EC: ELECTRONICS AND COMMUNICATION ENGINEERING - 2021

EE25BTECH11037 - Divyansh

I. General Aptitude

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) $9,95,006$ c) $10,00,000$ d) $12,51,506$

(GATE EC 2021)

2) 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) 7 c) 9 d) 11

(GATE EC 2021)

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

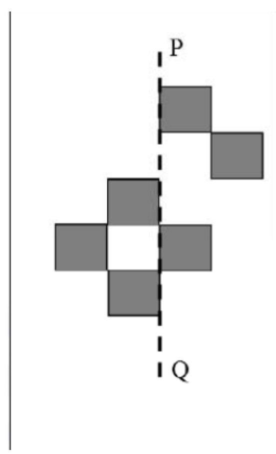

Fig. 1: for q-3

a) 4 b) 3 c) 6 d) 7

(GATE EC 2021)

4) Nostalgia is to anticipation as _________ is to _________.
Which one of the following options maintains a similar logical relation in the above sentence?

a) Present, past b) Future, past c) Past, future d) Future, present

(GATE EC 2021)

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 (ii) b) (i) and (iii) c) (ii) and (iii) d) (i) and (iv)

(GATE EC 2021)

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) Only conclusion I is correct.
b) Only conclusion II is correct.
c) Either conclusion I or II is correct.
d) Both conclusion I and II are correct.

(GATE EC 2021)

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 (iii) b) (ii) and (iv) c) (i), (iii) and (iv) d) (i) and (iii)

(GATE EC 2021)

8) Consider a square sheet of 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) $\frac{3\pi}{2}$ d) 3π

(GATE EC 2021)

9) The number of minutes spent by two students, X and Y, exercising every day in a given week are shown in the $Fig.$ **??**.

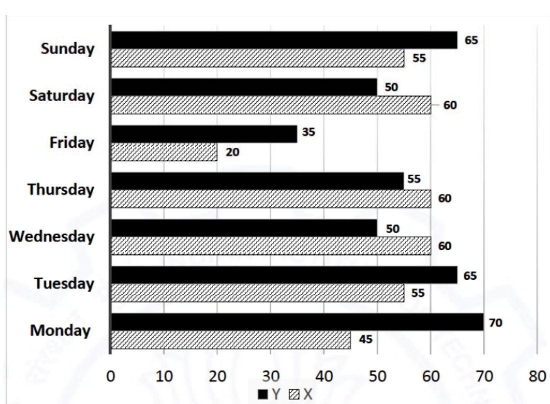

Fig. 2: for q-9

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) 5 c) 6 d) 7

(GATE EC 2021)

10) Corners are cut from an equilateral triangle to produce a regular convex hexagon. The ratio of the area of the regular convex hexagon to the area of the original equilateral triangle is

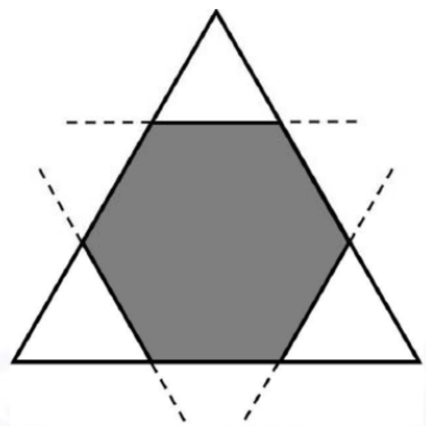

Fig. 3: for q-10

a) 2 : 3 b) 3 : 4 c) 4 : 5 d) 5 : 6

(GATE EC 2021)

II. ECE

1) The vector function $\mathbf{F}(r) = -x\hat{i} + y\hat{j}$ is defined over a circular arc C. The line integral of $\mathbf{F}(r) \cdot d\mathbf{r}$ is

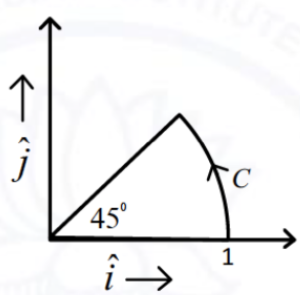

Fig. 4: for q-1

a) $\frac{1}{2}$ b) $\frac{1}{4}$ c) $\frac{1}{6}$ d) $\frac{1}{3}$

(GATE EC 2021)

2) 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) $\left(1-x^2\right)^{-3/4}$ b) $\left(1-x^2\right)^{-1/4}$ c) $\left(1-x^2\right)^{-3/2}$ d) $\left(1-x^2\right)^{-1/2}$

(GATE EC 2021)

3) 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) $\sigma_Y^2 = 2\sigma_X^2$ b) $\sigma_Y^2 = 4\sigma_X^2$ c) $\sigma_Y^2 = 5\sigma_X^2$ d) $\sigma_Y^2 = 25\sigma_X^2$

(GATE EC 2021)

4) Consider a real-valued baseband signal $x(t)$, band-limited to $10kHz$. 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

(GATE EC 2021)

5) 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) $k = 0, 1, 2, \ldots, 15$ b) $k = 0$ c) $k = 15$ d) $k = 0$ and $k = 15$

(GATE EC 2021)

6) 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 $100\ \mu s$, 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) $2\times10^{32}\ cm^{-6}$

(GATE EC 2021)

7) 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 Fig. **??**. The valence 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.

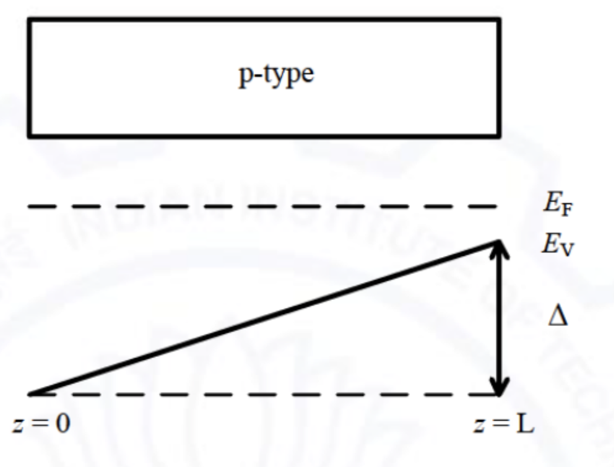

Fig. 5: for q-7

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

a) $\dfrac{\Delta}{qL}$ b) $\dfrac{2\Delta}{qL}$ c) $\dfrac{\Delta}{2qL}$ d) $\dfrac{3\Delta}{2qL}$

(GATE EC 2021)

8) In the circuit shown in $Fig.$ **??**, 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 resistances are r_{o1} and r_{o2}, respectively.

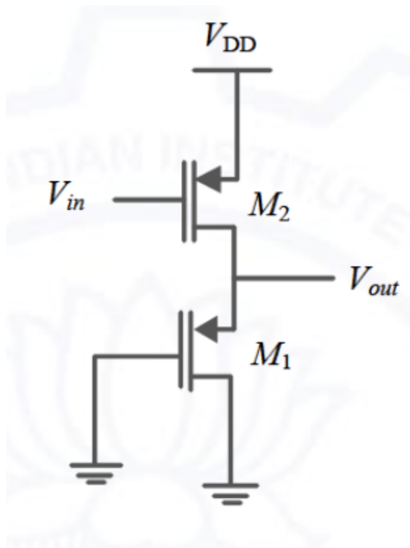

Fig. 6: for q-8

Ignoring the body effect, the AC small signal voltage gain $\dfrac{v_{\text{out}}}{v_{\text{in}}}$ of the circuit is

a) $-g_{m2}\left(r_{o1} \parallel r_{o2}\right)$

b) $-g_{m2}\left(\dfrac{1}{g_{m1}} \parallel r_{o2}\right)$

c) $-g_{m1}\left(\dfrac{1}{g_{m1}} \parallel r_{o1} \parallel r_{o2}\right)$

d) $-g_{m2}\left(\dfrac{1}{g_{m2}} \parallel r_{o1} \parallel r_{o2}\right)$

(GATE EC 2021)

9) For the circuit with an ideal OPAMP shown in $Fig.$ **??**, V_{REF} is fixed.

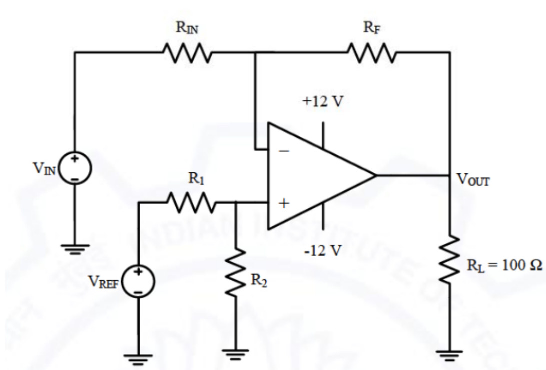

Fig. 7: for q-9

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

a) 3.285 b) 2.860 c) 3.825 d) 5.555

(GATE EC 2021)

10) Consider the circuit with an ideal OPAMP as in *Fig.* **??**.

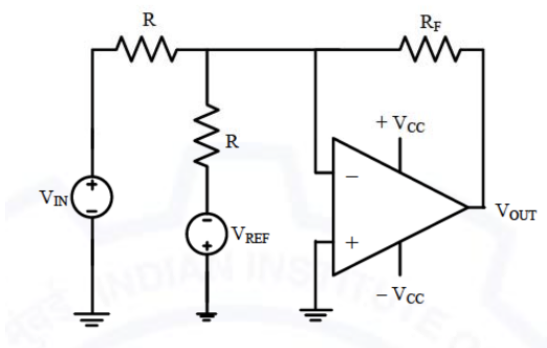

Fig. 8: for q-10

Assuming $|V_{\text{IN}}| \ll |V_{\text{CC}}|$ and $|V_{\text{REF}}| \ll |V_{\text{CC}}|$, the condition at which $V_{\text{OUT}} = 0$ is

a) $V_{\text{IN}} = V_{\text{REF}}$ b) $V_{\text{IN}} = 0.5V_{\text{REF}}$ c) $V_{\text{IN}} = 2V_{\text{REF}}$ d) $V_{\text{IN}} = 2 + V_{\text{REF}}$

(GATE EC 2021)

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

a) $x = 7$ and $y = 5$
b) $x = 8$ and $y = 6$
c) $x = 6$ and $y = 4$
d) $x = 9$ and $y = 7$

(GATE EC 2021)

12) Addressing of a $32K \times 16$ memory is realized using a single decoder. The minimum number of AND gates required for the decoder is

a) 2^8 b) 2^{32} c) 2^{15} d) 2^{19}

(GATE EC 2021)

13) The block diagram of a feedback control system is shown in *Fig.* **??**. The transfer function $\frac{X(s)}{Y(s)}$ of the system is

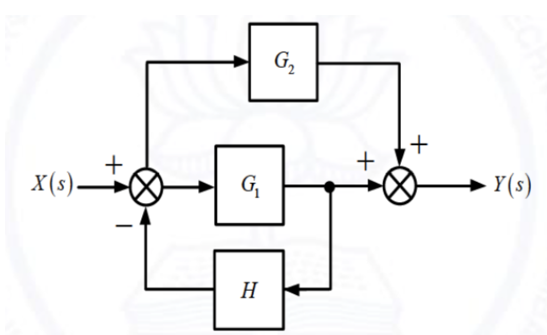

Fig. 9: for q-13

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

(GATE EC 2021)

14) The complete Nyquist plot of the open-loop transfer function $G(s)H(s)$ of a feedback control system is shown in $Fig.$ **??**.

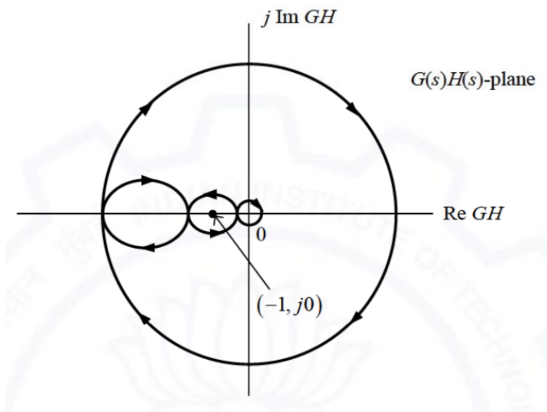

Fig. 10: for q-14

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) 0 b) 1 c) 4 d) 3

(GATE EC 2021)

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

a) $\frac{1}{3}$ b) $\frac{3}{5}$ c) $\frac{2}{5}$ d) $\frac{2}{3}$

(GATE EC 2021)

16) A 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 __________.

(GATE EC 2021)

17) Consider a vector field $F = a_x(4y-c_1z)+a_y(4x+2z)+a_z(2y+z)$ 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 __________.

(GATE EC 2021)

18) Consider the circuit shown in $Fig.$ **??**.

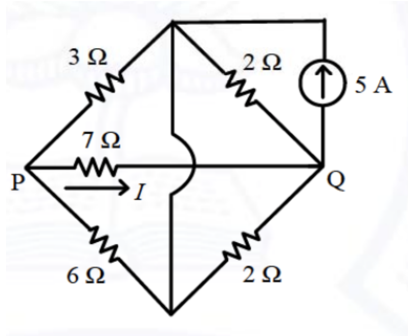

Fig. 11: for q-18

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

(GATE EC 2021)

19) Consider the circuit shown in $Fig.$ **??**.

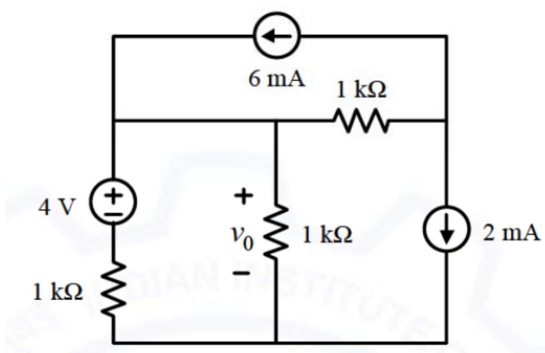

Fig. 12: for q-19

The value of V_o (rounded off to one decimal place) is __________ V.

(GATE EC 2021)

20) An 8-bit unipolar digital-to-analog converter (DAC) has a full-scale voltage range from 0 V to 7.68 V. If the digital input code is 10010110, the analog output voltage (rounded off to one decimal place) is __________ V.

(GATE EC 2021)

21) The autocorrelation function $R_x(\tau)$ of a wide-sense stationary random process $X(t)$ is shown in $Fig.$ **??**.

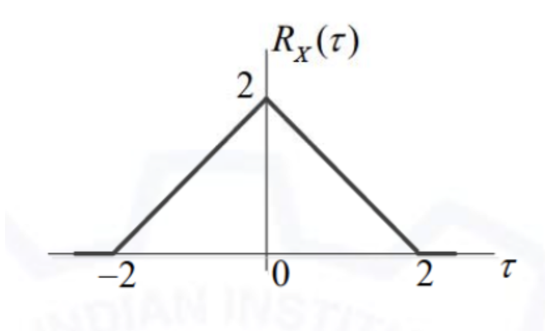

Fig. 13: for q-21

The average power of $X(t)$ is __________ .

(GATE EC 2021)

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

(GATE EC 2021)

23) 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 of $-5V\ to\ +5V$, are subsequently quantized in an 8-bit uniform quantizer and transmitted over a voice-grade AWGN 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 signal with arbitrarily small probability of transmission error (rounded off to two decimal places) is __________ kHz.

(GATE EC 2021)

24) A 4 kHz sinusoidal message signal with amplitude 4 V 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.

(GATE EC 2021)

25) 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 optical fiber to achieve total internal reflection, (rounded off to two decimal places) is __________ degree.

(GATE EC 2021)

26) Consider the integral $\int_C \frac{\sin(x)}{x^2(x^2+4)}dx$ where C is a counter-clockwise oriented circle defined as $|x-i| = 2$. The value of the integral is

a) $-\frac{\pi\sin(2i)}{8}$ b) $\frac{\pi\sin(2i)}{4}$ c) $-\frac{\pi}{4}\sin(2i)$ d) $\frac{\pi}{4}\sin(2i)$

(GATE EC 2021)

27) A box contains three coins:

I. A fair coin with head on one face and tail on the other face.
II. A coin with heads on both faces.
III. A coin with tails on both faces.

A coin is picked randomly 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) $\frac{2}{5}$ b) $\frac{1}{3}$ c) $\frac{1}{2}$ d) $\frac{2}{3}$

(GATE EC 2021)

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

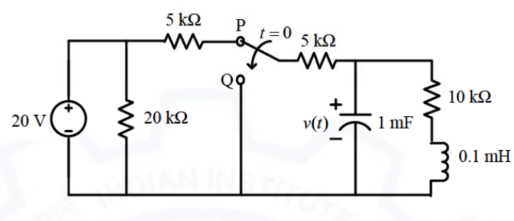

Fig. 14: for q-28

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

a) 0 V/s b) 3 V/s c) −3 V/s d) −5 V/s

(GATE EC 2021)

29) Consider the two-port network shown in Fig. **??**.

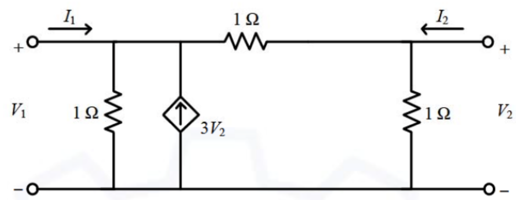

Fig. 15: for q-29

The admittance parameters, in siemens, are

a) $y_{11} = 2$, $y_{12} = -4$, $y_{21} = -4$, $y_{22} = 2$
b) $y_{11} = 1$, $y_{12} = -2$, $y_{21} = -1$, $y_{22} = 3$
c) $y_{11} = 2$, $y_{12} = -4$, $y_{21} = -1$, $y_{22} = 2$
d) $y_{11} = 2$, $y_{12} = -4$, $y_{21} = -4$, $y_{22} = 3$

(GATE EC 2021)

30) For an n-channel silicon MOSFET with 10 nm gate oxide thickness, the substrate sensitivity $\frac{\partial V_T}{\partial |V_{BS}|}$ is found to be 50 mV/V at $|V_{BS}| = 2$ V, where V_T is the threshold voltage of MOSFET. Assume $|V_{BS}| \gg 2\Phi_B$ where $q\Phi_B$ is the separation between 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) $7.37 \times 10^{15} cm^{-3}$ b) $4.37 \times 10^{15} cm^{-3}$ c) $2.37 \times 10^{15} cm^{-3}$ d) $9.37 \times 10^{15} cm^{-3}$

(GATE EC 2021)

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

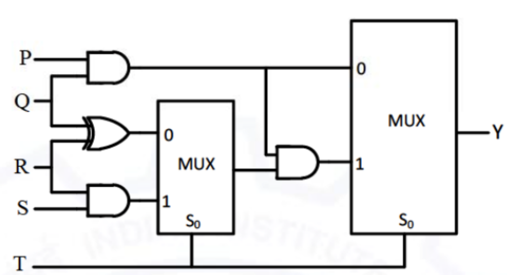

Fig. 16: for q-31

If all 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) 5 ns c) 6 ns d) 7 ns

(GATE EC 2021)

32) The content of the registers are $R1 = 25H$, $R2 = 30H$, and $R3 = 40H$. The following machine instructions are executed:
PUSH($R1$),
PUSH($R2$),
PUSH($R3$),
POP($R1$),
POP($R2$),
POP($R3$) After execution, the content of registers $R1$, $R2$, $R3$ are

a) $R1 = 40H$, $R2 = 30H$, $R3 = 25H$
b) $R1 = 25H$, $R2 = 30H$, $R3 = 40H$
c) $R1 = 30H$, $R2 = 40H$, $R3 = 25H$
d) $R1 = 40H$, $R2 = 25H$, $R3 = 30H$

(GATE EC 2021)

33) The electrical system shown in Fig. **??** converts input source current $i_s(t)$ to output voltage $v_o(t)$.

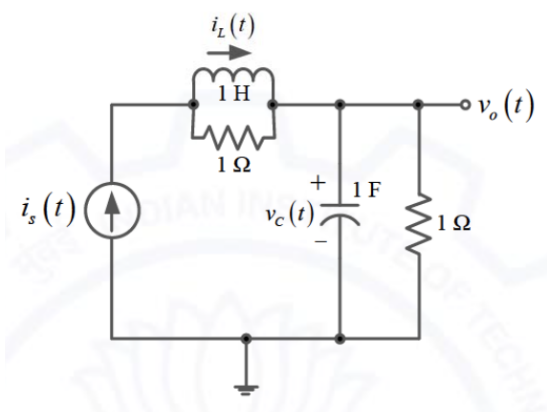

Fig. 17: for q-33

Current $i_z(t)$ in the inductor and voltage $v_c(t)$ across the capacitor are taken as the state variables, both initially zero. The system is

a) completely state controllable as well as completely observable
b) completely state controllable but not observable
c) completely observable but not state controllable
d) neither state controllable now observable

(GATE EC 2021)

34) 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 $(m_i; c_i)$, where c_i is the codeword corresponding to the i^{th} message m_i, are known to be (1 1 0 0; 0 1 0 1 1 0 0), (1 1 1 0; 0 0 1 1 1 1 0) and (0 1 1 0; 1 0 0 0 1 1 0), the which of the following is the codeword in this code?

a) 1 1 0 1 0 0 1 b) 1 1 1 1 0 1 0 c) 0 0 0 1 0 1 1 d) 0 1 1 1 1 0 0

(GATE EC 2021)

35) The impedance matching network shown in the Fig. **??** is to match a lossless line having characteristic 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 0.25λconnected across PQ and the other one is an open-circuited ($O.C.$) stub of length 0.5λ connected across RS.

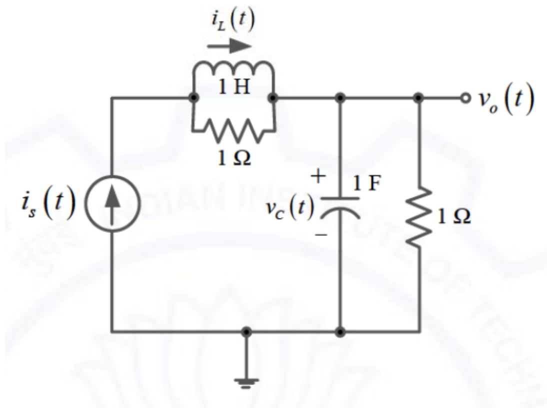

Fig. 18: for q-35

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

a) 112.5 Ω   b) 75.0 Ω   c) 50.0 Ω   d) 33.3 Ω

(GATE EC 2021)

36) A real 2×2 non-singular matrix A with repeated eigenvalue as $A = \begin{pmatrix} x & -3.0 \\ 3.0 & 4.0 \end{pmatrix}$ where x is a real positive number. The value of x (rounded off to one decimal place) is __________.

(GATE EC 2021)

37) For a vector field $D = \rho \cos^2 \phi \, a_\rho + z^2 \sin^2 \phi \, a_\phi$ in a cylindrical coordinate system (ρ, ϕ, 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 __________.

(GATE EC 2021)

38) In the circuit shown in $Fig.$ **??**, the switch is closed at time $t = 0$, while the capacitor is initially charged to -5 V ($i.e.$, $v_c(0) = -5$ V).

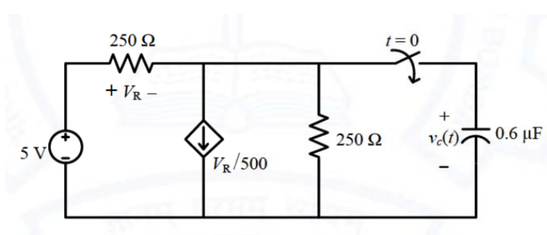

Fig. 19: for q-38

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

(GATE EC 2021)

39) The exponential Fourier series representation of a continuous-time periodic signal $x(t)$ is defined as $x(t) = \sum_{k=-\infty}^{\infty} a_k e^{jk\omega_0 t}$ where ω_0 is the fundamental angular frequency of $x(t)$ and the coeffiecients of the series are a_k. The following information is given about $x(t)$ and a_k.

I. $x(t)$ is real and even, with fundamental period 6

II. Average value of $x(t)$ is 2

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

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

(GATE EC 2021)

40) For a unit step input $u[n]$, a discrete-time LTI system produces an output signal $28u[n+1] + 8u[n] + 8u[n-1]$. Let $y[n]$ be the output of the system for input $\left(\left(\frac{1}{2}\right)^n u[n]\right)$. The value of $y[0]$ is _____ .

(GATE EC 2021)

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 DTFTs of $x[n]$ and $y[n]$, respectively. The value of the integral $\dfrac{1}{2\pi}\int_0^{2\pi} X(e^{j\omega})Y(e^{-j\omega})d\omega$ (rounded off to one decimal place) is _____ .

(GATE EC 2021)

42) A silicon PN junction is shown in $Fig.$ **??**. The doping in the P region is $5 \times 10^{16}\ cm^{-3}$ and in the N region is $10 \times 10^{16}\ cm^{-3}$. Given:
- Built-in voltage $V_{bi} = 0.8$ V
- Electron charge $q = 1.6 \times 10^{-19}$ C
- Vacuum permittivity $\varepsilon_0 = 8.85 \times 10^{-12}$ F/m
- Relative permittivity of silicon $\varepsilon_{si} = 12$

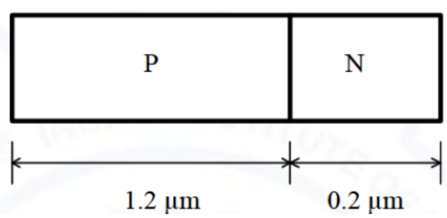

Fig. 20: for q-42

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

(GATE EC 2021)

43) An asymmetrical periodic pulse train v_{in} of 10 V amplitude with on-time $T_{\text{ON}} = 1$ ms and off-time $T_{\text{OFF}} = 1\ \mu$s is applied to the circuit shown in $Fig.$ **??**. The diode D_1 is ideal.

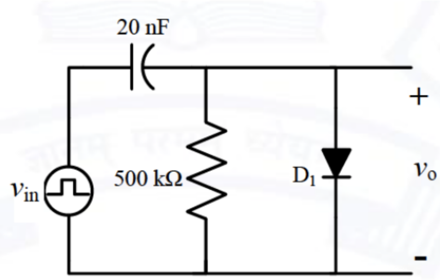

Fig. 21: for q-43

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

(GATE EC 2021)

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

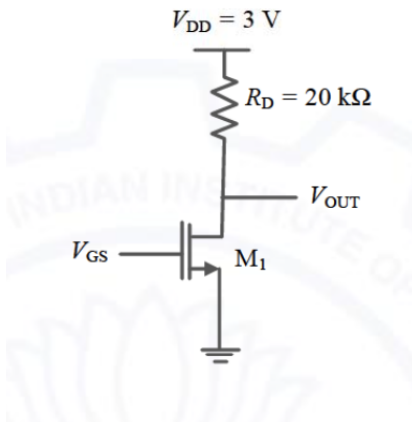

Fig. 22: for q-44

Ignoring channel length modulation. if the gate-to-source voltage V_{GS} = 1 V to keep the transistor at the edge of saturation, then the threshold voltage of the transistor (rounded off to one decimal place) is _____ V.

(GATE EC 2021)

45) A circuit with an ideal OPAMP is shown in $Fig.$ **??**. A pulse V_{IN} of 20 ms duration is applied to the input. Capacitors are initially uncharged.

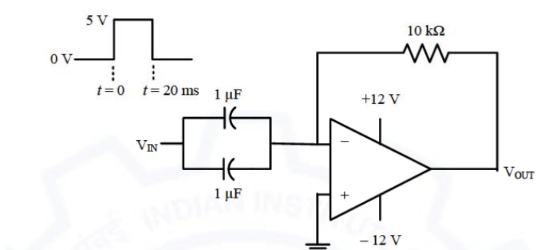

Fig. 23: for q-45

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

(GATE EC 2021)

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

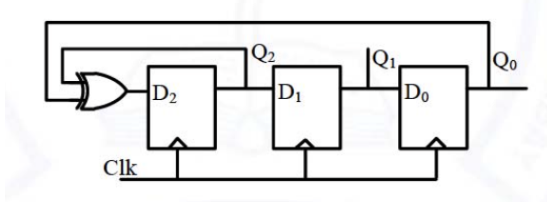

Fig. 24: for q-46

Starting from the initial value of the flip-flop outputs $Q_2Q_1Q_0$ = 1 1 1 with D_2 = 1, the minimum number of triggering clock edges after which the outputs $Q_2Q_1Q_0$ become 1 0 0 (in integer) is _____ .

(GATE EC 2021)

47) The circuit shown in *Fig*. **??** contains a current source driving a load having an inductor and a resistor in series, with a shunt capacitor across the load. The ammemeter is assumed to have zero resistance. The switch is closed at time $t = 0$.

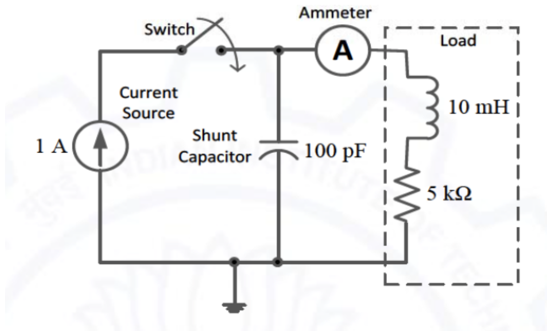

Fig. 25: for q-47

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 time till it settles to a final steady value. The maximum ammeter reading observed after the switch is closed (rounded off to two decimal places) is _____ A.

(GATE EC 2021)

48) A unity feedback system uses proportional-integral (PI) control as shown in the *Fig*. **??**.

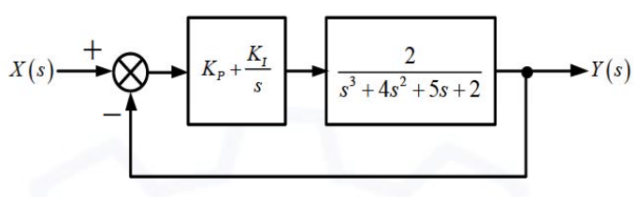

Fig. 26: for q-48

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 to keep the system stable or marginally stable (rounded off to three decimal places) is _____.

(GATE EC 2021)

49) A sinusoidal message signal having RMS value 4 V and frequency $1kHz$ is fed to a phase modulator with phase deviation constant 2 rad/V. 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.

(GATE EC 2021)

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

(GATE EC 2021)

51) In a high school with equal number of boys and girls, 75% study Science and remaining 25% study Commerce. Commerce students are twice as likely to be boys as Science students. The amount of information gained in knowing that a randomly selected girl studies Commerce (rounded off to 3 decimal places) is _____ bits.

(GATE EC 2021)

52) A message signal with peak-to-peak value 2 V, RMS value 0.1 V and bandwidth $5kHz$ is sampled and fed to a pulse code modulation (PCM) system using a uniform quantizer. The PCM output is

transmitted over a channel that can support a maximum transmission rate of 50 kbps. Assuming that the quantizxation 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 _____ .

(GATE EC 2021)

53) Consider a polar Nnon-return to zero (*NRZ*) waveform using +2 V and −2 V for 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 priori* (*MAP*) receiver (rounded off to two decimal places) is _____ V.

(GATE EC 2021)

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

(GATE EC 2021)

55) 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.

(GATE EC 2021)