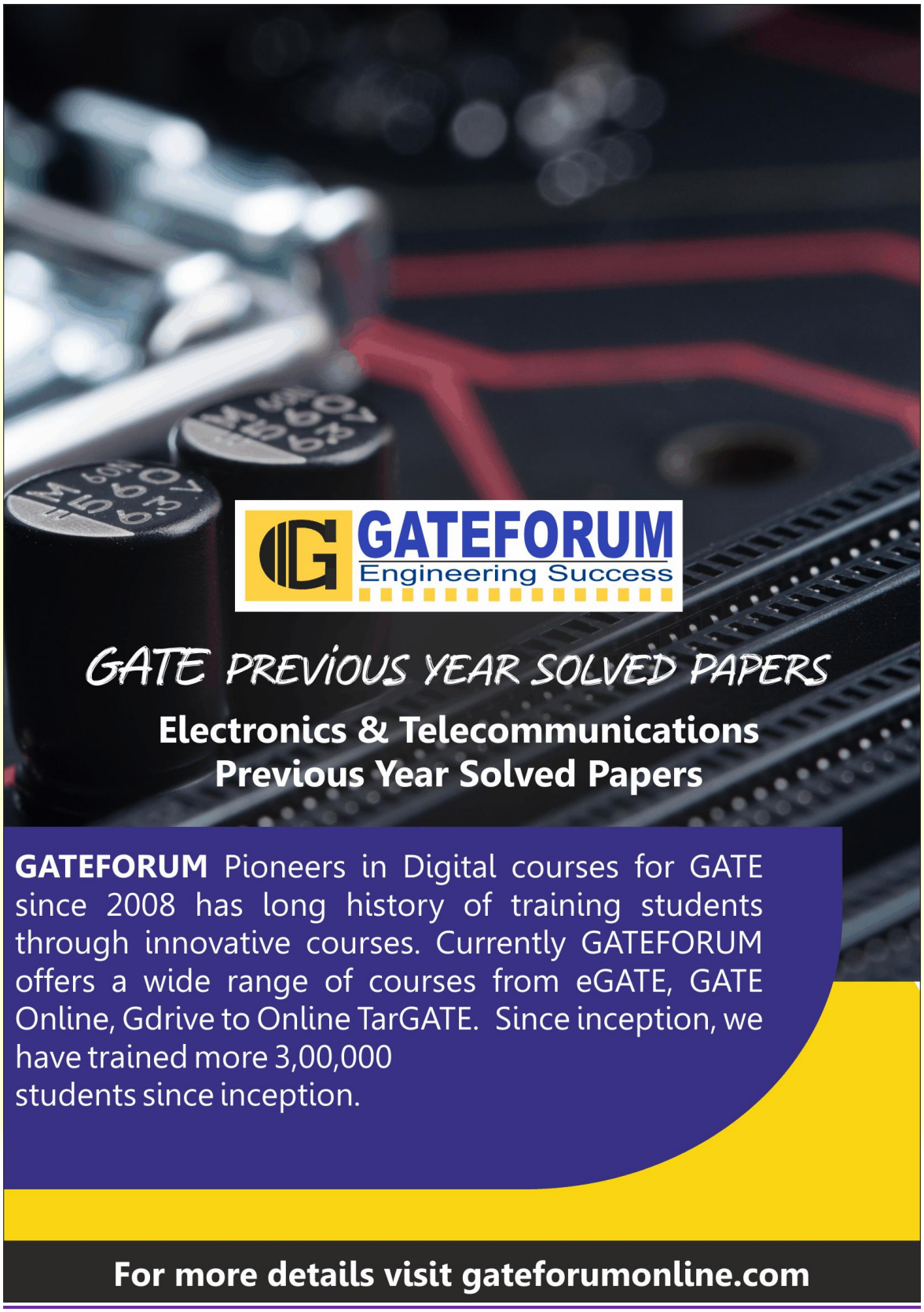


GENERAL APTITUDE

Q. No. 1 to 5 Carry One Mark Each

1. "India is a country of rich heritage and cultural diversity." Which one of the following facts best supports the claim made in the above sentence?

(A) India is a union of 28 states and 7 union territories.

(B) India has a population of over 1.1 billion.

(C) India is home to 22 official languages and thousands of dialects.

(D) The Indian cricket team draws players from over ten states.

Answer: (C)

---

2. The value of one U.S. dollar is 65 Indian Rupees today, compared to 60 last year. The Indian Rupee has _____.

(A) Depressed (B) Depreciated (C) Appreciated (D) Stabilized

Answer: (B)

---

3. 'Advice' is _____.

(A) a verb (B) a noun

(C) an adjective (D) both a verb and a noun

Answer: (B)

---

4. The next term in the series 81, 54, 36, 24 … is _____

Answer: (16)

---

5. In which of the following options will the expression P < M be definitely true?

(A) M < R > P > S (B) M > S < P < F

(C) Q < M < F = P (D) P = A < R < M

Answer: (D)

Q. No. 6 to 10 Carry Two Marks Each

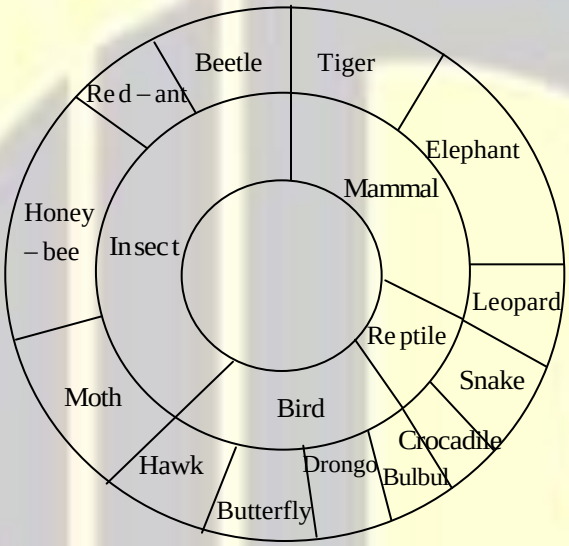
6. Find the next term in the sequence: 7G, 11K, 13M, ___

(A) 15Q (B) 17Q (C) 15P (D) 17P

Answer: (B)

---

7. The multi-level hierarchical pie chart shows the population of animals in a reserve forest. The correct conclusions from this information are:



(i) Butterflies are birds

(ii) There are more tigers in this forest than red ants

(iii) All reptiles in this forest are either snakes or crocodiles

(iv) Elephants are the largest mammals in this forest

(A) (i) and (ii) only (B) (i), (ii), (iii) and (iv)

(C) (i), (iii) and (iv) only (D) (i), (ii) and (iii) only

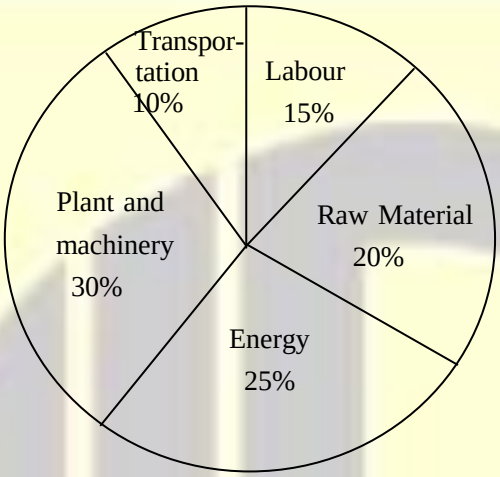
Answer: (D)

---

8. A man can row at 8 km per hour in still water. If it takes him thrice as long to row upstream, as to row downstream, then find the stream velocity in km per hour.

Answer: (4)

9. A firm producing air purifiers sold 200 units in 2012. The following pie chart presents the share of raw material, labour, energy, plant & machinery, and transportation costs in the total manufacturing cost of the firm in 2012. The expenditure on labour in 2012 is Rs. 4,50,000. In 2013, the raw material expenses increased by 30% and all other expenses increased by 20%. If the company registered a profit of Rs. 10 lakhs in 2012, at what price (in Rs.) was each air purifier sold?



Answer: (20000)

---

10. A batch of one hundred bulbs is inspected by testing four randomly chosen bulbs. The batch is rejected if even one of the bulbs is defective. A batch typically has five defective bulbs. The probability that the current batch is accepted is _____

Answer: (0.8145)

Electronics and Communications Engineering

Q. No. 1 – 25 Carry One Mark Each

1. The maximum value of the function f(x) = ln(1 + x)- x (where .x > - 1) occurs at x=_____.

Answer: (0)

---

2. Which ONE of the following is a linear non-homogeneous differential equation, where x and y are the independent and dependent variables respectively?

(A) $\frac{dy}{dx} + xy = e^{-x}$

(B) $\frac{dy}{dx} + xy = 0$

(C) $\frac{dy}{dx} + xy = e^{-y}$

(D) $\frac{dy}{dx} + e^{-y} = 0$

Answer: (A)

---

3. Match the application to appropriate numerical method.

Application	Numerical Method
P1: Numerical integration	**M1:** Newton-Raphson Method
P2: Solution to a transcendental equation	**M2:** Runge-Kutta Method
P3: Solution to a system of linear equations	**M3:** Simpson's 1/3-rule
P4: Solution to a differential equation	**M4:** Gauss Elimination Method

(A) P1—M3, P2—M2, P3—M4, P4—M1

(B) P1—M3, P2—M1, P3—M4, P4—M2

(C) P1—M4, P2—M1, P3—M3, P4—M2

(D) P1—M2, P2—M1, P3—M3, P4—M4

Answer: (B)

---

4. An unbiased coin is tossed an infinite number of times. The probability that the fourth head appears at the tenth toss is

(A) 0.067 (B) 0.073 (C) 0.082 (D) 0.091

Answer: (C)

---

5. If z = xyln(xy), then

(A) $x\frac{\partial z}{\partial x}+y\frac{\partial z}{\partial y}=0$

(B) $y\frac{\partial z}{\partial x}=x\frac{\partial z}{\partial y}$

(C) $x\frac{\partial z}{\partial x}=y\frac{\partial z}{\partial y}$

(D) $y\frac{\partial z}{\partial x}+x\frac{\partial z}{\partial y}=0$

Answer: (C)

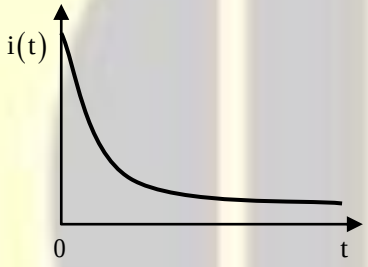
---

6. A series RC circuit is connected to a DC voltage source at time t = 0. The relation between the source voltage V_S, The resistance R, the capacitance C, and the current i(t) is given below:

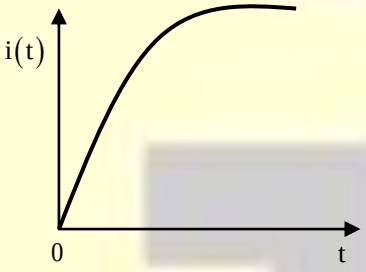
$$V_S = Ri(t)+\frac{1}{C}\int_0^t i(u)du.$$

Which one of the following represents the current i(t)?

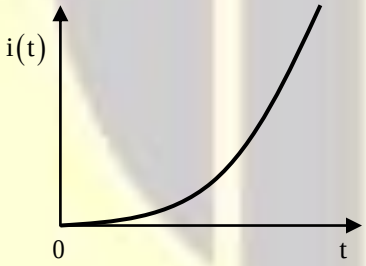
(A)



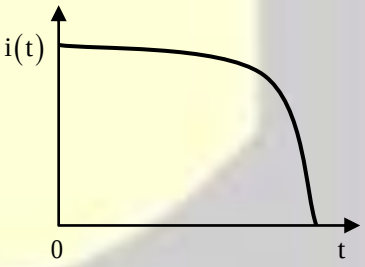
(B)



(C)



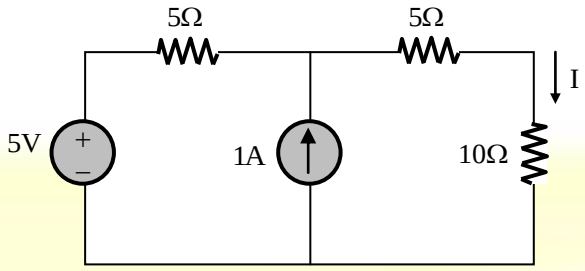
(D)



Answer: (A)

---

7. In the figure shown, the value of the current I (in Amperes) is _____.



Answer: (0.5)

---

8. In MOSFET fabrication, the channel length is defined during the process of

(A) Isolation oxide growth

(B) Channel stop implantation

(C) Poly-silicon gate patterning

(D) Lithography step leading to the contact pads

Answer: (C)

---

9. A thin P-type silicon sample is uniformly illuminated with light which generates excess carriers. The recombination rate is directly proportional to

(A) The minority carrier mobility

(B) The minority carrier recombination lifetime

(C) The majority carrier concentration

(D) The excess minority carrier concentration

Answer: (D)

---

10. At T = 300 K, the hole mobility of a semiconductor $\mu_p = 500\,cm^2/V-s$ and $\frac{kT}{q} = 26\,mV$. The hole diffusion constant D_p in cm^2/s is _____

Answer: (13)

11. The desirable characteristics of a transconductance amplifier are

(A) High input resistance and high output resistance

(B) High input resistance and low output resistance

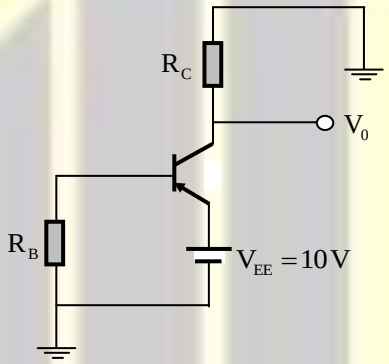
(C) Low input resistance and high output resistance

(D) Low input resistance and low output resistance

Answer: (A)

---

12. In the circuit shown, the PNP transistor has $|V_{BE}| = 0.7V$ and $\beta = 50$.

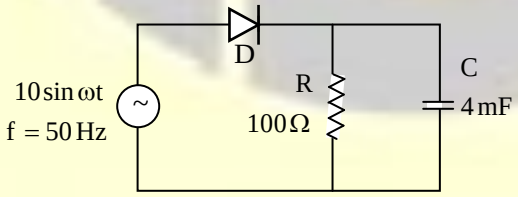


Assume that $R_B = 100k\Omega$, for V_0 to be 5 V, the value of $R_C\,(\text{in}\,k\Omega)$ _____.

Answer: (1.075)

---

13. The figure shows a half-wave rectifier. The diode D is ideal. The average steady-state current (in Amperes) through the diode is approximately _____.



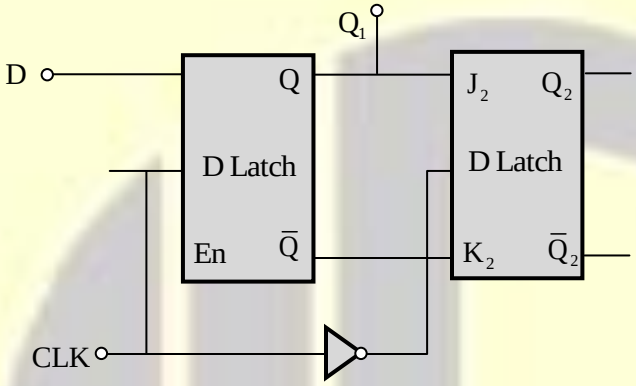
Answer: (0.09)

---

14. An analog voltage in the range 0 to 8 V is divided in 16 equal intervals for conversion to 4-bit digital output. The maximum quantization error (in V) is _____

Answer: (0.25)

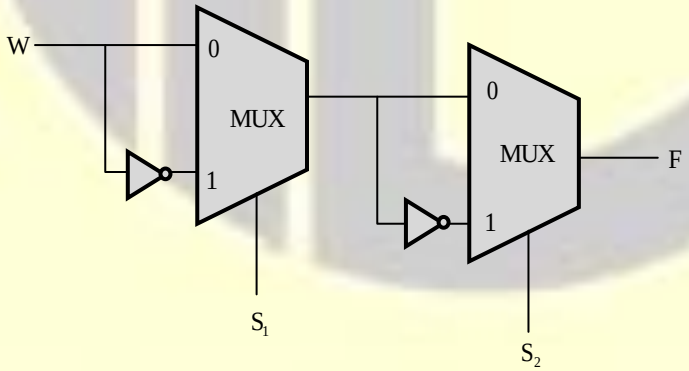
15. The circuit shown in the figure is a



(A) Toggle Flip Flop
(B) JK Flip Flop
(C) SR Latch
(D) Master-Slave D Flip Flop

Answer: (D)

16. Consider the multiplexer based logic circuit shown in the figure.



Which one of the following Boolean functions is realized by the circuit?

(A) $F = W\overline{S}_1\overline{S}_2$
(B) $F = WS_1 + WS_2 + S_1S_2$
(C) $F = \overline{W} + S_1 + S_2$
(D) $F = W \oplus S_1 \oplus S_2$

Answer: (D)

17. Let $x(t)= \cos(10\pi t) + \cos(30\pi t)$ be sampled at 20 Hz and reconstructed using an ideal low-pass filter with cut-off frequency of 20 Hz. The frequency/frequencies present in the reconstructed signal is/are

(A) 5 Hz and 15 Hz only (B) 10 Hz and 15 Hz only

(C) 5 Hz, 10 Hz and 15 Hz only (D) 5 Hz only

Answer: (A)

---

18. For an all-pass system $H(z)=\dfrac{(z^{-1}-b)}{(1-az^{-1})}$, where $|H(e^{-j\omega})|=1$, for all ω. If $Re(a)\neq 0, Im(a)\neq 0$, then b equals

(A) a (B) a* (C) 1/a* (D) 1/a

Answer: (B)

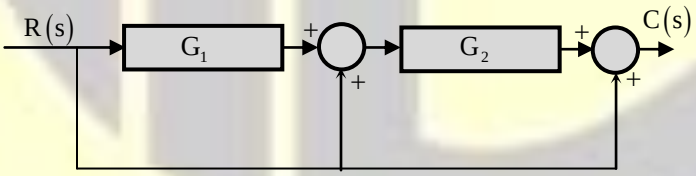
---

19. A modulated signal is y(t) = m.(t)cos(40000 πt), where the baseband signal m(t) has frequency components less than 5 kHz only. The minimum required rate (in kHz) at which y(t) should be sampled to recover m(t) is _____.

Answer: (10)

---

20. Consider the following block diagram in the figure.



The transfer function $\dfrac{C(s)}{R(s)}$ is

(A) $\dfrac{G_1G_2}{1+G_1G_2}$ (B) $G_1G_2+G_1+1$ (C) $G_1G_2+G_2+1$ (D) $\dfrac{G_1}{1+G_1G_2}$

Answer: (C)

21. The input $-3e^{2t}u(t)$, where u(t) is the unit step function, is applied to a system with transfer function . $\frac{s-2}{s+3}$. If the initial value of the output is -2, then the value of the output at steady state is_____.

Answer: (0)

---

22. The phase response of a passband waveform at the receiver is given by

$$\phi(f) = -2\pi\alpha(f - f_c) - 2\pi\beta f_c$$

Where f_c is the centre frequency, and α and β are positive constants. The actual signal propagation delay from the transmitter to receiver is

(A) $\frac{\alpha-\beta}{\alpha+\beta}$ (B) $\frac{\alpha\beta}{\alpha+\beta}$ (C) α (D) β

Answer: (C)

---

23. Consider an FM signal $f(t) = \cos\left[2\pi f_c t + \beta_1 \sin 2\pi f_1 t + \beta_2 \sin 2\pi f_2 t.\right]$. The maximum deviation of the instantaneous frequency from the carrier frequency f_c is

(A) $\beta_1 f_1 + \beta_2 f_2$ (B) $\beta_1 f_2 + \beta_2 f_1$ (C) $\beta_1 + \beta_2$ (D) $f_1 + f_2$

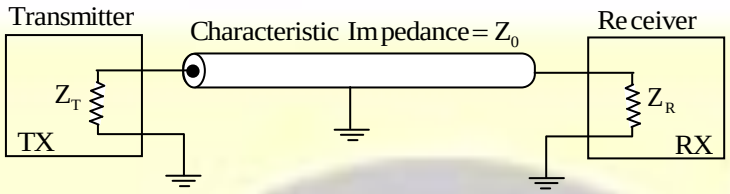
Answer: (A)

---

24. Consider an air filled rectangular waveguide with a cross-section of 5 cm × 3 cm. For this waveguide, the cut-off frequency (in MHz) of TE_{21} mode is _____.

Answer: (7810)

25. In the following figure, the transmitter Tx sends a wideband modulated RF signal via a coaxial cable to the receiver Rx. The output impedance Z_T of Tx, the characteristic impedance Z_0 of the cable and the input impedance Z_R of Rx are all real.



Which one of the following statements is TRUE about the distortion of the received signal due to impedance mismatch?

(A) The signal gets distorted if $Z_R \neq Z_0$, irrespective of the value of Z_T

(B) The signal gets distorted if $Z_T \neq Z_0$, irrespective of the value of Z_R

(C) Signal distortion implies impedance mismatch at both ends: $Z_T \neq Z_0$ and $Z_R \neq Z_0$

(D) Impedance mismatches do NOT result in signal distortion but reduce power transfer efficiency

Answer: (C)

Q. No. 26 – 55 Carry Two Marks Each

26. The maximum value of $f(x)=2x^3 - 9x^2 + 12x - 3$ in the interval $0 \leq x \leq 3$ is _____.

Answer: (6)

27. Which one of the following statements is NOT true for a square matrix?

(A) If A is upper triangular, the eigenvalues of A are the diagonal elements of it

(B) If A is real symmetric, the eigenvalues of A are always real and positive

(C) If A is real, the eigenvalues of A and A^T are always the same

(D) If all the principal minors of A are positive, all the eigenvalues of A are also positive

Answer: (B)

28. A fair coin is tossed repeatedly till both head and tail appear at least once. The average number of tosses required is _____.

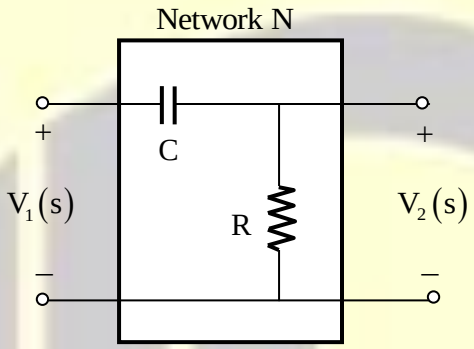
Answer: (3)

29. Let X_1, X_2, and X_3 be independent and identically distributed random variables with the uniform distribution on [0, 1]. The probability $P\{X_1 + X_2 \leq X_3\}$ is _____.

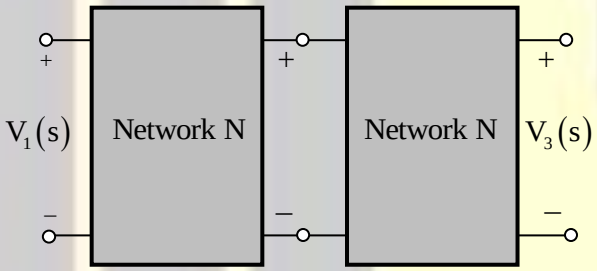
Answer: (0.16)

---

30. Consider the building block called 'Network N' shown in the figure. Let $C = 100\mu F$ and $R = 10k\Omega$.



Two such blocks are connected in cascade, as shown in the figure.

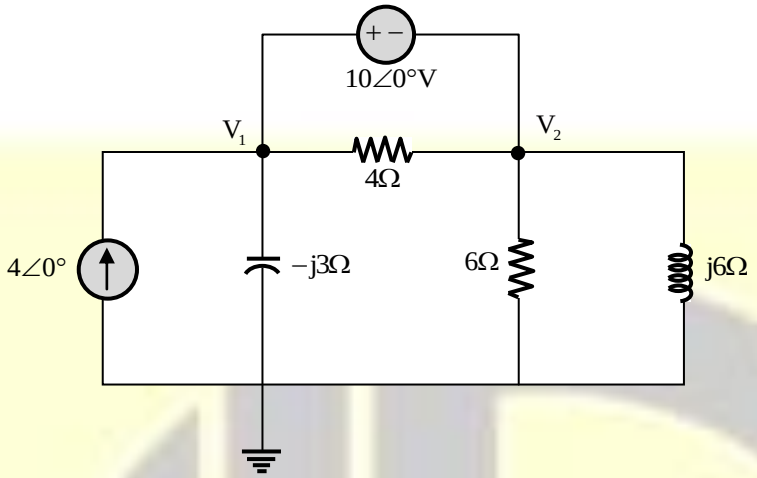


The transfer function $\frac{V_3(s)}{V_1(s)}$ of the cascaded network is

(A) $\frac{s}{1+s}$ (B) $\frac{s^2}{1+3s+s^2}$ (C) $\left(\frac{s}{1+s}\right)^2$ (D) $\frac{s}{2+s}$

Answer: (B)

31. In the circuit shown in the figure, the value of node voltage V_2 is

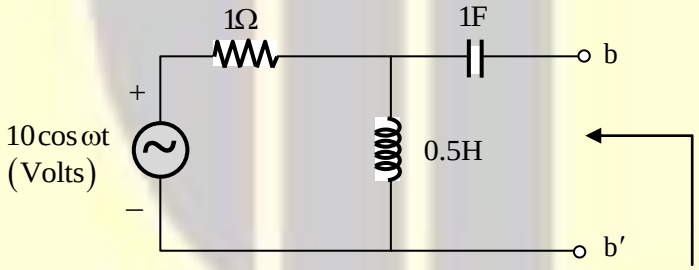


(A) 22 + j 2V (B) 2 + j 22 V (C) 22 – j2 V (D) 2 – j 22 V

Answer: (D)

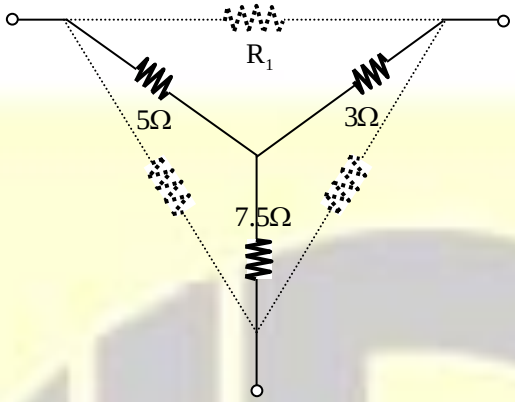
---

32. In the circuit shown in the figure, the angular frequency ω (in rad/s), at which the Norton equivalent impedance as seen from terminal $b - b'$ is purely resistive, is _____.



Answer: (2)

33. For the Y-network shown in the figure, the value of $R_1(\text{in}\Omega)$ in the equivalent Δ-network is _____.



Answer: (10)

---

34. The donor and accepter impurities in an abrupt junction silicon diode are 1 x 10^{16} cm^{-3} and 5 x 10^{18} cm^{-3}, respectively. Assume that the intrinsic carrier concentration in silicon n_i = 1.5 x 10^{10} cm^{-3} at 300 K, $\frac{kT}{q} = 26\,\text{mV}$ and the permittivity of silicon $\varepsilon_{si} = 1.04\times10^{-12}\,\text{F/cm}$. The built-in potential and the depletion width of the diode under thermal equilibrium conditions, respectively, are

(A) 0.7 V and 1 x 10^{-4} cm
(B) 0.86 V and 1 x 10^{-4} cm
(C) 0.7 V and 3.3 x 10^{-5} cm
(D) 0.86 V and 3.3 x 10^{-5} cm

Answer: (D)

---

35. The slope of the I_D vs V_{GS} curve of an n-channel MOSFET in linear regime is $10^{-3}\Omega^{-1}$ at $V_{DS} = 0.1\text{V}$.. For the same device, neglecting channel length modulation, the slope of the $\sqrt{I_D}$ vs V_{GS} curve $\left(\text{in}\ \sqrt{\text{A}}/\text{V}\right)$ under saturation regime is approximately _____.

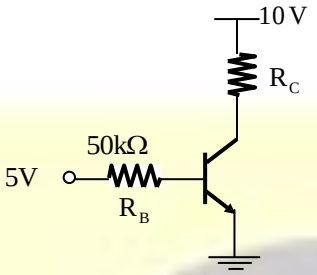
Answer: (0.07)

---

36. An ideal MOS capacitor has boron doping-concentration of 10^{15} cm^{-3} in the substrate. When a gate voltage is applied, a depletion region of width 0.5 μm is formed with a surface (channel) potential of 0.2 V. Given that $\varepsilon_o = 8.854\times10^{-14}$ F/cm and the relative permittivities of silicon and silicon dioxide are 12 and 4, respectively, the peak electric field (in V/μm) in the oxide region is _____.

Answer: (2.4)

37. In the circuit shown, the silicon BJT has $\beta = 50$. Assume V_{BE} =0.7V and $V_{CE(sat)}$ = 0.2 V. Which one of the following statements is correct?



(A) For R_C = 1 kΩ, the BJT operates in the saturation region

(B) For R_C = 3 kΩ, the BJT operates in the saturation region

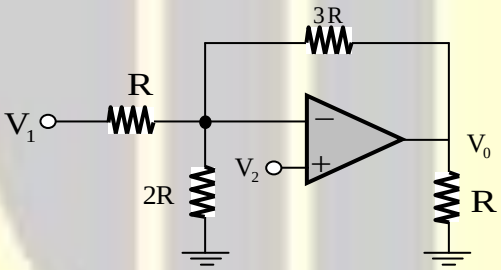
(C) For R_C =20 kΩ, the BJT operates in the cut-off region

(D) For R_C =20 kΩ, the BJT operates in the linear region

Answer: (B)

---

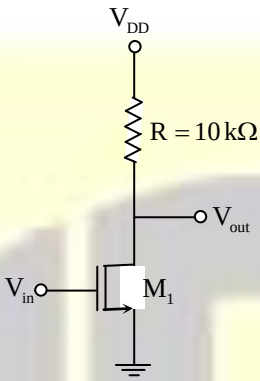
38. Assuming that the Op-amp in the circuit shown is ideal, V_O is given by



(A) $\frac{5}{2}V_1 - 3V_2$ (B) $ZV_1 - \frac{5}{2}V_2$ (C) $-\frac{3}{2}V_1 + \frac{7}{2}V_2$ (D) $-3V_1 + \frac{11}{2}V_2$

Answer: (D)

39. For the MOSFET M_1 shown in the figure, assume W/L = 2, V_{DD} = 2.0 V, $\mu_n C_{ox} = 100\mu A/V^2$ and V_{TH} = 0.5 V. The transistor M_1 switches from saturation region to linear region when V_{in} (in Volts) is_____.

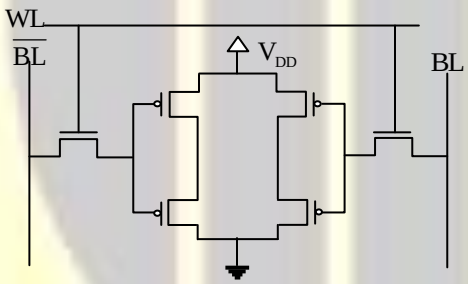


Answer: (1.5)

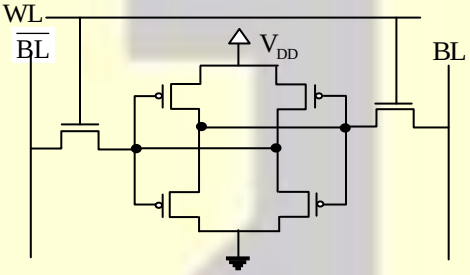
---

40. If WL is the word Line and BL the Bit Line an SRAM cell is shown in

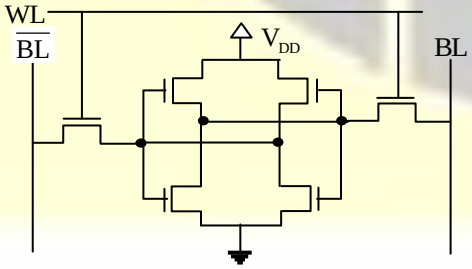
(A)



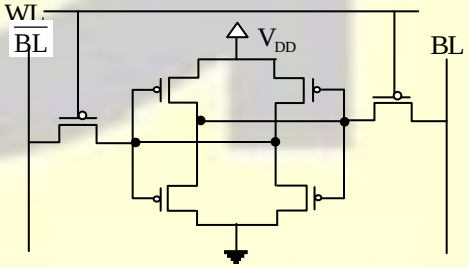
(B)



(C)

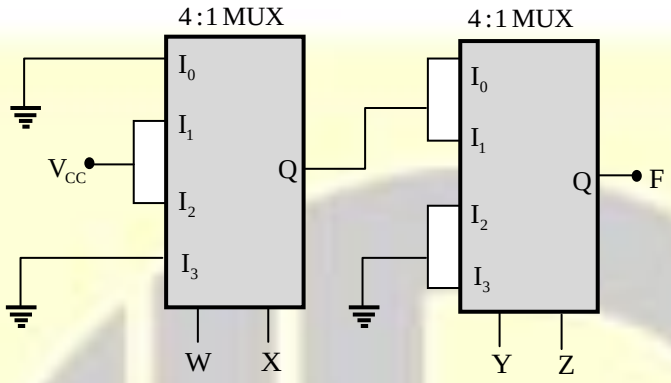


(D)



Answer: (B)

41. In the circuit shown, W and Y are MSBs of the control inputs. The output F is given by



(A) $F = W\overline{X} + \overline{W}X + \overline{Y}\,\overline{Z}$

(B) $F = W\overline{X} + \overline{W}X + \overline{Y}Z$

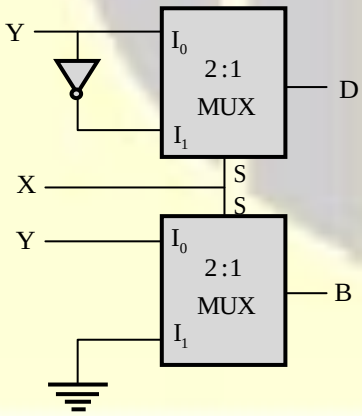
(C) $F = W\overline{X}\,\overline{Y} + \overline{W}X\overline{Y}$

(D) $F = (\overline{W} + \overline{X})\overline{Y}Z$

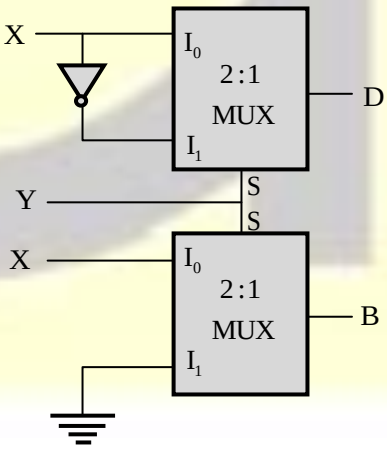
Answer: (C)

42. If X and Y are inputs and the Difference (D = X – Y) and the Borrow (B) are the outputs, which one of the following diagram implements a half-substractor?

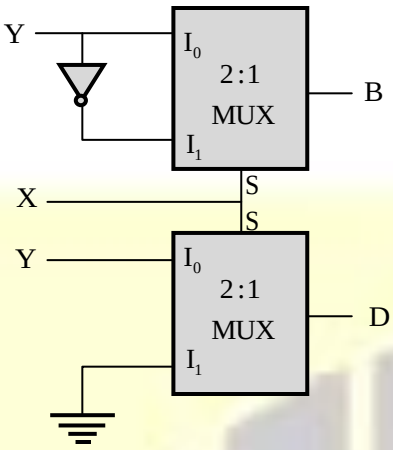
(A)



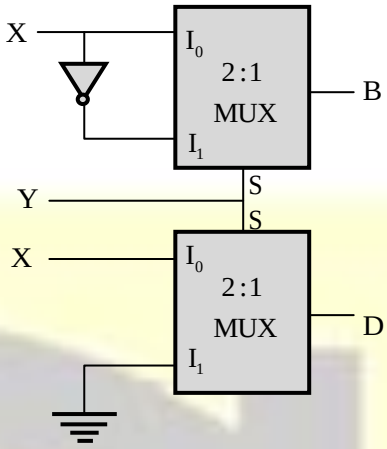
(B)



(C)



(D)



Answer: (D)

---

43. Let $H_1(z)=\left(1-pz^{-1}\right)^{-1}, H_2(z)=\left(1-qz^{-1}\right)^{-1}, H(z)=H_1(z)+rH_2(z)$. The quantities p, q, r are real numbers. Consider $p=\frac{1}{2}, q=\frac{1}{4}, |r|<1$. If the zero of H(z) lies on the unit circle, then r = _____

Answer: (–0.5)

---

44. Let h(t) denote the impulse response of a causal system with transfer function $\frac{1}{s+1}$. Consider the following three statements.

S1: The system is stable.

S2: $\frac{h(t+1)}{h(t)}$ is independent of t for t 0.

S3: A non-causal system with the same transfer function is stable.

For the above system,

(A) Only S1 and S2 are true

(B) only S2 and S3 are true

(C) Only S1 and S3 are true

(D) S1, S2 and S3 are true

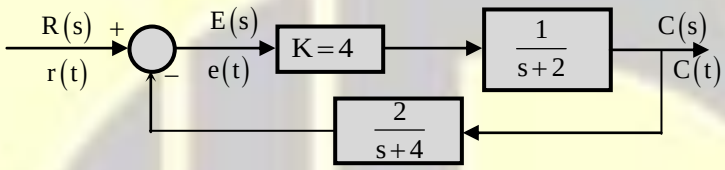
Answer: (A)

---

45. The z-transform of the sequence x[n] is given by $X(z)=\dfrac{1}{\left(1-2z^{-1}\right)^2}$,, with the region of convergence $|z|>2$. Then, $x[2]$ is _____.

Answer: (12)

46. The steady state error of the system shown in the figure for a unit step input is _____.



Answer: (0.5)

47. The state equation of a second-order linear system is given by

$$\dot{x}(t)=Ax(t),\ x(0)=x_0$$

For $x_0=\begin{bmatrix}1\\-1\end{bmatrix}$, $x(t)=\begin{bmatrix}e^{-t}\\-e^{-t}\end{bmatrix}$ and for $x_0=\begin{bmatrix}0\\1\end{bmatrix}$, $x(t)=\begin{bmatrix}e^{-t}-e^{-2t}\\-e^{-t}+2e^{-2t}\end{bmatrix}$

when $x_0=\begin{bmatrix}3\\5\end{bmatrix}$, $x(t)$ is

(A) $\begin{bmatrix}-8e^{-t}+11e^{-2t}\\8e^{-t}-22e^{-2t}\end{bmatrix}$

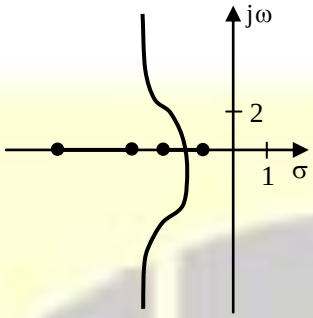
(B) $\begin{bmatrix}11e^{-t}-8e^{-2t}\\-11e^{-t}+16e^{-2t}\end{bmatrix}$

(C) $\begin{bmatrix}3e^{-t}-5e^{-2t}\\-3e^{-t}+10e^{-2t}\end{bmatrix}$

(D) $\begin{bmatrix}5e^{-t}-3e^{-2t}\\-5e^{-t}+6e^{-2t}\end{bmatrix}$

Answer: (B)

48. In the root locus plot shown in the figure, the pole/zero marks and the arrows have been removed. Which one of the following transfer functions has this root locus?



(A) $\dfrac{s+1}{(s+2)(s+4)(s+7)}$

(B) $\dfrac{s+4}{(s+1)(s+2)(s+7)}$

(C) $\dfrac{s+7}{(s+1)(s+2)(s+4)}$

(D) $\dfrac{(s+1)(s+2)}{(s+7)(s+4)}$

Answer: (B)

---

49. Let X(t) be a wide sense stationary (WSS) random process with power spectral density $S_X(f)$. If Y(t) is the process defined as $Y(t)=X(2t-1)$, the power spectral density $S_Y(f)$ is

(A) $S_Y(f)=\dfrac{1}{2}S_X\left(\dfrac{f}{2}\right)e^{-j\pi f}$

(B) $S_Y(f)=\dfrac{1}{2}S_X\left(\dfrac{f}{2}\right)e^{-j\pi f/2}$

(C) $S_Y(f)=\dfrac{1}{2}S_X\left(\dfrac{f}{2}\right)$

(D) $S_Y(f)=\dfrac{1}{2}S_X\left(\dfrac{f}{2}\right)e^{-j2\pi f}$

Answer: (C)

---

50. A real band-limited random process X(t) has two-sided power spectral density

$$S_x(f)=\begin{cases}10^{-6}\,(3000-|f|)\ \text{Watts/Hz} & \text{for } |f|\le 3\text{kHz}\\ 0 & \text{otherwise}\end{cases}$$

Where f is the frequency expressed in Hz. The signal X(t)modulates a carrier cos16000 πt and the resultant signal is passed through an ideal band-pass filter of unity gain with centre frequency of 8 kHz and band-width of 2 kHz. The output power (in Watts) is _____.

Answer: (2.5)

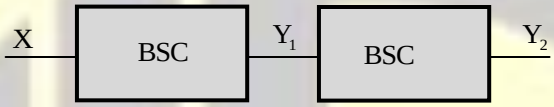
---

51. In a PCM system, the signal $m(t) = \{\sin(100\pi t) + \cos(100\pi t)\}$ V is sampled at the Nyquist rate. The samples are processed by a uniform quantizer with step size 0.75 V. The minimum data rate of the PCM system in bits per second is _____.

Answer: (200)

---

52. A binary random variable X takes the value of 1 with probability 1/3. X is input to a cascade of 2 independent identical binary symmetric channels (BSCs) each with crossover probability 1/2. The outputs of BSCs are the random variables Y_1 and Y_2 as shown in the figure.



The value of $H(Y_1) + H(Y_2)$ in bits is_____.

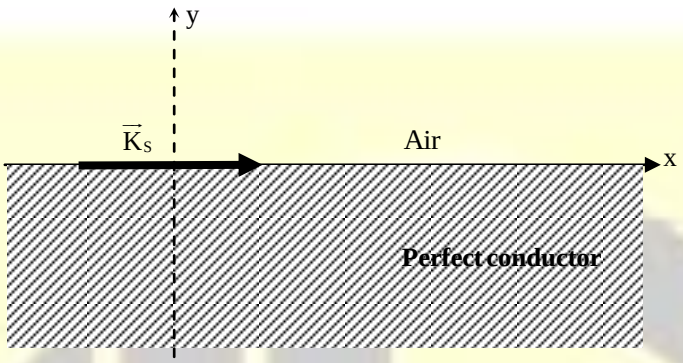
Answer: (2)

---

53. Given the vector $A = (\cos x)(\sin y)\hat{a}_x + (\sin x)(\cos y)\hat{a}_y$, where $\hat{a}_x, \hat{a}_y$ denote unit vectors along x,y directions, respectively. The magnitude of curl of A is _____

Answer: (0)

54. A region shown below contains a perfect conducting half-space and air. The surface current $\vec{K_s}$ on the surface of the perfect conductor is $\vec{K_s} = \hat{x}2$ amperes per meter. The tangential $\vec{H}$ field in the air just above the perfect conductor is



(A) $(\hat{x}+\hat{z})2$ amperes per meter

(B) $\hat{x}2$ amperes per meter

(C) $-\hat{z}2$ amperes per meter

(D) $\hat{z}2$ amperes per meter

Answer: (D)

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55. Assume that a plane wave in air with an electric field $\vec{E} = 10\cos\left(\omega t - 3x - \sqrt{3z}\right)\hat{a}_y$ V/m is incident on a non-magnetic dielectric slab of relative permittivity 3 which covers the region. Z > 0 The angle of transmission in the dielectric slab is _____ degrees.

Answer: (30)