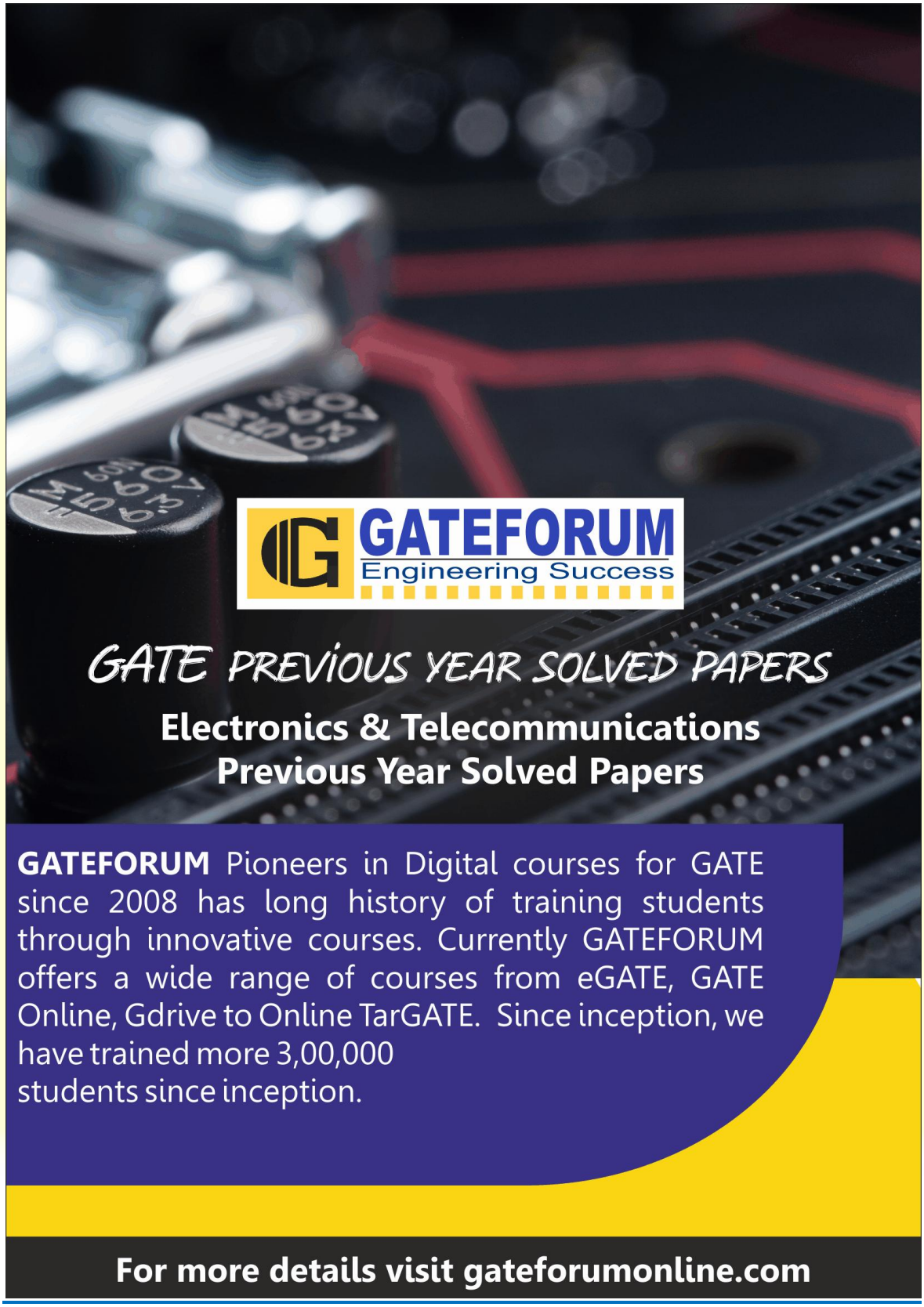


GENERAL APTITUDE

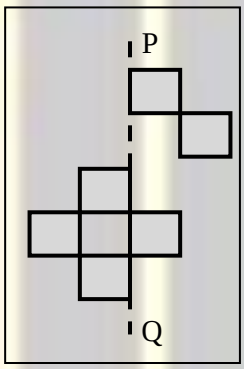
Q. No. 1 - 5 Carry One Mark Each

1. The current population of a city is 11,02,500. If it has been increasing at the rate of 5% per annum, what was its population 2 years ago?

(A) 9,92,500 (B) 12,51,506 (C) 9,95,006 (D) 10,00,000

Answer: (D) **Click here to watch video explanation**

2.



The least number of squares that must be added so that the line P-Q becomes the line of symmetry is _____.

(A) 6 (B) 3 (C) 4 (D) 7

Answer: (A) **Click here to watch video explanation**

3. p and q are positive integers and $\frac{p}{q}+\frac{q}{p}=3$, then, $\frac{p^2}{q^2}+\frac{q^2}{p^2}=$

(A) 3 (B) 9 (C) 7 (D) 11

Answer: (C) **Click here to watch video explanation**

4. Nostalgia is to anticipation as _____ is to _____

Which one of the following options maintains a similar logical relation in the above sentence?

(A) Future, present (B) Past, future

(C) Future, past (D) Present, past

Answer: (B) **Click here to watch video explanation**

5. Consider the following sentences:

(i) I woke up from sleep

(ii) I woked up from sleep

(iii) I was woken up from sleep

(iv) I was wokened up from sleep

Which of the above sentences are grammatically CORRECT?

(A) (i) and (iv) (B) (i) and (iii) (C) (ii) and (iii) (D) (i) and (ii)

Answer: (B) **Click here to watch video explanation**

Q. No. 6- 10 Carry Two Marks Each

6. Given below are two statements and two conclusions.

Statement 1: All purple are green.

Statement 2: All black are green.

Conclusion I: Some black are purple

Conclusion II: No black is purple

Based on the above statements and conclusions, which one of the following options is logically CORRECT?

(A) Either conclusion I or II is correct (B) Only conclusion I is correct

(C) Both conclusion I and II are correct (D) Only conclusion II is correct

Answer: (A) **Click here to watch video explanation**

7. Computers are ubiquitous. They are used to improve efficiency in almost all fields from agriculture to space exploration. Artificial intelligence (AI) is currently a hot topic. AI enables computers to learn, given enough training data. For humans, sitting in front of a computer for long hours can lead to health issues.

Which of the following can be deduced from the above passage?

(i) Nowadays, computers are present in almost all places.

(ii) Computers cannot be used for solving problems in engineering.

(iii) For humans, there are both positive and negative effects of using computers.

(iv) Artificial intelligence can be done without data.

(A) (ii) and (iv) (B) (i) and (iii) (C) (ii) and (iii) (D) (i), (iii) and (iv)

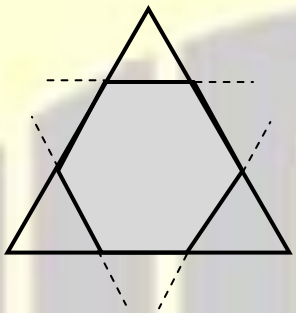
Answer: (B) **Click here to watch video explanation**

8. Consider a square sheet of a side 1 unit. In the first step, it is cut along the main diagonal to get two triangles. In the next step, one of the cut triangles is revolved about its short edge to form a solid cone. The volume of the resulting cone, in cubic units, is _____.

(A) $\frac{\pi}{3}$ (B) $\frac{2\pi}{3}$ (C) 3π (D) $\frac{3\pi}{2}$

Answer: (A) **Click here to watch video explanation**

9.



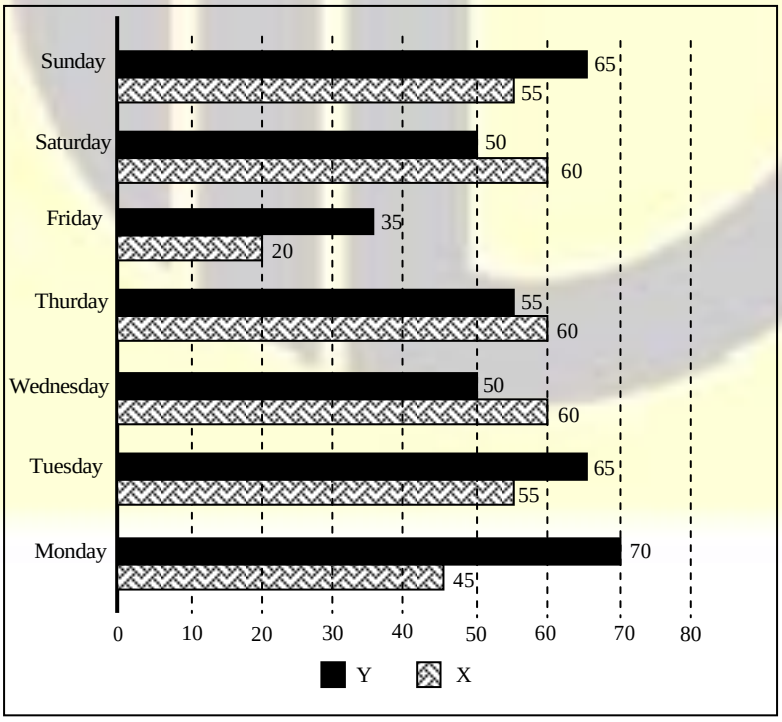
Corners are cut from an equilateral triangle to produce a regular convex hexagon as shown in the figure above.

The ratio of the area of the regular convex hexagon to the area of the original equilateral triangle is

(A) 4 : 5 (B) 5 : 6 (C) 3 : 4 (D) 2 : 3

Answer: (D) **Click here to watch video explanation**

10.



The number of minutes spent by two students, X and Y, exercising every day in a given week are shown in the bar chart above.

The number of days in the given week in which one of the students spent a minimum of 10% more than the other student, on a given day, is

(A) 4 (B) 7 (C) 6 (D) 5

Answer: (C) **Click here to watch video explanation**

ELECTRONICS AND COMMUNICATIONS

Q. No. 1 to 25 Carry One Mark Each

1. If $(1235)_x = (3033)_y$, where x and y indicate the bases of the corresponding numbers, then

(A) x = 9 and y = 7 (B) x = 8 and y = 6

(C) x = 7 and y = 5 (D) x = 6 and y = 4

Answer: (B) **Click here to watch video explanation**

2. Addressing of a 32K × 16 memory is realized using a single decoder. The minimum number of AND gates required for the decoder is

(A) 2^8 (B) 2^{19} (C) 2^{15} (D) 2^{32}

Answer: (C) **Click here to watch video explanation**

3. Consider the differential equation given below.

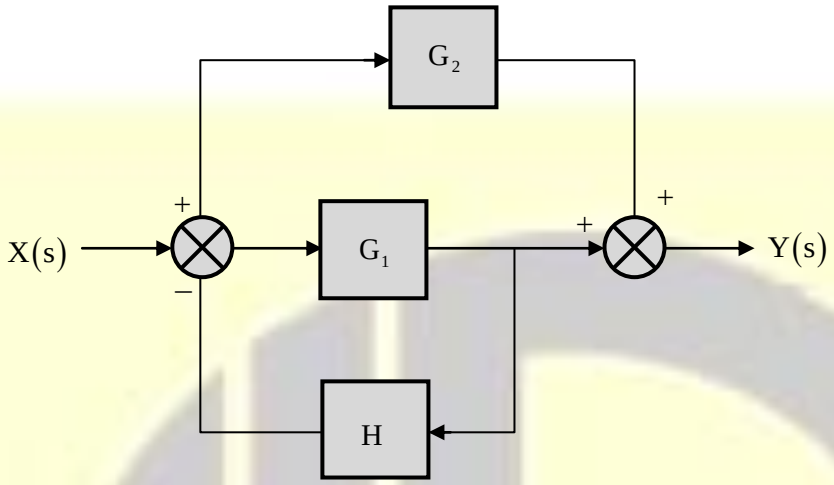
$$\frac{dy}{dx} + \frac{x}{1-x^2} y = x\sqrt{y}$$

The integrating factor of the differential equation is

(A) $(1-x^2)^{-1/4}$ (B) $(1-x^2)^{-3/4}$ (C) $(1-x^2)^{-1/2}$ (D) $(1-x^2)^{-3/2}$

Answer: (A) **Click here to watch video explanation**

4. The block diagram of a feedback system is shown in the figure.



The transfer function $\frac{Y(s)}{X(s)}$ of the system is

(A) $\frac{G_1+G_2+G_1G_2H}{1+G_1H}$

(B) $\frac{G_1+G_2}{1+G_1H+G_2H}$

(C) $\frac{G_1+G_2}{1+G_1H}$

(D) $\frac{G_1+G_2+G_1G_2H}{1+G_1H+G_2H}$

Answer: (C) **Click here to watch video explanation**

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5. A speech signal, band limited to 4 kHz, is sampled at 1.25 times the Nyquist rate. The speech samples, assumed to be statistically independent and uniformly distributed in the range –5V to +5V, are subsequently quantized in an 8-bit uniform quantizer and then transmitted over a voice-grade AWGN telephone channel. If the ratio of transmitted signal power to channel noise power is 26 dB, the minimum channel bandwidth required to ensure reliable transmission of the signal with arbitrarily small probability of transmission error (rounded off to two decimal places) is _____kHz.

Answer: (9.25) **Click here to watch video explanation**

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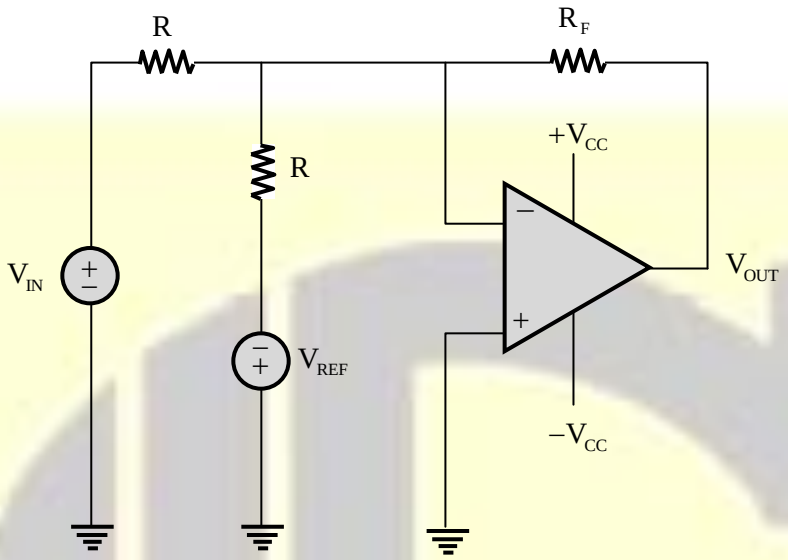
6. Consider the circuit with an ideal OPAMP shown in the figure.



Assuming $|V_{IN}| << |V_{CC}|$ and $|V_{REF}| << |V_{CC}|$, the condition at which V_{OUT} equals to zero is

(A) $V_{IN} = 0.5\,V_{REF}$ (B) $V_{IN} = 2 + V_{REF}$ (C) $V_{IN} = 2V_{REF}$ (D) $V_{IN} = V_{REF}$

Answer: (D) **Click here to watch video explanation**

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7. A bar of silicon is doped with boron concentration of $10^{16}\,cm^{-3}$ and assumed to be fully ionized. It is exposed to light such that electron-hole pairs are generated throughout the volume of the bar at the rate of $10^{20}\,cm^{-3}s^{-1}$. If the recombination lifetime is 100 μs, intrinsic carrier concentration of silicon is $10^{10}\,cm^{-3}$ and assuming 100% ionization of boron, then the approximate product of steady-state electron and hole concentrations due to this light exposure is

(A) $10^{20}\,cm^{-6}$ (B) $2\times10^{20}\,cm^{-6}$ (C) $10^{32}\,cm^{-6}$ (D) $2\times10^{32}\,cm^{-6}$

Answer: (D) **Click here to watch video explanation**

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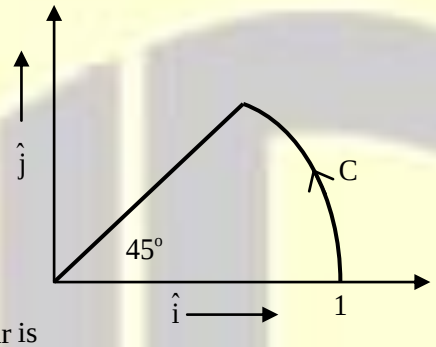
8. The refractive indices of the core and cladding of an optical fiber are 1.50 and 1.48, respectively. The critical propagation angle, which is defined as the maximum angle that the light beam makes with the axis of the optical fiber to achieve the total internal reflection, (rounded off to two decimal places) is _____ degree.

Answer: (9.36) **Click here to watch video explanation**

9. A 4 kHz sinusoidal message signal having amplitude 4V is fed to a delta modulator (DM) operating at a sampling rate of 32 kHz. The minimum step size required to avoid slope overload noise in the DM (rounded off to two decimal places) is _____V.

Answer: (3.14) **Click here to watch video explanation**

10. The vector function $F(r) = -x\hat{i} + y\hat{j}$ is defines over a circular arc C shown in the figure.



The line integral $\int_C F(r).dr$ is

(A) $\frac{1}{4}$ (B) $\frac{1}{3}$ (C) $\frac{1}{2}$ (D) $\frac{1}{6}$

Answer: (C) **Click here to watch video explanation**

11. Consider two 16-point sequences $x[n]$ and $h[n]$. Let the linear convolution of $x[n]$ and $h[n]$ be denoted by $y[n]$, while $z[n]$ denotes the 16-point inverse discrete Fourier transform (IDFT) of the product of the 16-point DFTs of $x[n]$ and $h[n]$. The value(s) of k for which $z[k] = y[k]$ is/are

(A) k = 0 (B) k = 0, 1, 2, …,15

(C) k = 15 (D) k = 0 and k = 15

Answer: (C) **Click here to watch video explanation**

12. Consider a rectangular coordinate system (x, y, z) with unit vectors a_x, a_y and a_z. A plane wave travelling in the region $z \geq 0$ with electric field vector $E = 10\cos(2\times10^8 t + \beta z)a_y$ is incident normally on the plane at z = 0, where β is the phase constant. The region $z \geq 0$ is in the free space and the region z < 0 is filled with a lossless medium (permittivity $\varepsilon = \varepsilon_0$, permeability $\mu = 4\mu_0$, where $\varepsilon_0 = 8.85\times10^{-12}$ F/m and $\mu_0 = 4\pi\times10^{-7}$ H/m). The value of the reflection coefficient is

(A) $\frac{3}{5}$ (B) $\frac{1}{3}$ (C) $\frac{2}{5}$ (D) $\frac{2}{3}$

Answer: (B) **Click here to watch video explanation**

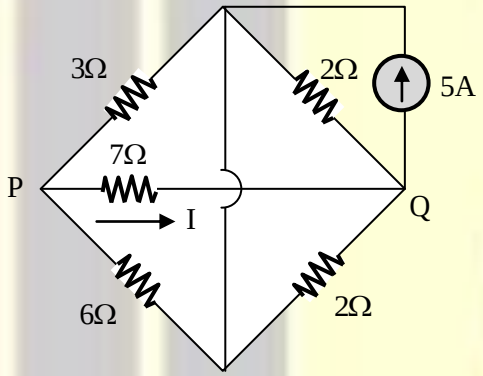
13. Consider the vector field $F = a_x(4y - c_1 z) + a_y(4x + 2z) + a_z(2y + z)$ in a rectangular coordinate system (x, y, z) with unit vectors a_x, a_y and a_z. If the field F is irrotational (conservative), then the constant c_1 (in integer) is _____.

Answer: (0) **Click here to watch video explanation**

14. An 8-bit unipolar (all analog output values are positive) digital-to-analog converter (DAC) has a full-scale voltage range from 0V to 7.68V. If the digital input code is 10010110 (the leftmost bit is MSB), then the analog output voltage of the DAC (rounded off to one decimal place) is _____V.

Answer: (4.5) **Click here to watch video explanation**

15. Consider the circuit shown in the figure.



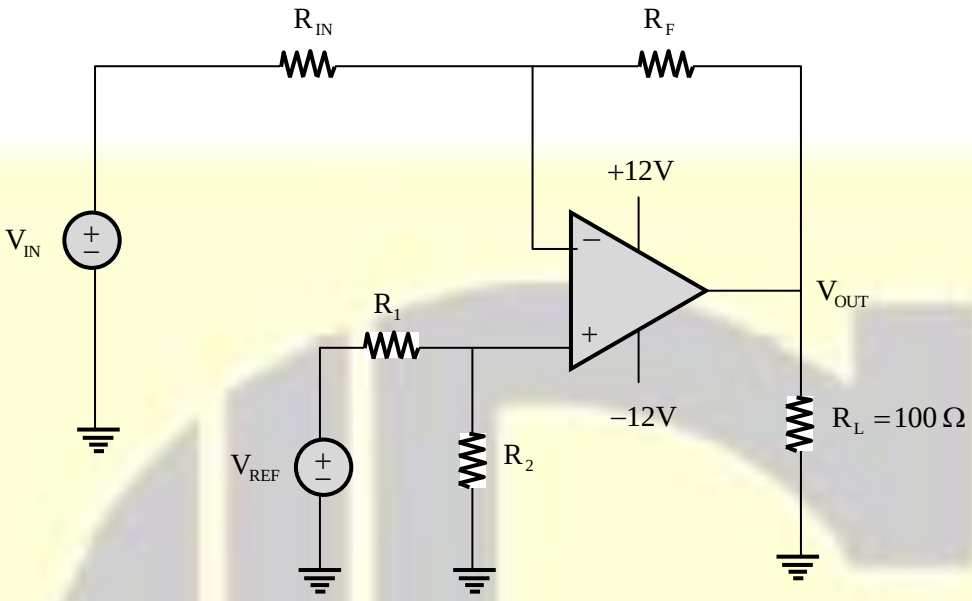
The current I flowing through the 7Ω resistor between P and Q (rounded off to one decimal place) is _____A

Answer: (0.5) **Click here to watch video explanation**

16. Consider a carrier signal which is amplitude modulated by a single-tone sinusoidal message signal with a modulation index of 50%. If the carrier and one of the sidebands are suppressed in the modulated signal, the percentage of power saved (rounded off to one decimal place) is_____.

Answer: (94.4) **Click here to watch video explanation**

17. For the circuit with an ideal OPAMP shown in the figure, V_{REF} is fixed.



If $V_{OUT} = 1$ volt for $V_{IN} = 0.1$ volt and $V_{OUT} = 6$ volt for $V_{IN} = 1$ volt, where V_{OUT} is measured across R_L connected at the output of this OPAMP, the value of R_F/R_{IN} is

(A) 5.555 (B) 2.860 (C) 3.825 (D) 3.285

Answer: (*) **Click here to watch video explanation**

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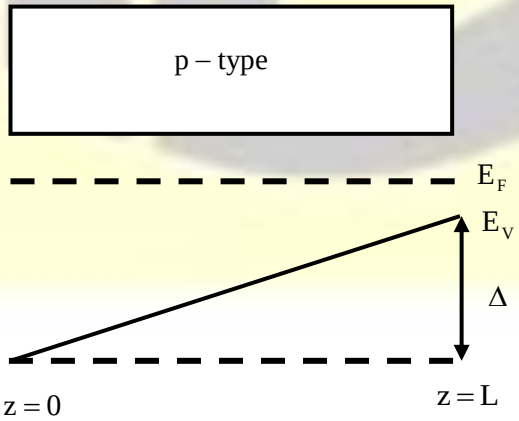
18. The energy band diagram of a p-type semiconductor bar of length L under equilibrium condition (i.e., the Fermi energy level E_F is constant) is shown in the figure. The valance band E_V is sloped since doping is non-uniform along the bar. The difference between the energy levels of the valence band at the two edges of the bar is Δ.



If the charge of an electron is q, then the magnitude of the electric field developed inside this semiconductor bar is

(A) $\frac{2\Delta}{qL}$ (B) $\frac{\Delta}{2qL}$ (C) $\frac{\Delta}{qL}$ (D) $\frac{3\Delta}{2qL}$

Answer: (C) **Click here to watch video explanation**

19. A standard air-filled rectangular waveguide with dimensions a = 8 cm, b = 4 cm, operates at 3.4 GHz. For the dominant mode of wave propagation, the phase velocity of the signal is v_p. The value (rounded off to two decimal places) of v_p/c, where c denotes the velocity of light, is _____.

Answer: (1.199) **Click here to watch video explanation**

20. Consider a polar non-return to zero (NRZ) waveform, using +2V and –2V for representing binary '1' and '0' respectively, is transmitted in the presence of additive zero-mean white Gaussian noise with variance 0.4 V^2. If the a priori probability of transmission of a binary '1' is 0.4, the optimum threshold voltage for a maximum a posteriori (MAP) receiver (rounded off to two decimal places) is _____V.

Answer: (0.04) **Click here to watch video explanation**

21. Consider a real-valued base-band signal x(t), band limited to 10 kHz. The Nyquist rate for the signal $y(t)=x(t)x\left(1+\frac{t}{2}\right)$ is

(A) 15 kHz (B) 30 kHz (C) 60 kHz (D) 20 kHz

Answer: (B) **Click here to watch video explanation**

22. Two continuous random variables X and Y are related as

$Y = 2X + 3$

Let σ_X^2 and σ_Y^2 denote the variances of X and Y, respectively. The variances are related as

(A) $\sigma_Y^2 = 5\sigma_X^2$ (B) $\sigma_Y^2 = 2\sigma_X^2$ (C) $\sigma_Y^2 = 25\sigma_X^2$ (D) $\sigma_Y^2 = 4\sigma_X^2$

Answer: (D) **Click here to watch video explanation**

23. An antenna with a directive gain of 6 dB is radiating a total power of 16 kW. The amplitude of the electric field in free space at a distance of 8 km from the antenna in the direction of 6 dB gain (rounded off to three decimal places) is _____V/m.

Answer: (0.245) **Click here to watch video explanation**

24. A message signal having peak-to-peak value of 2V, root mean square value of 0.1V and bandwidth of 5 kHz is sampled and fed to a pulse code modulation (PCM) system that uses a uniform quantizer. The PCM output is transmitted over a channel that can support a maximum transmission rate of 50 kbps. Assuming that the quantization error is uniformly distributed, the maximum signal to quantization noise ratio that can be obtained by the PCM system (rounded off to two decimal places) is _____.

Answer: (30.72) **Click here to watch video explanation**

25. If the vectors (1.0, –1.0, 2.0), (7.0, 3.0, x) and (2.0, 3.0, 1.0) in R^3 are linearly dependent, the value of x is _____.

Answer: (8) **Click here to watch video explanation**

Q. No. 26 to 55 Carry Two Marks Each

26. A box contains the following three coins.

I. A fair coin with head on one face and tail on the other face.

II. A coin with heads on both the faces.

III. A coin with tails on both the faces.

A coin is picked randomly from the box and tossed. Out of the two remaining coins in the box, one coin is then picked randomly and tossed. If the first toss results in a head, the probability of getting a head in the second toss is

(A) $\frac{1}{2}$ (B) $\frac{2}{5}$ (C) $\frac{2}{3}$ (D) $\frac{1}{3}$

Answer: (D) **Click here to watch video explanation**

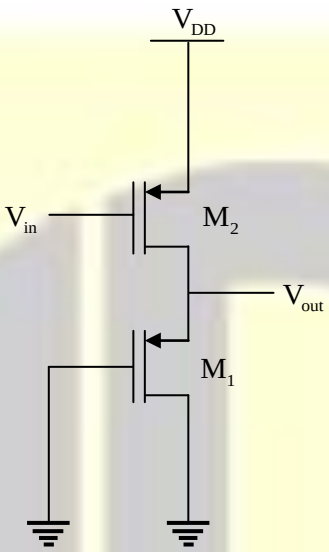
27. Consider the integral $\oint_C \frac{\sin(x)}{x^2(x^2+4)}dx$

Where C is a counter-clockwise oriented circle defined as $|x-i|=2$. The value of the integral is

(A) $-\frac{\pi}{4}\sin(2i)$ (B) $\frac{\pi}{4}\sin(2i)$ (C) $\frac{\pi}{8}\sin(2i)$ (D) $-\frac{\pi}{8}\sin(2i)$

Answer: (*) **Click here to watch video explanation**

28. In the circuit shown in the figure, the transistors M_1 and M_2 are operating in saturation. The channel length modulation coefficients of both the transistors are non-zero. The transconductance of the MOSFETs M_1 and M_2 are g_{m1} and g_{m2}, respectively, and the internal resistance of the MOSFETs M_1 and M_2 are r_{01} and r_{02}, respectively.



Ignoring the body effect, the ac small signal voltage gain $\left(\frac{\partial V_{out}}{\partial V_{in}}\right)$ of the circuit is

(A) $-g_{m2}\left(\frac{1}{g_{m1}} \| r_{o2}\right)$

(B) $-g_{m2}\left(r_{01} \| r_{o2}\right)$

(C) $-g_{m2}\left(\frac{1}{g_{m1}} \| r_{01} \| r_{o2}\right)$

(D) $-g_{m1}\left(\frac{1}{g_{m2}} \| r_{o1} \| r_{02}\right)$

Answer: (C) **Click here to watch video explanation**

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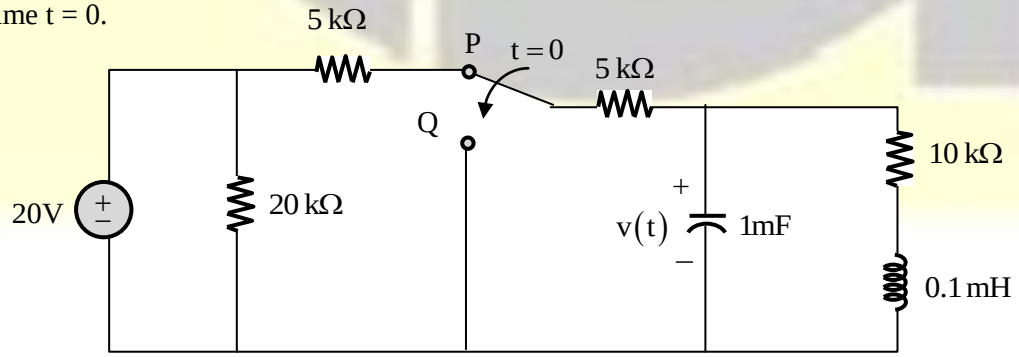
29. The switch in the circuit in the figure is in position P for a long time and then moved to position Q at time t = 0.



The value of $\frac{dv(t)}{dt}$ at $t = 0^+$ is

(A) $3\ V/s$ (B) $-5\ V/s$ (C) $-3\ V/s$ (D) $0\ V/s$

Answer: (C) **Click here to watch video explanation**

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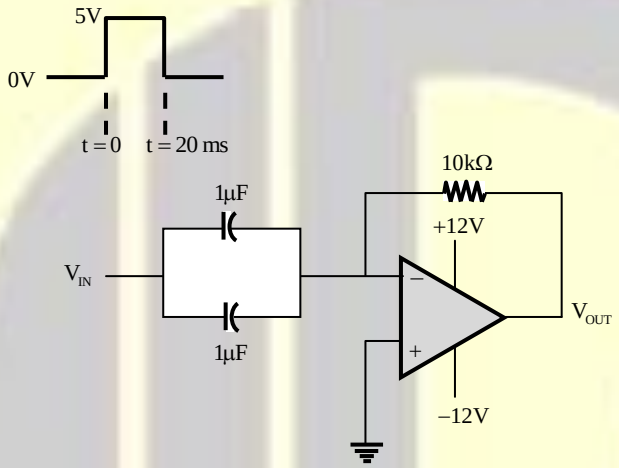
30. A circuit with an ideal OPAMP is shown in the figure. A pulse V_{IN} of 20 ms duration is applied to the input. The capacitors are initially unchanged.



The output voltage V_{OUT} of this circuit at $t = 0^+$ (in integer) is _____V.

Answer: (–12) **Click here to watch video explanation**

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31. The exponential Fourier series representation of a continuous-time periodic signal x(t) is defined as

$$x(t) = \sum_{k=-\infty}^{\infty} a_k e^{jk\omega_o t}$$

Where ω_0 is the fundamental angular frequency of x(t) and the coefficient of the series are a_k. The following information is given about x(t) and a_k.

I. x(t) a real and even, having a fundamental period of 6

II. The average value of x(t) is2

III. $a_k = \begin{cases} k, & 1 \le k \le 3 \\ 0, & k > 3 \end{cases}$

The average power of the signal x(t) (rounded off to one decimal place) is _____.

Answer: (32) **Click here to watch video explanation**

32. For a vector field $D=\rho\cos^2\varphi a_\rho + z^2\sin^2\varphi a_\varphi$ in a cylindrical coordinate system (ρ,φ,z) with unit vectors a_ρ, a_φ and a_z, the net flux of D leaving the closed surface of the cylinder $(\rho=3, 0\le z\le 2)$ (rounded off to two decimal places) is _____.

Answer: (56.55) **Click here to watch video explanation**

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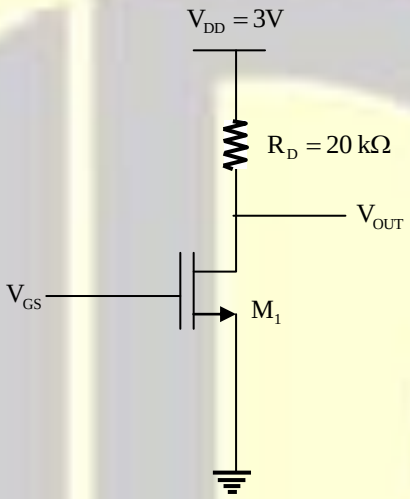
33. For the transistor M_1 in the circuit shown in the figure, $\mu_n C_{ox}=100\,\mu A/V^2$ and $(W/L)=10$, where μ_n is the mobility of electron, C_{ox} is the oxide capacitance per unit area, W is the width and L is the length.



The channel length modulation coefficient is ignored. If the gate-to-source voltage V_{GS} is 1V to keep the transistor at the edge of saturation, then the threshold voltage of the transistor (rounded off to one decimal place) is _____V.

Answer: (0.55) **Click here to watch video explanation**

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34. In a high school having equal number of boy students and girl students, 75% of the students study science and the remaining 25% students study Commerce. Commerce students are two times more likely to be a boy than are Science students. The amount of information gained in knowing that a randomly selected girl student studies Commerce (rounded off to three decimal places) is _____ bits.

Answer: (3.34) **Click here to watch video explanation**

35. For a unit step input u[n], a discrete-time LTI system produces an output signal $\left(2\delta[n+1]+\delta[n]+\delta[n-1]\right)$. Let y[n] be the output of the system for an input $\left(\left(\frac{1}{2}\right)^n u[n]\right)$. The value of $y[0]$ is _____.

Answer: (0) **Click here to watch video explanation**

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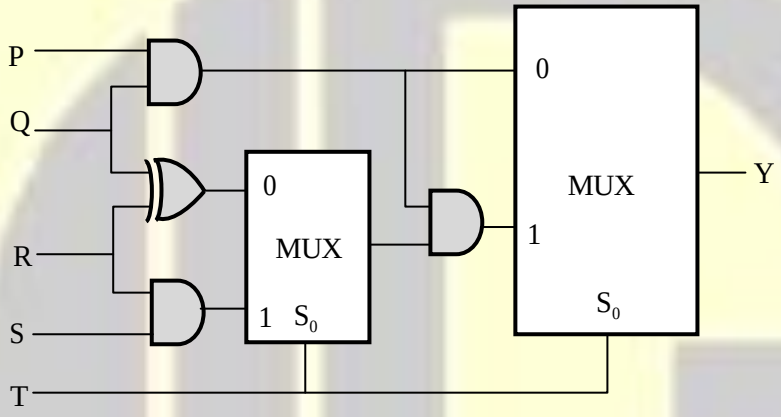
36. The propagation delays of the XOR gate, AND gate and multiplexer (MUX) in the circuit shown in the figure are 4ns, 2ns and 1 ns, respectively.



If all the inputs P, Q, R, S and T are applied simultaneously and held constant, the maximum propagation delay of the circuit is

(A) 3 ns (B) 6 ns (C) 5 ns (D) 7 ns

Answer: (B) **Click here to watch video explanation**

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37. A digital transmission system uses a (7, 4) systematic linear Hamming code for transmitting data over a noisy channel. If three of the message-codeword pairs in this code $(m_t : c_t)$, where c_t is the codeword corresponding to the i^{th} message m_i, are known to be (1100; 0101100), (1110; 0011110) and (0110; 1000110), then which of the following is a **valid codeword** in this code?

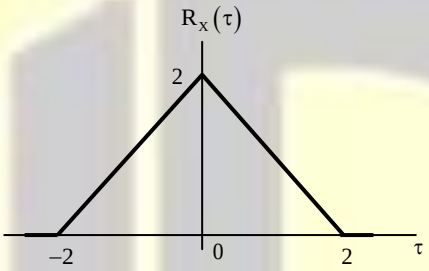
(A) 1101001 (B) 0110100 (C) 0001011 (D) 1011010

Answer: (C) **Click here to watch video explanation**

38. A sinusoidal message signal having root mean square value of 4V and frequency of 1 kHz fed to a phase modulator with phase deviation constant 2 rad/volt. If the carrier signal is $c(t)=2\cos\left(2\pi 10^6 t\right)$, the maximum instantaneous frequency of the phase modulated signal (rounded off to one decimal place) is _____Hz.

Answer: (1011312) **Click here to watch video explanation**

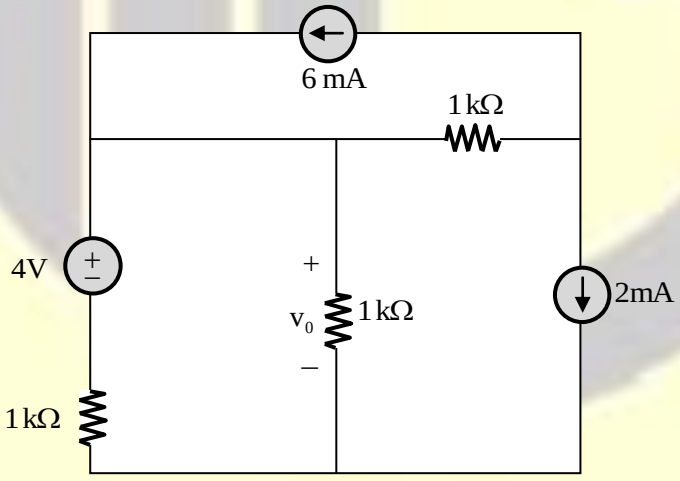
39. The autocorrelation function $R_X(\tau)$ of a wide-sense stationary random process X(t) is shown in the figure.



The average power of X(t) is _____.

Answer: (2) **Click here to watch video explanation**

40. Consider the circuit shown in the figure.



The value of v_0 (rounded off to one decimal place) is _____V.

Answer: (D) **Click here to watch video explanation**

41. Consider the signals $x[n]=2^{n-1}u[-n+2]$ and $y[n]=2^{-n+2}u[n+1]$, where $u[n]$ is the unit step sequence. Let $X(e^{j\omega})$ and $Y(e^{j\omega})$ be the discrete-time Fourier transform of $x[n]$ and $y[n]$, respectively. The value of the integral

$$\frac{1}{2\pi}\int_0^{2\pi} X(e^{j\omega})Y(e^{-j\omega})d\omega$$

(rounded off to one decimal place) is _____.

Answer: (8) **Click here to watch video explanation**

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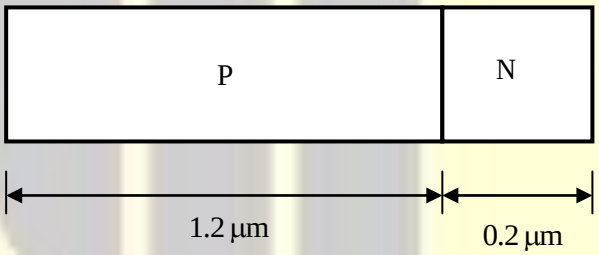
42. A silicon P-N junction is shown in the figure. The doping in the P region is $5\times10^{16}\,cm^{-3}$ and doping in the N region is $10\times10^{16}\,cm^{-3}$. The parameters given are

Build-in voltage $(\phi_{bi})=0.8V$

Electron charge $(q)=1.6\times10^{-19}C$

Vacuum permittivity $(\varepsilon_0)=8.85\times10^{-12}\,F/m$

Relative permittivity of silicon $(\varepsilon_{Si})=12$



The magnitude of reverse bias voltage that would completely deplete one of the two regions (P or N) prior to the other (rounded off to one decimal place) is _____V.

Answer: (8.23) **Click here to watch video explanation**

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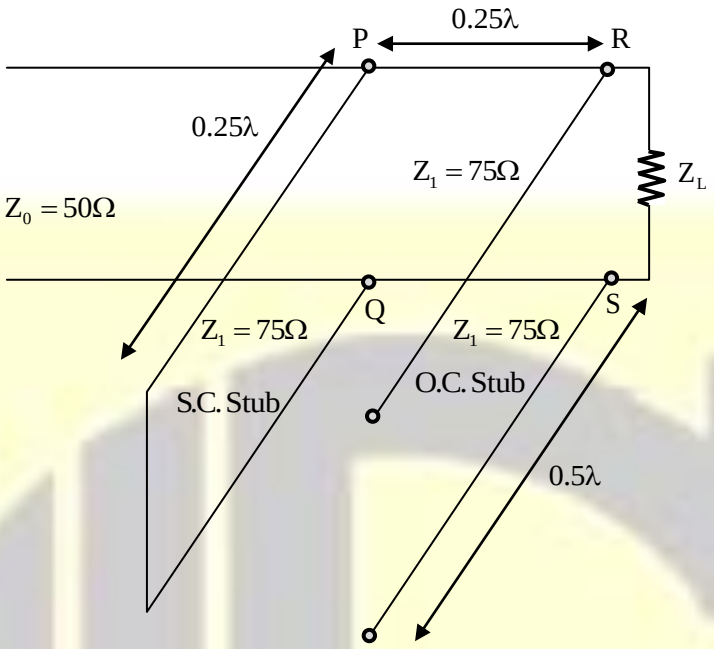
43. The impedance matching network shown in the figure is to match a lossless line having characteristics impedance $Z_0=50\Omega$ with a load impedance Z_L. A quarter-wave line having a characteristic impedance $Z_1=75\Omega$ is connected to Z_L. Two stubs having characteristic impedance of 75Ω each are connected to this quarter-wave line. One is a short-circuited (S.C) stub of length 0.25λ connected across PQ and the other one is an open-circuited (O.C) stub of length 0.5λ connected across RS.



The impedance matching is achieved when the real part of Z_L is

(A) 33.3Ω (B) 50.0Ω (C) 75.0Ω (D) 112.5Ω

Answer: (D) **Click here to watch video explanation**

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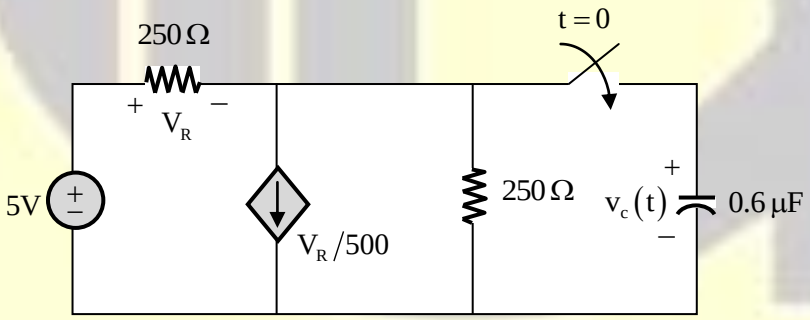
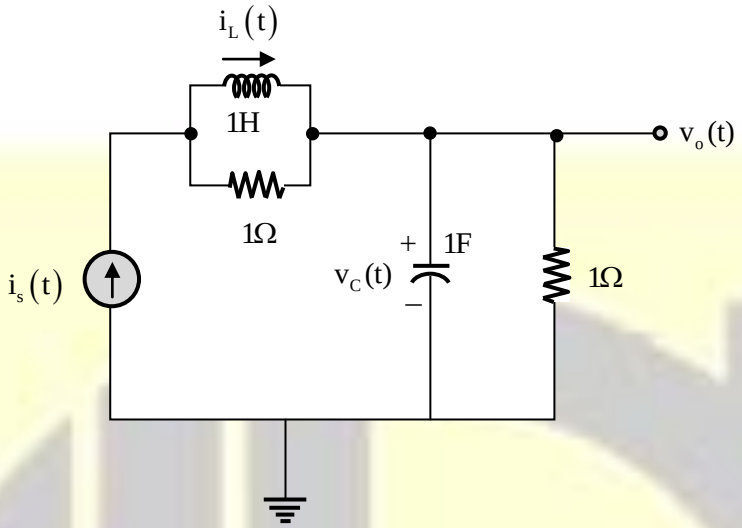
44. In the circuit shown in the figure, the switch is closed at time t = 0, while the capacitor is initially charged to –5V (i.e., $v_c(0) = -5\,V$).



The time after which the voltage across the capacitor becomes zero (rounded off to three decimal places) is _____ms.

Answer: (0.1389) **Click here to watch video explanation**

45. The electrical system shown in the figure converts input source current $i_s(t)$ to output voltage $v_o(t)$.



Current $i_L(t)$ in the inductor and voltage $v_C(t)$ across the capacitor are taken as the state variables, both assumed to be initially equal to zero, i.e., $i_L(0)=0$ and $v_C(0)=0$. The system is

(A) completely state controllable but not observable

(B) completely state controllable as well as completely observable

(C) neither state controllable nor observable

(D) completely observable but not state controllable

Answer: (C) **Click here to watch video explanation**

46. A real 2 × 2 non-singular matrix A with repeated eigen value is given as

$$A=\begin{bmatrix} x & -3.0 \\ 3.0 & 4.0 \end{bmatrix}$$

Where x is a real positive number. The value of x (rounded off to one decimal place) is _____.

Answer: (10) **Click here to watch video explanation**

47. For an n-channel silicon MOSFET with 10 nm gate oxide thickness, the substrate sensitivity $\left(\frac{\partial V_T}{\partial |V_{BS}|}\right)$ is found to be 50 mV/V at a substrate voltage $|V_{BS}| = 2V$, where V_T is the threshold voltage of the MOSFET. Assume that, $|V_{BS}| >> 2\phi_B$, where $q\phi_B$ is the separation between the Fermi energy level E_F and the intrinsic level E_i in the bulk. Parameters given are

Electron charge $(q) = 1.6\times10^{-19}$ C

Vacuum permittivity $(\varepsilon_0) = 8.85\times10^{-12}$ F/m

Relative permittivity of silicon $(\varepsilon_{Si}) = 12$

Relative permittivity of oxide $(\varepsilon_{ox}) = 4$

The doping concentration of the substrate is

(A) $7.37\times10^{15}\,cm^{-3}$ (B) $4.37\times10^{15}\,cm^{-3}$

(C) $2.37\times10^{15}\,cm^{-3}$ (D) $9.37\times10^{15}\,cm^{-3}$

Answer: (A) **Click here to watch video explanation**

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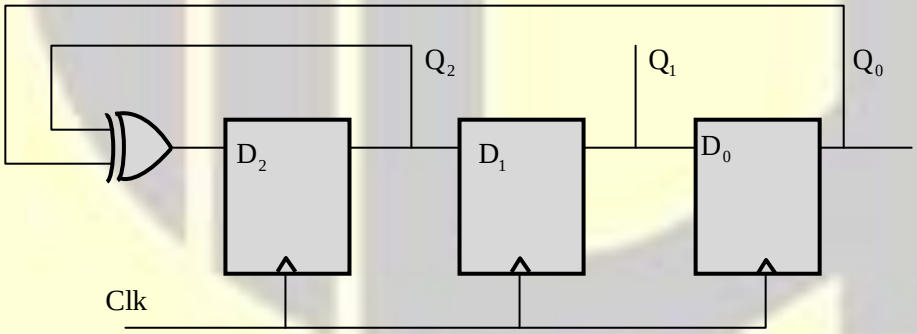
48. The propagation delay of the exclusive-OR (XOR) gate in the circuit in the figure is 3 ns. The propagation delay of all the flip-flops is assumed to be zero. The clock (Clk) frequency provided to the circuit is 500 MHz.



Starting from the initial value of the flip-flop outputs $Q_2Q_1Q_0 = 111$ with $D_2 = 1$, the minimum number of triggering clock edges after which the flip-flop outputs $Q_2Q_1Q_0$ becomes 100 (in integer) is _____.

Answer: (5) **Click here to watch video explanation**

49. The content of the registers are $R_1 = 25H$, $R_2 = 30H$ and $R_3 = 40H$. The following machine instructions are executed.

PUSH $\{R_1\}$
PUSH $\{R_2\}$
PUSH $\{R_3\}$
POP $\{R_1\}$
POP $\{R_2\}$
POP $\{R_3\}$

After execution, the content of registers R_1, R_2, R_3 are

(A) $R_1 = 30H, R_2 = 40H, R_3 = 25H$ (B) $R_1 = 25H, R_2 = 30H, R_3 = 40H$

(C) $R_1 = 40H, R_2 = 30H, R_3 = 25H$ (D) $R_1 = 40H, R_2 = 25H, R_3 = 30H$

Answer: (C) **Click here to watch video explanation**

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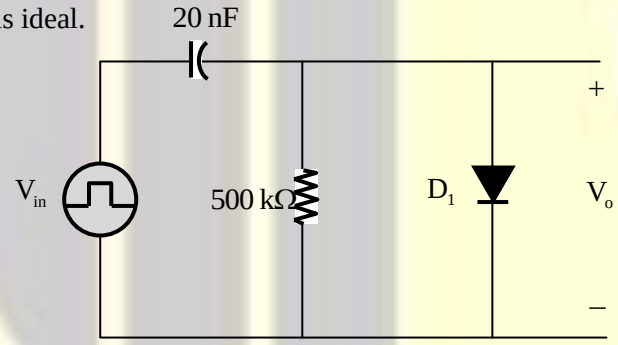
50. An asymmetrical periodic pulse train v_{in} of 10V amplitude with on-time $T_{ON} = 1\,ms$ and off-time $T_{OFF} = 1\,\mu s$ is applied to the circuit shown in the figure.

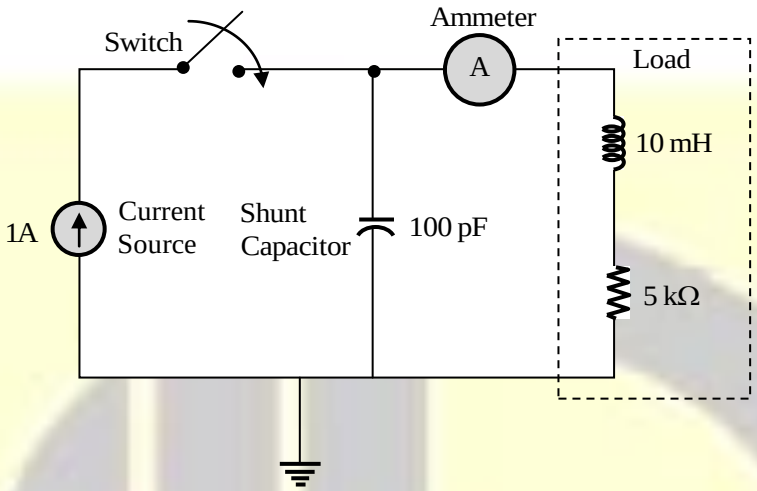
The diode D_1 is ideal.



The difference between the maximum voltage and minimum voltage of the output waveform v_o (in integer) is _____V.

Answer: (10) **Click here to watch video explanation**

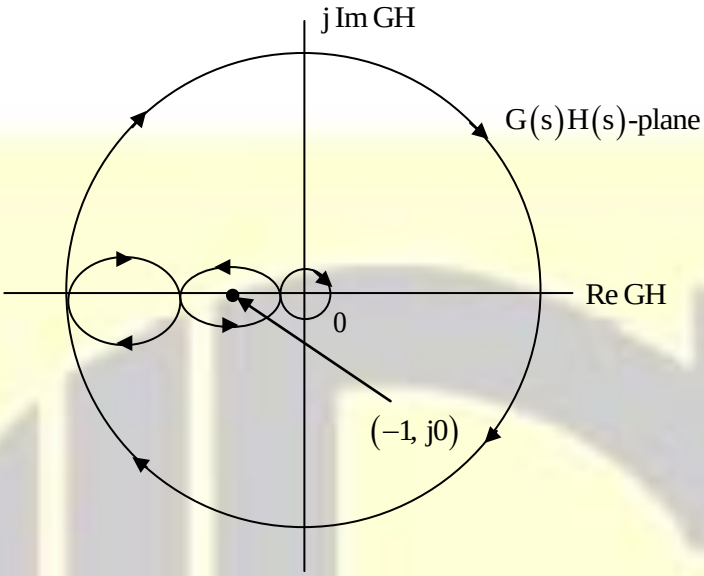
51. The circuit in the figure contains a current source driving a load having an inductor and a resistor in series, with a shunt capacitor across the load. The ammeters is assumed to have zero resistance. The switch is closed at time t = 0.



Initially, when the switch is open, the capacitor is discharged and the ammeter reads zero ampere. After the switch is closed, the ammeter reading keeps fluctuating for some till it settles to a final steady value. The maximum ammeter reading that one will observe after the switch is closed (rounded off to two decimal places) is _____A.

Answer: (1.44) **Click here to watch video explanation**

52. The complete Nyquist plot of the open-loop transfer function G(s)H(s) of a feedback control system is shown in the figure.



If G(s)H(s) has one zero in the right-half of the s-plane, the number of poles that the closed-loop system will have in the right-half of the s-plane is

(A) 1 (B) 3 (C) 4 (D) 0

Answer: (B) **Click here to watch video explanation**

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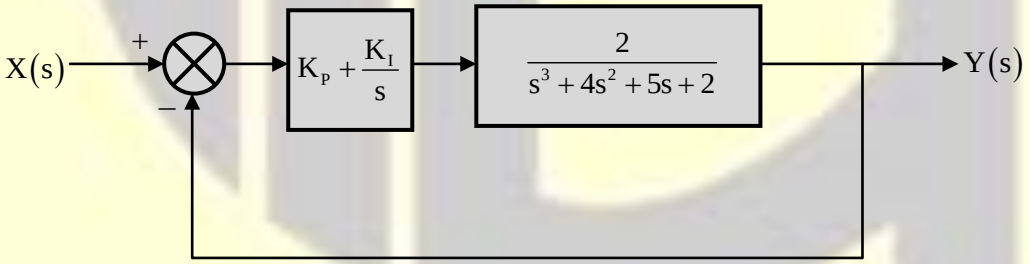
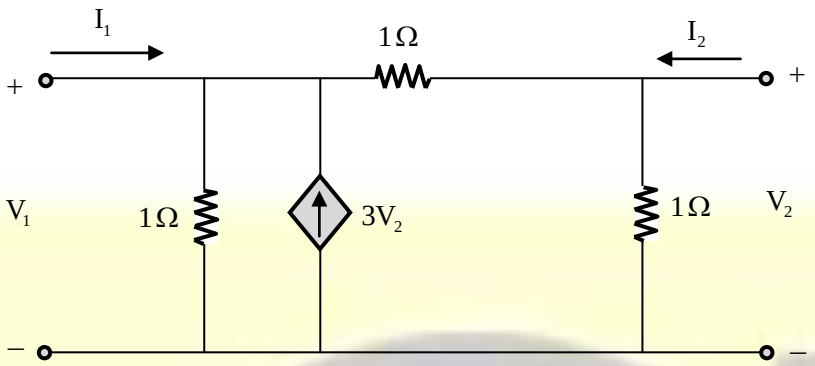
53. A unity feedback system that uses proportional-integral (PI) control is shown in the figure.



The stability of the overall system is controlled by tuning the PI control parameters K_P and K_I. The maximum value of K_I that can be chosen so as to keep the overall system stable or, in the worst case, marginally stable (rounded off to three decimal places) is _____.

Answer: (3.125) **Click here to watch video explanation**

54. Consider the two-port network shown in the figure.



The admittance parameters, in siemens, are

(A) $y_{11}=2, y_{12}=-4, y_{21}=-1, y_{22}=2$

(B) $y_{11}=1, y_{12}=-2, y_{21}=-1, y_{22}=3$

(C) $y_{11}=2, y_{12}=-4, y_{21}=-4, y_{22}=3$

(D) $y_{11}=2, y_{12}=-4, y_{21}=-4, y_{22}=2$

Answer: (A) **Click here to watch video explanation**

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55. Consider a superheterodyne receiver tuned to 600 kHz. If the total oscillator feeds a 1000 kHz signal to the mixer, the image frequency (in integer) is _____ kHz.

Answer: (1400) **Click here to watch video explanation**