cm}^{-3}$
  - $0.818 \times 10^{12} \text{ cm}^{-3}$
17. Assume that the values of mobility of holes and that of electrons in an intrinsic semiconductor are equal and the values of conductivity and intrinsic electron density are  $2.32/\Omega\text{m}$  and  $2.5 \times 10^{19} / \text{m}^3$  respectively. Then, the mobility of electron / hole is approximately :
- $0.3 \text{ m}^2/\text{Vs}$
  - $0.5 \text{ m}^2/\text{Vs}$
  - $0.7 \text{ m}^2/\text{Vs}$
  - $0.9 \text{ m}^2/\text{Vs}$
18. A silicon sample A is doped with  $10^{18} \text{ atom/cm}^3$  of Boron and another silicon sample B of identical dimensions is doped with  $10^{18} \text{ atom/cm}^3$  of Phosphorous. If the ratio of electron to hole mobility is 3, then the ratio of conductivity of the sample A to that of B is :
- $\frac{3}{2}$
  - $\frac{2}{3}$
  - $\frac{1}{3}$
  - $\frac{1}{2}$
19. The Hall-coefficient of a specimen of doped semiconductor is  $3.06 \times 10^{-4} \text{ m}^3 \text{ C}^{-1}$  and the resistivity of the specimen is  $6.93 \times 10^{-3} \Omega\text{m}$ . The majority carrier mobility will be :
- $0.014 \text{ m}^2\text{V}^{-1}\text{s}^{-1}$
  - $0.024 \text{ m}^2\text{V}^{-1}\text{s}^{-1}$
  - $0.034 \text{ m}^2\text{V}^{-1}\text{s}^{-1}$
  - $0.044 \text{ m}^2\text{V}^{-1}\text{s}^{-1}$
20. Doped silicon has Hall-coefficient of  $3.68 \times 10^{-4} \text{ m}^3\text{C}^{-1}$  and then its carrier concentration value is :
- $2.0 \times 10^{22} \text{ m}^{-3}$
  - $2.0 \times 10^{-22} \text{ m}^{-3}$
  - $0.2 \times 10^{22} \text{ m}^{-3}$
  - $0.2 \times 10^{-22} \text{ m}^{-3}$

21. What is the value of current  $I$  through the ideal diode in the circuit ?

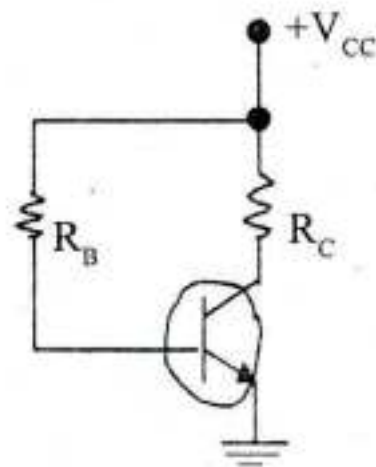


- (a) 100 mA  
 (b) 150 mA  
 (c) 200 mA  
 (d) 250 mA
22. What is the output voltage  $V_o$  for the circuit shown below assuming an ideal diode ?



- (a)  $-\frac{18}{5}$  V  
 (b)  $\frac{18}{5}$  V  
 (c)  $-\frac{13}{5}$  V  
 (d)  $\frac{13}{5}$  V
23. In a semiconductor diode, cut-in voltage is the voltage :
- (a) upto which the current is zero  
 (b) upto which the current is very small  
 (c) at which the current is 10% of the maximum rated current  
 (d) at which depletion layer is formed

24. A transistor circuit is shown in the figure. Assume  $\beta = 100$ ,  $R_B = 200$  k $\Omega$ ,  $R_C = 1$  k $\Omega$ ,  $V_{CC} = 15$  V,  $V_{BE_{act}} = 0.7$  V,  $V_{BE_{sat}} = 0.8$  V and  $V_{CE_{sat}} = 0.2$  V.



The transistor is operating in :

- (a) Saturation  
 (b) Cut-off  
 (c) Normal active  
 (d) Reverse active
25. The position of the intrinsic Fermi level of an undoped semiconductor ( $E_{Fi}$ ) is given by :

- (a)  $\frac{E_C - E_V}{2} + \frac{kT}{2} \ln \frac{N_V}{N_C}$   
 (b)  $\frac{E_C + E_V}{2} - \frac{kT}{2} \ln \frac{N_V}{N_C}$   
 (c)  $\frac{E_C + E_V}{2} + \frac{kT}{2} \ln \frac{N_V}{N_C}$   
 (d)  $\frac{E_C - E_V}{2} - \frac{kT}{2} \ln \frac{N_V}{N_C}$

26. The stability factor S in a bipolar junction transistor is :

(a)  $\frac{1+\beta}{1-\beta \left( \frac{dI_B}{dI_C} \right)}$

(b)  $\left( \frac{1+\beta}{1-\beta} \right) \left[ 1 - \left( \frac{dI_B}{dI_C} \right) \right]$

(c)  $(1+\beta) \left[ 1 - \beta \left( \frac{dI_B}{dI_C} \right) \right]$

(d)  $\frac{\beta-1}{\left[ 1 - \beta \left( \frac{dI_B}{dI_C} \right) \right]}$

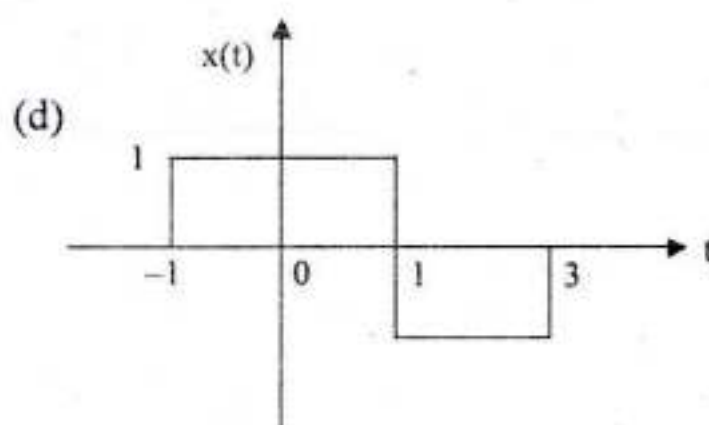
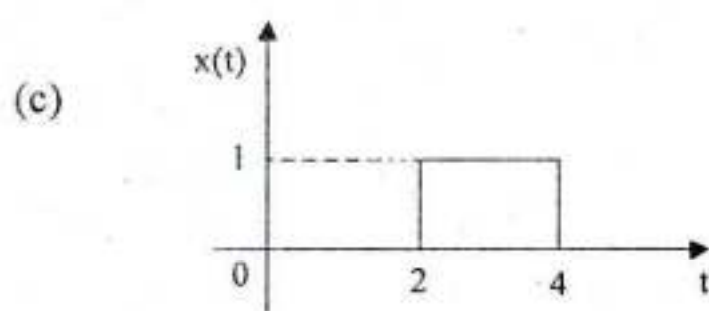
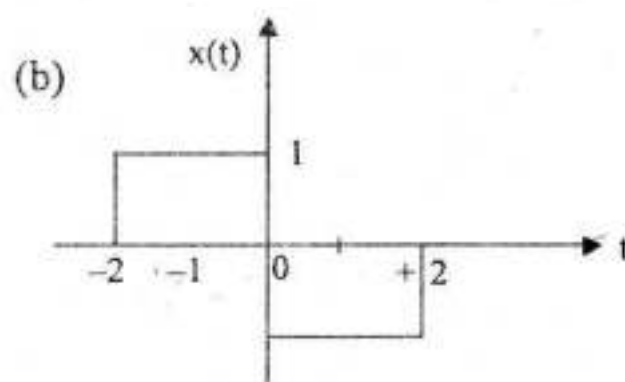
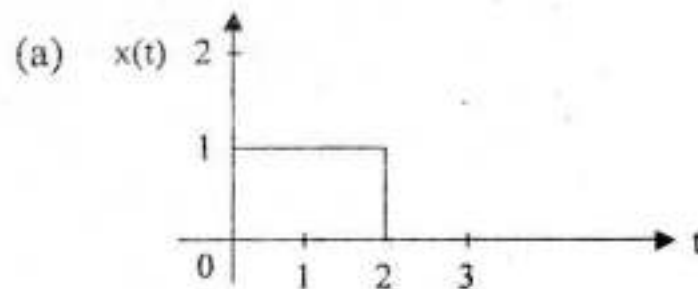
27. The leakage current in an NPN transistor is due to the flow of :

- (a) Holes from base to emitter
- (b) Electrons from collector to base
- (c) Holes from collector to base
- (d) Minority carriers from emitter to collector

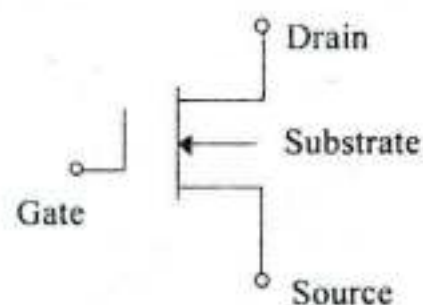
28. In Early effect :

- (a) Increase in magnitude of Collector voltage increases space charge width at the input junction of a BJT
- (b) Increase in magnitude of Emitter-Base voltage increases space charge width of output junction of a BJT
- (c) Increase in magnitude of Collector voltage increases space charge width of output junction of a BJT
- (d) Decrease in magnitude of Emitter-Base voltage increases space charge width of output junction of a BJT

29. The signal  $x(t) = u(t + 2) - 2u(t) + u(t - 2)$  is represented by :

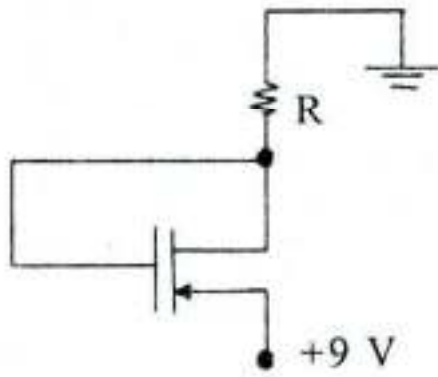


30. The figure shown represents :



- (a) n-channel MOSFET
- (b) Enhanced-mode E-MOSFET
- (c) p-Channel MOSFET
- (d) J-FET

31. The PMOSFET circuit shown in the figure has  $V_{TP} = -1.4$  V,  $K'_p = 25 \mu\text{A}/\text{V}^2$ ,  $L = 2 \mu\text{m}$ ,  $\lambda = 0$ . If  $I_{DS} = -0.1$  mA and  $V_{DS} = -2.4$  V then the width of channel  $W$  and  $R$  are respectively :



- (a)  $16 \mu\text{m}$  and  $66 \text{ k}\Omega$   
 (b)  $18 \mu\text{m}$  and  $33 \text{ k}\Omega$   
 (c)  $16 \mu\text{m}$  and  $33 \text{ k}\Omega$   
 (d)  $18 \mu\text{m}$  and  $66 \text{ k}\Omega$
32. Maximum energy of electrons liberated photoelectrically is :
- (a) Proportional to light intensity and independent of frequency of the light  
 (b) Independent of light intensity and varies linearly with frequency of the light  
 (c) Proportional to both, light intensity and frequency of the light  
 (d) Independent of light intensity and inversely proportional to frequency of the light

33. The response of a Gaussian random process applied to a stable linear system is :
1. A Gaussian random process
  2. Not a Gaussian random process
  3. Completely specified by its mean and auto-covariance functions

Which of the above statements is/are correct ?

- (a) 1 only  
 (b) 2 only  
 (c) 2 and 3  
 (d) 1 and 3
34. Consider a system, which computes the 'MEDIAN' of signal values in a window of size 'N'. Such a discrete time system is :
- (a) Linear  
 (b) Non-linear  
 (c) Sometimes linear  
 (d) Sometimes non-linear
35. Consider a discrete time system which satisfies the additivity property, i.e., if the output for  $u_1[n]$  is  $y_1[n]$  and that for  $u_2[n]$  is  $y_2[n]$ , then output for  $u_1[n] + u_2[n]$  is  $y_1[n] + y_2[n]$ . Such a system is :
- (a) Linear  
 (b) Sometimes linear  
 (c) Non-linear  
 (d) Sometimes non-linear
36. Consider an ideal low pass filter. Such a discrete-time system is :
- (a) always realizable physically  
 (b) never realizable physically  
 (c) a non linear system  
 (d) a linear, causal system

(Contd.)

37. The result of  $h(2t) * \delta(t - t_0)$  ("\*" denotes convolution and " $\delta(\cdot)$ " denotes the Dirac delta function) is :

- (a)  $h(2t - 2t_0)$
- (b)  $h(2t_0 - 2t)$
- (c)  $h(-2t - 2t_0)$
- (d)  $h(2t + 2t_0)$

38. A ray of light incident on a glass slab (of refractive index 1.5) with an angle  $\frac{\pi}{4}$ , then the value of sine of angle of refraction is :

- (a)  $\frac{1}{\sqrt{2}}$
- (b)  $\frac{3}{\sqrt{2}}$
- (c)  $\frac{\sqrt{2}}{3}$
- (d)  $\sqrt{2}$

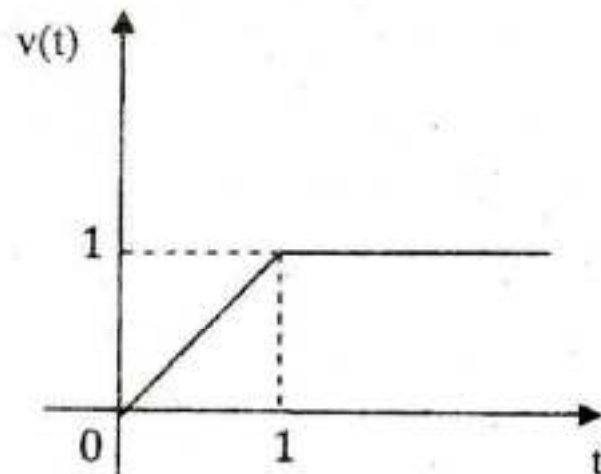
39. The complex exponential power form of Fourier series of  $x(t)$  is :

$$x(t) = \sum_{k=-\infty}^{\infty} a_k \cdot e^{j\frac{2\pi}{T_0} \cdot kt}$$

If  $x(t) = \sum_{b=-\infty}^{\infty} \delta(t - b)$ , then the value of  $a_k$  is :

- (a)  $1 - (-1)^k$
- (b)  $1 + (-1)^k$
- (c) 1
- (d) -1

40. Laplace transform of the function  $v(t)$  shown in the figure is :



- (a)  $s^2[1 - e^s]$
- (b)  $s^2[1 - e^{-s}]$
- (c)  $\frac{1}{s^2}[1 - e^s]$
- (d)  $\frac{1}{s^2}[1 - e^{-s}]$

41. In a discrete-time complex exponential sequence of frequency  $\omega_0 = 1$ , the sequence is :

1. Periodic with period  $\frac{2\pi}{\omega_0}$
2. Non-periodic
3. Periodic for some value of period N

Which of the above statements is/are correct ?

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



42. Consider the following transforms :
1. Fourier transform
  2. Laplace transform
- Which of the above transforms is/are used in signal processing ?
- (a) 1 only
  - (b) 2 only
  - (c) Both 1 and 2
  - (d) Neither 1 nor 2
43. The varactor diode has a voltage-dependent :
1. Resistance
  2. Capacitance
  3. Inductance
- Which of the above is/are correct ?
- (a) 1 only
  - (b) 2 only
  - (c) 3 only
  - (d) 1 and 3
44. The impulse response for the discrete-time system :
- $$y[n] = 0.24 (x[n] + x[n-1] + x[n-2] + x[n-3])$$
- is given by
- (a) 0 for  $0 \leq n \leq 3$  and 0.24 otherwise
  - (b) 0.24 for  $0 \leq n \leq 3$  and 0 otherwise
  - (c) 0.24 for  $n = 0$  to  $n = \infty$
  - (d) 0 for  $n = 0$  to  $n = \infty$
45. The product of emitter efficiency ( $\gamma$ ) and transport factor ( $\beta^*$ ) for a BJT is equal to :
- (a) Small signal current gain
  - (b) High frequency current gain
  - (c) Power loss in the BJT
  - (d) Large-signal current gain
46. Consider a two-sided discrete-time signal (neither left sided, nor right sided). The region of convergence (ROC) of the Z-transform of the sequence is:
1. All region of z-plane outside a unit circle (in z-plane)
  2. All region of z-plane inside a unit circle (in z-plane)
  3. Ring in z-plane
- Which of the above is/are correct ?
- (a) 1 only
  - (b) 2 only
  - (c) 3 only
  - (d) 1 and 3
47. When is a function  $f(n)$  said to be left-sided ?
- (a)  $f(n) = 0$  for  $n < 0$
  - (b)  $f(n) < 0$  for  $n > 0$
  - (c)  $f(n) = 0$  for  $n > n_0$
  - (d)  $f(n) = \infty$  for  $n < n_0$
- ( $n_0 \rightarrow$  Positive or negative integer)
48. Z-transform deals with discrete time systems for their :
1. Transient behaviour
  2. Steady-state behavior
- Which of the above behaviours is/are correct ?
- (a) 1 only
  - (b) 2 only
  - (c) Both 1 and 2
  - (d) Neither 1 nor 2

49. The response of a linear, time-invariant, discrete-time system to a unit step input  $u[n]$  is  $\delta[n]$ . The system response to a ramp input  $n u[n]$  would be :

- (a)  $\delta[n - 1]$
- (b)  $u[n - 1]$
- (c)  $n \delta[n - 1]$
- (d)  $n u[n - 1]$

50. Consider a discrete-random variable  $z$  assuming finitely many values. The cumulative distribution function,  $F_z(z)$  has the following properties :

1.  $\int_{-\infty}^{+\infty} F_z(z) dz = 1$
2.  $F_z(z)$  is non-decreasing with finitely many jump-discontinuities
3.  $F_z(z)$  is negative and non-decreasing

Which of the above properties is/are correct ?

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

51. Consider a random process given by :  $x(t) = A \cos(2\pi f_c t + \theta)$ , where  $A$  is a Rayleigh distributed random variable and  $\theta$  is uniformly distributed in  $[0, 2\pi]$ .  $A$  and  $\theta$  are independent. For any time  $t$ , the probability density function (PDF) of  $x(t)$  is :

- (a) Gaussian
- (b) Rayleigh
- (c) Rician
- (d) Uniform in  $[-A, A]$

52. Poisson's equation is derived with the following assumption about the medium. The medium is :

- (a) Non-homogeneous and isotropic
- (b) Non-homogeneous and non-isotropic
- (c) Homogeneous and non-isotropic
- (d) Homogeneous and isotropic

53. The state space representation of a linear time invariant system is :

$$\begin{aligned} \dot{X}(t) &= A X(t) + B u(t) \\ Y(t) &= C X(t) \end{aligned}$$

What is the transfer function  $H(s)$  of the system ?

- (a)  $C (sI - A)^{-1} B$
- (b)  $B (sI - A)^{-1} C$
- (c)  $C (sI - A) B$
- (d)  $B (sI - A) C$

54.  $x(t) = \frac{1}{T_0} + \sum_{k=1}^N \frac{2}{T_0} \cos k \omega_0 t$ , is the

combined trigonometric form of Fourier series for :

- (a) Half rectified wave
- (b) Saw-tooth wave
- (c) Rectangular wave
- (d) Impulse train

55. A signal  $x_n$  is given by  $x_0 = 3, x_1 = 2, x_2 = 5, x_3 = 1, x_4 = 0, x_5 = 1, x_6 = 2, x_7 = 2, x_8 = 4$ , where the subscript 'n' denotes time. The peak value of the auto correlation of  $x_{2n-11}$  is :

- (a) 0
- (b) 10
- (c) 54
- (d) 64

56. A system has impulse response  $h[n] = \cos(n)u[n]$ . The system is :

- (a) Causal and stable
- (b) Non causal and stable
- (c) Non causal and not stable
- (d) Causal and not stable

57. If the three resistors in a delta network are all equal in values i.e.  $R_{\text{DELTA}}$ , then the value of the resultant resistors in each branch of the equivalent star network i.e.  $R_{\text{STAR}}$  will be equal to :

- (a)  $\frac{R_{\text{DELTA}}}{3}$
- (b)  $\frac{R_{\text{DELTA}}}{2}$
- (c)  $2 R_{\text{DELTA}}$
- (d)  $R_{\text{DELTA}}$

58. Loop-voltage equations of a passive circuit are given by :

$$\begin{bmatrix} Z_{11} & Z_{12} & Z_{13} \\ Z_{21} & Z_{22} & Z_{23} \\ Z_{31} & Z_{32} & Z_{33} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix}$$

1.  $Z_{ij} = Z_{ji}$ ,  $i, j = 1, 2, 3$
2.  $Z_{ii} > 0$ ,  $i = 1, 2, 3$
3.  $\Delta Z \leq 0$

Which of the above relations are correct ?

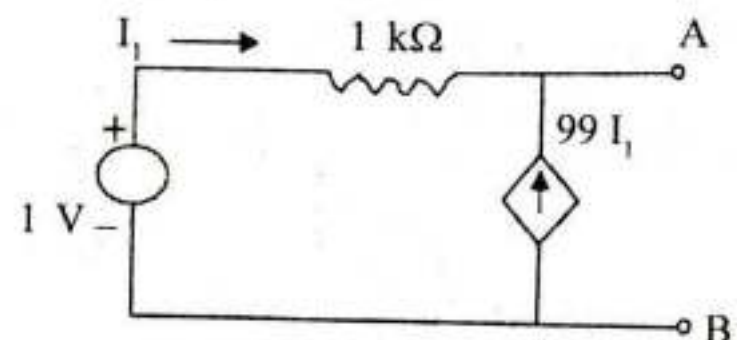
- (a) 1 and 2 only
- (b) 1 and 3 only
- (c) 2 and 3 only
- (d) 1, 2 and 3

59. A function  $c(t)$  satisfies the differential equation  $\dot{c}(t) + c(t) = \delta(t)$ . For zero initial condition  $c(t)$  can be represented by :

- (a)  $e^{-t}$
- (b)  $e^t$
- (c)  $e^t u(t)$
- (d)  $e^{-t} u(t)$

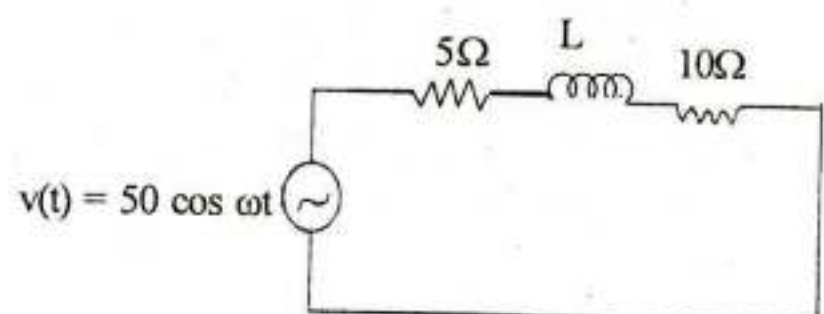
where  $u(t)$  is a unit step function.

60. For the network shown, Thevenin's equivalent voltage source and resistance are, respectively :



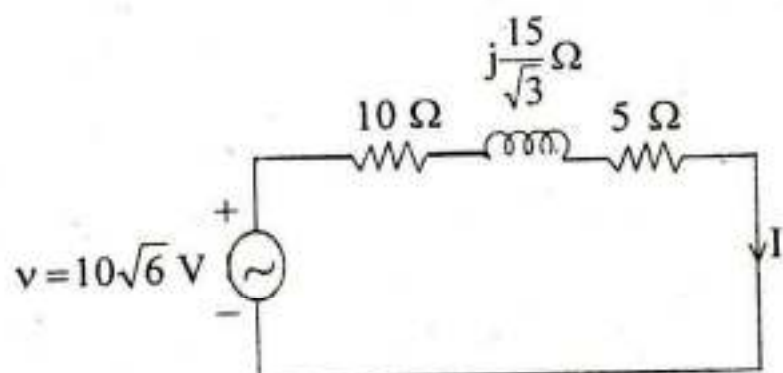
- (a) 1 mV and  $10 \Omega$
- (b) 1 V and  $1 \text{ k}\Omega$
- (c) 1 mV and  $1 \text{ k}\Omega$
- (d) 1 V and  $10 \Omega$

61. In the circuit shown, if the power consumed by the  $5 \Omega$  resistor is 10 W, then the power factor of the circuit is :



- (a) 0.8
- (b) 0.6
- (c) 0.4
- (d) 0.2

62. For the circuit shown, if the power consumed by  $5\ \Omega$  resistor is  $10\ \text{W}$ , then :



1.  $|I| = \sqrt{2}\ \text{A}$
2. Total impedance =  $5\ \Omega$
3. Power factor =  $0.866$

Which of the above are correct ?

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

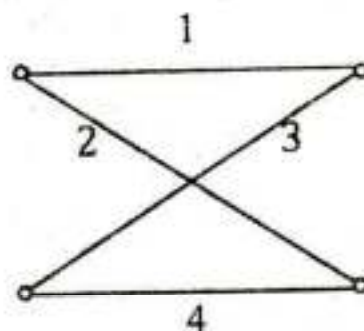
63. For a given fixed tree of a network, the following form an independent set :

1. Branch currents
2. Link voltages

Which of the above is/are correct ?

- (a) 1 only
- (b) 2 only
- (c) Both 1 and 2
- (d) Neither 1 nor 2

64. For the network graph, the number of trees (P) and the number of cut-sets (Q) are respectively :



- (a) 4 and 2
- (b) 6 and 2
- (c) 4 and 6
- (d) 2 and 6

65. For which one of the following measurements a thermistor can be used ?

- (a) Velocity
- (b) Humidity
- (c) Displacement
- (d) Percent of  $\text{CO}_2$  in air

66. According to network graphs, the network with :

1. Only two odd vertices is traversable
2. No odd vertices is traversable
3. Two or more than two odd vertices are traversable

Which of the above statements is/are correct ?

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

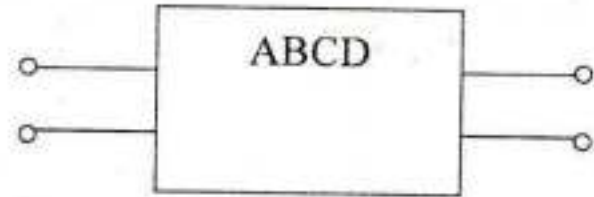
67. For any lumped network, for any cut sets and at any instant of time the algebraic sum of all branch currents traversing the cut-set branches is always :

- (a) One
- (b) Zero
- (c) Infinity
- (d) Greater than zero, but less than one

68. Which one of the following statements concerning Tellegen's theorem is correct ?

- (a) It is useful in determining the effects in all parts of a linear four-terminal network
- (b) It is applicable for any lumped network having elements which are linear or nonlinear, active or passive, time varying or time-invariant, and may contain independent or dependent sources
- (c) It can be applied to a branch, which is not coupled to other branches in a network
- (d) It states that the sum of powers taken by all elements of a circuit within constraints imposed by KCL and KVL is non-zero

69. The open circuit input impedance of a 2-port network is :



- (a)  $\frac{A}{C} \Omega$
- (b)  $\frac{B}{D} \Omega$
- (c)  $\frac{D}{C} \Omega$
- (d)  $\frac{A}{B} \Omega$

70. Consider the following statements :

1. Two identical 2<sup>nd</sup> order Butterworth LP filters when connected in cascade will make a 4<sup>th</sup> order Butterworth LP filter.
2. A high 2<sup>nd</sup> order filter will exhibit a peak if Q exceeds certain value.
3. A band pass filter cannot be of order one.
4. A network consists of an amplifier of real gain A and a  $\beta$  network in cascade with each other. The network will generate sinusoidal oscillations if the  $\beta$  network is a first order LP filter.

Which of the above statements are correct ?

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

71. The lowest and the highest critical frequencies of RC driving point admittance are, respectively :

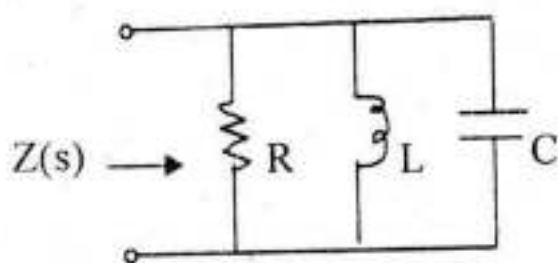
- (a) a zero and a pole
- (b) a pole and a zero
- (c) a zero and a zero
- (d) a pole and a pole

72. The poles and zeros of a voltage function  $v(t)$  are : zero at the origin and simple poles at  $-1, -3$  and the scale factor is 5. The contribution of the pole at  $-3$  to  $v(t)$  is :

- (a)  $2.5 e^{-3t}$
- (b)  $7.5 e^{-3t}$
- (c)  $2.5 e^{+3t}$
- (d)  $7.5 e^{+3t}$

73. The driving point impedance of the circuit

shown is given by  $Z(s) = \frac{0.2s}{s^2 + 0.1s + 2}$ .



The component values R, L and C are respectively :

- (a)  $0.5 \Omega, 1 \text{ H and } 0.1 \text{ F}$
- (b)  $2 \Omega, 5 \text{ H and } 5 \text{ F}$
- (c)  $0.5 \Omega, 0.1 \text{ H and } 0.1 \text{ F}$
- (d)  $2 \Omega, 0.1 \text{ H and } 5 \text{ F}$

74. Consider the following driving point impedances which are to be realized using passive elements :

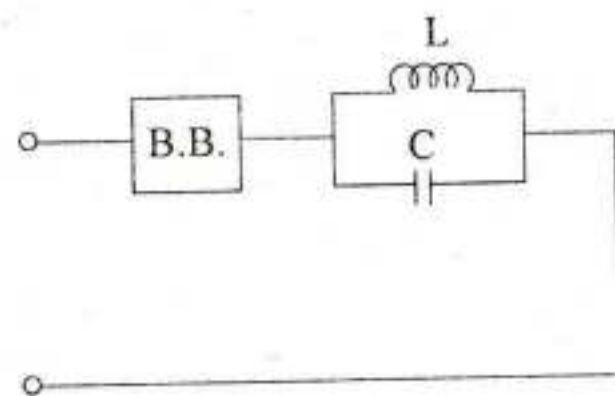
1.  $\frac{s+3}{s^2(s+5)}$

2.  $\frac{s^2+3}{s^2(s^2+5)}$

Which of the above is/are realizable ?

- (a) 1 only
- (b) 2 only
- (c) Both 1 and 2
- (d) Neither 1 nor 2

75. A reactance function in the first Foster form has poles at  $\omega = 0$  and  $\omega = \infty$ . The black-box (B.B.) in the network contains :



- (a) An inductor
- (b) A capacitor
- (c) A parallel L-C circuit
- (d) A series L-C circuit

76. Consider the following statements :

1. The magnetic field at the centre of a circular coil of a wire carrying current is inversely proportional to the radius of the coil
2. Lifting power of a magnet is proportional to square of magnetic flux density
3. A static electric field is conservative (irrotational)
4. If the divergence of a vector 'A' is zero, then vector 'A' can be expressed as Curl of a vector F

Which of the above statements are correct ?

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

77. Consider the following :

1. Electric current flowing in a conducting wire
2. A moving charged belt
3. An electron beam in a cathode ray tube
4. Electron movement in a vacuum tube

Which of the above are examples of convection current ?

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

78. Consider the following sources :

1. A permanent magnet
2. A charged disc rotating at uniform speed
3. An accelerated charge
4. An electric field which changes linearly with time

Which of the above are the sources of steady magnetic field ?

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

79. A charge Q is enclosed by a Gaussian spherical surface of radius R. If R is doubled then the outward flux is :

- (a) Doubled
- (b) Increased four times
- (c) Reduced to a quarter
- (d) Remains unaltered

80. Divergence of a vector  $\text{div } D$  in the cylindrical coordinate system is :

- (a)  $\frac{1}{\rho} \frac{\partial}{\partial \rho} (\rho D_\rho) + \frac{1}{\rho} \frac{\partial D_\phi}{\partial \phi} + \frac{\partial D_z}{\partial z}$
- (b)  $\frac{1}{\rho} \frac{\partial}{\partial \rho} (\rho D_\rho) + \frac{1}{\rho} \frac{\partial (\phi D_\phi)}{\partial \phi} + \frac{1}{z} \frac{\partial (z D_z)}{\partial z}$
- (c)  $\frac{1}{\rho} \frac{\partial}{\partial \rho} (\rho D_\rho) + \frac{1}{\rho} \frac{\partial D_\phi}{\partial \phi} + \frac{\partial D_z}{\partial z}$
- (d)  $\frac{\partial D_\rho}{\partial \rho} + \frac{\partial D_\phi}{\partial \phi} + \frac{\partial D_z}{\partial z}$

81. What is the value of work required to move a + 8 nC charge from infinity to a point P which is at 2 m distance from a point charge  $Q = + 5 \mu\text{C}$  ?
- (a) 180  $\mu\text{J}$   
 (b) 180 nJ  
 (c) 18  $\mu\text{J}$   
 (d) 18 nJ
82. An electrostatic force between two point charges increases when they are :
- (a) More apart and dielectric constant of the medium between them decreases  
 (b) Less apart and dielectric constant of the medium between them decreases  
 (c) More apart and dielectric constant of the medium between them increases  
 (d) Less apart and dielectric constant of the medium between them increases
83. A plane  $Y = 2$  carries infinite sheet of charge  $6 \text{ nC/m}^2$ . If medium is free space then force on a point charge of 10 mC located at the origin is :
- (a)  $-1080 \pi \bar{a}_y \text{ N}$   
 (b)  $-108 \pi \bar{a}_y \text{ N}$   
 (c)  $-10.8 \pi \bar{a}_y \text{ N}$   
 (d)  $-1.08 \pi \bar{a}_y \text{ N}$

84. The potential at the centroid of an equilateral triangle of side  $r\sqrt{3}$  due to three equal positive point charges each of value  $q$  and placed at the vertices of the triangle would be :
- (a)  $\frac{q}{2\pi\epsilon_0 r}$   
 (b)  $\frac{\sqrt{3} q}{8\pi\epsilon_0 r}$   
 (c)  $\frac{3 q}{4\pi\epsilon_0 r}$   
 (d) Zero
85. The point form of the relation connecting vector magnetic potential  $A$  and current density  $J$  is :
- (a)  $\nabla \times A = J + \frac{\partial D}{\partial t}$   
 (b)  $A = \int \frac{\mu_0 J}{4\pi \epsilon R} dv$   
 (c)  $\nabla^2 A = -\mu_0 J$   
 (d)  $\frac{\partial A}{\partial t} = -\frac{J}{\sigma}$
86. In the region  $Z < 0$ ,  $\epsilon_{r1} = 2$ ,  $\bar{E}_1 = -3\bar{a}_x + 4\bar{a}_y - 2\bar{a}_z \text{ V/m}$ . For region  $Z > 0$ , where  $\epsilon_{r2} = 6.5$ ,  $\bar{E}_2$  is :
- (a)  $-3\bar{a}_x + 4\bar{a}_y + \frac{6.5}{4} \bar{a}_z \text{ V/m}$   
 (b)  $-3\bar{a}_x + 4\bar{a}_y + \frac{4}{6.5} \bar{a}_z \text{ V/m}$   
 (c)  $-3\bar{a}_x + 4\bar{a}_y - \frac{6.5}{4} \bar{a}_z \text{ V/m}$   
 (d)  $-3\bar{a}_x + 4\bar{a}_y - \frac{4}{6.5} \bar{a}_z \text{ V/m}$



87. Consider the following statements regarding a conductor and free space boundary :

1. No charge and no electric field can exist at any point within the interior of a conductor
2. Charge may appear on the surface of a conductor

Which of the above statements are correct ?

- (a) 1 only
- (b) 2 only
- (c) Both 1 and 2
- (d) Neither 1 nor 2

88. A sphere of homogeneous linear dielectric material of dielectric constant  $\geq 1$  is placed in a uniform electric field  $E_0$ , then the electric field  $E$  that exists inside the sphere is :

- (a) Uniform and  $E \leq E_0$
- (b) Uniform and  $E \geq E_0$
- (c) Varies but  $E < E_0$  always
- (d) Varies but  $E > E_0$  always

89. Which of the following Maxwell's equations represents Ampere's law with correction made by Maxwell ?

- (a)  $\nabla \cdot E = \frac{\rho}{\epsilon_0}$
- (b)  $\nabla \cdot B = 0$
- (c)  $\nabla \times E = -\frac{\partial B}{\partial t}$
- (d)  $\nabla \times B = \mu_0 J + \mu_0 \epsilon_0 \frac{\partial E}{\partial t}$

90. 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

91. If phasors  $P_1 = 3 + j4$  and  $P_2 = 6 - j8$ , then  $|P_1 - P_2|$  is :

- (a) 5
- (b)  $\sqrt{53}$
- (c)  $\sqrt{73}$
- (d)  $\sqrt{153}$

92. A plane wave in free space has a magnetic field intensity of 0.2 A/m in the Y-direction. The wave is propagating in the Z-direction with a frequency of 3 GHz. The wavelength and amplitude of the electric field intensity are, respectively :

- (a) 0.05 m and 75 V/m
- (b) 0.10 m and 75 V/m
- (c) 0.05 m and 150 V/m
- (d) 0.10 m and 150 V/m

93. For energy propagation in a lossless transmission line, the characteristic impedance of the line is expressed in ohm as below (where notations have usual meanings).
- (a)  $\sqrt{LC} \Omega$
- (b)  $\sqrt{\frac{L}{C}} \Omega$
- (c)  $\sqrt{\frac{C}{L}} \Omega$
- (d)  $\sqrt{\frac{R + j\omega L}{G - j\omega L}} \Omega$
94. A quarter wave-length transformer is used to match a load of  $200 \Omega$  to a line with input impedance of  $50 \Omega$ . The characteristic impedance of the transformer would be :
- (a)  $40 \Omega$
- (b)  $100 \Omega$
- (c)  $400 \Omega$
- (d)  $1000 \Omega$
95. For a lossless transmission line  $L = 0.35 \mu\text{H/m}$ ,  $C = 90 \text{ pF/m}$  and frequency =  $500 \text{ MHz}$ . Then the magnitude of propagation constant is :
- (a) 14.48
- (b) 17.63
- (c) 19.59
- (d) 21.20
96. If an antenna has a main beam with both half-power beam widths equal to  $20^\circ$ , its directivity (D) is nearly :
- (a) 90.6
- (b) 102.5
- (c) 205
- (d) 226
97. An instrument always extracts some energy from the measured medium. Thus the measured quantity is always disturbed by the act of measurement, which makes a perfect measurement theoretically impossible and it is due to :
- (a) Skin-effect
- (b) Inductive effect
- (c) Loading effect
- (d) Lorenz effect
98. The characteristic impedance  $\eta_0$  of a free space is :
- (a)  $\frac{\mu_0}{\epsilon_0}$
- (b)  $\sqrt{\frac{\mu_0}{\epsilon_0}}$
- (c)  $\sqrt{\mu_0 \epsilon_0}$
- (d)  $\mu_0 \epsilon_0$
99. A  $3\frac{1}{2}$  digit voltmeter has an accuracy specification of  $\pm 0.5\%$  of reading  $\pm$  one digit. What is the possible error in volts when the instrument displays  $2.00 \text{ V}$  on the  $10 \text{ V}$  scale ?
- (a)  $0.03 \text{ V}$
- (b)  $0.02 \text{ V}$
- (c)  $0.01 \text{ V}$
- (d)  $0.005 \text{ V}$

100. A megger is an instrument used for measuring :

- (a) Very high voltages
- (b) Very low voltages
- (c) Very high resistances
- (d) Very low resistances

101. The values of capacitance and inductance used in the series LCR circuit are  $160 \text{ pF}$  and  $160 \text{ } \mu\text{H}$  with the inherent tolerance  $-10\%$  in each. Then, the resonance frequency of the circuit is in the range of :

- (a)  $0.8 \text{ MHz}$  to  $1.2 \text{ MHz}$
- (b)  $0.9 \text{ MHz}$  to  $1.0 \text{ MHz}$
- (c)  $0.8 \text{ MHz}$  to  $1.0 \text{ MHz}$
- (d)  $0.9 \text{ MHz}$  to  $1.2 \text{ MHz}$

102. Dynamic characteristics of instruments leading to variations during measurement are :

1. Speed of response
2. Fidelity
3. Dynamic error

Which of the above are correct ?

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

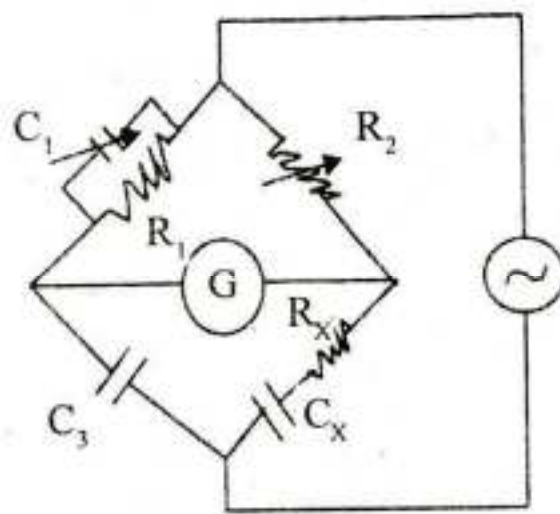
103. The reliability of an instrument refers to :

- (a) Degree to which repeatability continues to remain within specified limits
- (b) The extent to which the characteristics remain linear
- (c) Accuracy of the instrument
- (d) Sensitivity of the instrument

104. AC Voltmeters use diodes with :

- (a) High forward current and low reverse current ratings
- (b) Low forward current and low reverse current ratings
- (c) Low forward current and high reverse current ratings
- (d) High forward current and high reverse current ratings

105. The bridge circuit shown can be used to measure unknown lossy capacitor  $C_x$  with resistance  $R_x$ . At balance :



(a)  $R_x = \frac{C_1}{C_3} R_2$  and  $C_x = \frac{R_1}{R_2} C_3$

(b)  $R_x = \frac{C_3}{C_1} R_1$  and  $C_x = \frac{R_2}{R_1} C_3$

(c)  $R_x = \frac{R_1}{C_2} R_2$  and  $C_x = \frac{C_1}{R_1} R_2$

(d)  $R_x = R_2$  and  $C_x = C_3$

where  $R_1$ ,  $R_2$ ,  $C_1$  and  $C_3$  can be assumed ideal components

106. Inductance of a coil having Q value in the range of ( $1 < Q < 10$ ), can be measured by using :

- (a) Hay's bridge
- (b) De Sauty's bridge
- (c) Maxwell's bridge
- (d) Carry Foster's bridge

107. The instrument servomechanism is actually an instrument system made of components, which are :

- (a) Exclusively passive transducers
- (b) Exclusively active transducers
- (c) Combination of passive transducers and active transducers
- (d) Exclusively primary sensing elements

108. The scale of an electro-dynamometer usually reads the :

- (a) Average value of the ac
- (b) Mean value of the ac
- (c) Effective value of the ac
- (d) Squared value of the ac

109. The resolution of an indicating instrument can be defined as :

1. Variation in the meter reading for the same applied input
2. Detectable change in the deflection due to smallest change in the applied input
3. Detectable change in the output due to drifting of pointer

Which of the above statements are correct ?

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

110. While measuring the phase difference between the signals  $v_1(t) = 10 \sin \omega t$  and  $v_2(t) = 10 \sin(\omega t + \phi)$ , the Lissajous pattern observed on CRO is a circle. The value of  $\phi$  is :

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

111. The expected voltage across a resistor is 100 V. However, the voltmeter reads a value of 97 V. The relative error is :

- (a) 0.97
- (b) 0.03
- (c) 0.07
- (d) 3.00

112. A sinusoidal voltage of amplitude 150 V has been applied to a circuit having a rectifying device that prevents flow of current in one direction and offers a resistance of  $15 \Omega$  for the flow of current in the other direction. If hot wire type and PMMC type instruments are connected in this circuit to measure the electric current, their readings would respectively be :

- (a) 3.18 A and 5 A
- (b) 5 A and 3.18 A
- (c) 3.18 A and 5 mA
- (d) 5 A and 3.18 mA

113. A tachometer encoder can be used for measurement of speed :
- of false pulses because of electrical noise
  - in forward and reverse directions
  - in one direction only
  - for single revolution in a multiple track
114. A rotameter works on the principle of variable :
- Pressure
  - Length
  - Area
  - Resistance
115. An input voltage required to deflect a beam through 3 cm in a Cathode Ray Tube having an anode voltage of 1000 V and parallel deflecting plates 1 cm long and 0.5 cm apart, when screen is 30 cm from the centre of the plates is :
- 300 V
  - 200 V
  - 100 V
  - 75 V
116. A 6-bit ADC has a maximum precision supply voltage of 20 V. What are the voltage changes for each LSB present and voltage to be presented by (100110), respectively ?
- 0.317 V and 12.06 V
  - 3.17 V and 12.06 V
  - 0.317 V and 1.206 V
  - 3.17 V and 1.206 V
117. Which of the following transducers measures the pressure by producing emf as a function of its deformation ?
- Photoelectric transducer
  - Capacitive transducer
  - Inductive transducer
  - Piezoelectric transducer
118. Maxwell's bridge measures an unknown inductance in terms of :
- Known inductance
  - Known capacitance
  - Known resistance
  - Q of the coil
119. Strain gauges are constructed with Germanium chips because Germanium :
- has a strong Hall Effect
  - is crystalline in nature
  - can be doped
  - has piezo-electric property
120. The advantages of an LVDT is/are :
- Linearity
  - Infinite resolution
  - Low Hysteresis
- Which of the above advantages is/are correct ?
- 1 only
  - 2 only
  - 3 only
  - 1, 2 and 3

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