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PTQ

Prelims Through Questions

for

ESE 2021

Electrical Engineering

Day 9 of 11

Q.361 - Q.410

(Out of 500 Questions)

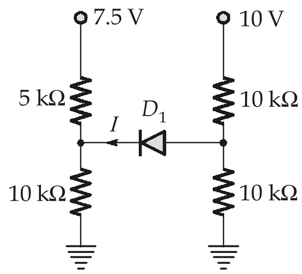
Analog Electronics + Basic Electronics Engineering + Engineering Mathematics + Microprocessors

Analog Electronics + B.E.E. + Engg. Mathematics + Microprocessors

Q.361 A BJT can act as a switch, when it changes from
(a) cut-off to active region
(b) active to saturation region
(c) forward active mode to reverse active mode
(d) saturation to cut-off region

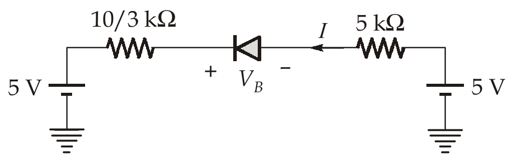
361. **(d)**
Maximum current is drawn in saturation while minimum or zero current is drawn in cut-off.

Q.362 Consider the circuit shown in the figure below



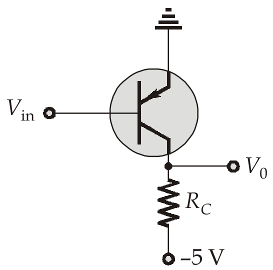
If the cut-in voltage of the diode D_1 is equal to 0.7 V, then the value of current flowing through the diode is
(a) 0
(b) 1 mA
(c) 2 mA
(d) 3 mA

362. **(a)**
Drawing the Thevenin equivalent circuit, we get

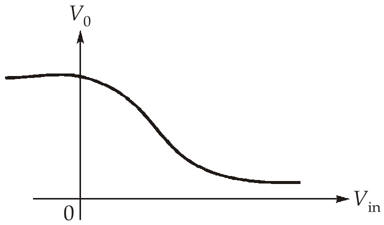


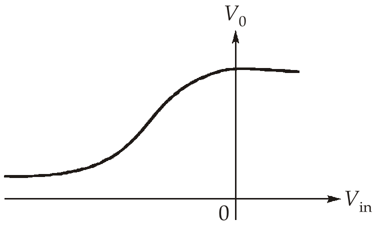
Applying KVL we get V_D = 0 V, thus no current will flow through the diode D_1.
Hence, $I = 0$ A

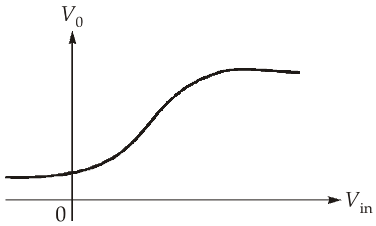
Q.363 Consider a *p-n-p* common emitter amplifier shown in the figure below:

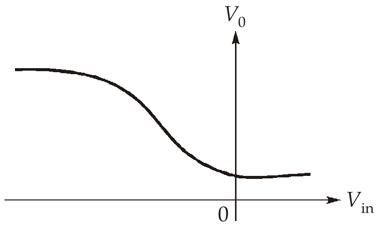


The transfer characteristic of the circuit can be approximately represented as

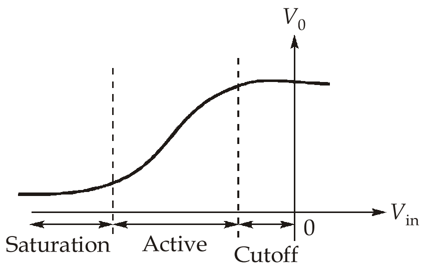
(a) 

(b) 

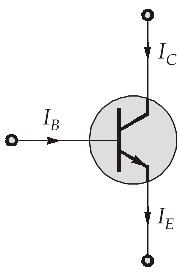
(c) 

(d) 

363. (b)



Q.364 Consider the BJT shown below:



Which of the following relation is correct?

(a) $I_C + I_E + \beta I_B = 0$

(b) $I_C = \beta I_B + \dfrac{1}{1+\beta} I_{CO}$

(c) $I_C = \beta I_B + \dfrac{1}{1-\alpha} I_{CO}$

(d) $I_C = \alpha I_B + (1 + \beta) I_{CO}$

364. (c)

$$I_C = \beta I_B + (1+\beta) I_{CO}$$

but
$$\beta = \frac{\alpha}{1-\alpha}$$

$\therefore$
$$I_C = \beta I_B + \left(1 + \frac{\alpha}{1-\alpha}\right) I_{CO} = \beta I_B + \frac{1-\alpha+\alpha}{1-\alpha} I_{CO}$$

$$I_C = \beta I_B + \frac{1}{1-\alpha} I_{CO}$$

Q.365 A Bipolar junction transistor has α = 0.98, base current I_B = 25 μA and I_{CBO} = 200 nA. The emitter current is

(a) 1.05 mA
(b) 1.235 mA
(c) 1.33 mA
(d) 1.26 mA

365. (d)

Given,

Base current, $I_B = 25\ \mu A$

$I_{CBO} = 200\ nA$

$\alpha = 0.98$

where, $$\beta = \frac{\alpha}{1-\alpha} = \frac{0.98}{1-0.98} = 49$$

Collector current, $I_C = \beta I_B + (1+\beta)I_{CBO}$

$\therefore$ $I_C = 49 \times 25 \times 10^{-6} + (50) \times 200 \times 10^{-9}$

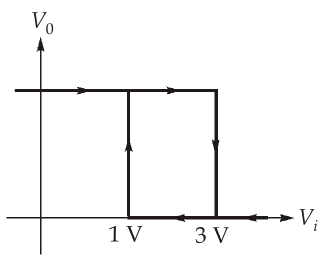
$I_C = 1.235 \times 10^{-3}$ A

Emitter current, $I_E = I_C + I_B$

$= 1.235$ mA + 0.025 mA

$\therefore$ $I_E = 1.26$ mA

Q.366 The input-output characteristic of a Schmitt trigger is shown in the figure below:



The noise margin of the schmitt trigger is equal to

(a) 1 V
(b) 2 V
(c) 3 V
(d) 4 V

366. (b)

Noise margin = 3 V – 1 V = 2 V (width of the hysteresis curve)

Q.367 Which of the following type of filter is suitable for small values of load resistance

(a) Capacitive filter
(b) Inductive filter
(c) LC filter
(d) None of these

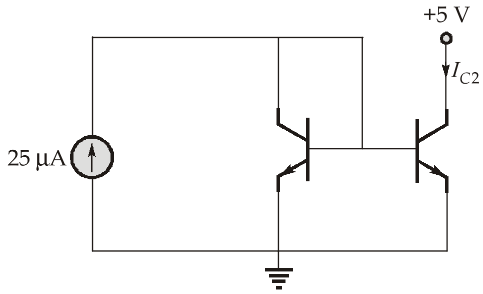
367. (b)

In an inductive filter,

Ripple factor α R_L (Load Resistance).

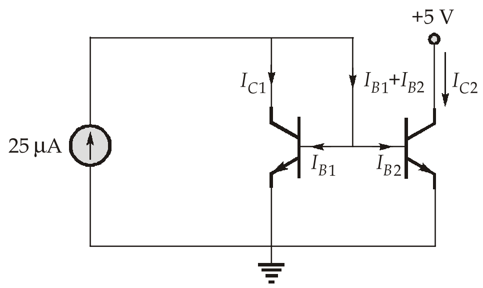
Thus if R_L is low then the ripple factor will also be less providing a good DC output.

Q.368 The two transistors in circuit shown below are identical. If β = 25, then the value of current I_{C2} will be



(a) 28 μA
(b) 23.15 μA
(c) 25 μA
(d) 24 A

368. (b)



Both transistors are in the forward active region.

So, $25\ \mu A = I_{C1} + I_{B1} + I_{B2}$

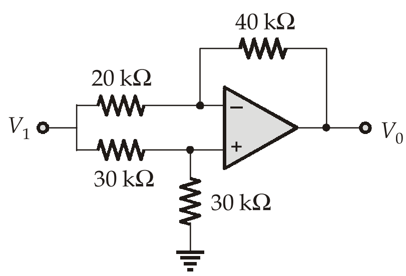
Since the transistor are identical and have the same V_{BE}

$$I_{C2} = I_{C1},\ I_{B1} = I_{B2}$$

So, $25\ \mu A = I_{C1} + 2I_{B1} = (2 + \beta)I_{B1}$

$$I_{C2} = \beta I_{B2} = \beta I_{B1} = \left(\frac{\beta}{\beta+2}\right) \times 25\ \mu A = \frac{25 \times 25}{27}\ \mu A = 23.15\ \mu A$$

Q.369 Consider an ideal op-amp circuit shown in the figure below:



The value of output voltage V_0 is equal to

(a) $2V_1$
(b) 0
(c) $4V_1$
(d) $-\frac{V_1}{2}$

369. (d)

By applying superposition theorem, we get,

When V_1 at non-inverting terminal is shorted

$$V_{01} = -\frac{40}{20}V_1 = -2V_1 \quad ...(i)$$

When V_1 at inverting terminal is shorted, then

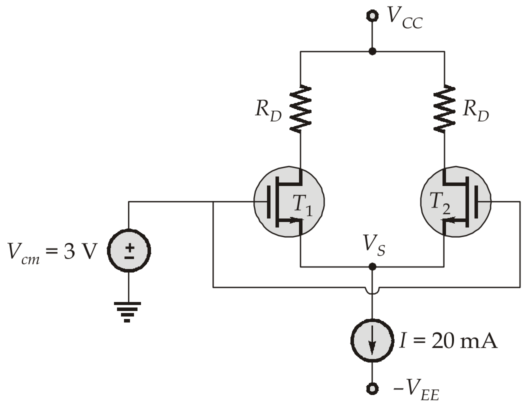
$$V_{02} = \left[1+\frac{40}{20}\right]\times\left[\frac{30}{30+30}\right]V_1 = 3\times\frac{3}{6}V_1 = 1.5\,V_1 \quad ...(ii)$$

Combining equation (i) and (ii), we get,

$$V_0 = V_{01} + V_{02} = -2V_1 + 1.5V_1$$

$$= -\frac{V_1}{2}$$

Q.370 Consider a differential amplifier circuit shown in the figure below:



The two transistors are exactly matched with $V_t = 0.5$ V, $\mu_n C_{ox} = 500\ \mu A/V^2$ and $\left(\frac{W}{L}\right) = 100$.

Then the value of voltage V_s is equal

(Assuming T_1 and T_2 are operating in saturation region)

(a) 1.868 V
(b) 2.413 V
(c) 3 V
(d) –1.124 V

370. (a)

The current of both the transistors are equal since they are perfectly matched.

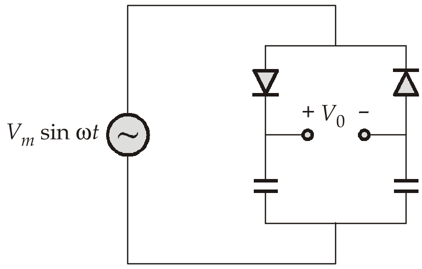
Thus, $$\frac{I}{2} = \frac{1}{2}\mu_n C_{ox}\left(\frac{W}{L}\right)(V_{GS1} - V_t)^2$$

$$10\times10^{-3} = \frac{1}{2}\times500\times10^{-6}\times100(V_{GS1} - 0.5)^2$$

∴ $$V_{GS1} = V_{GS2} = 1.132 \text{ V}$$

Thus, $$V_S = V_{cm} - V_{GS1} = 3 - 1.132 = 1.868 \text{ V}$$

Q.371 In the figure shown below, the voltage V_0 is



(a) $|V_m \sin(\omega t)|$ (b) $-2\ V_m$

(c) $-|V_m \sin(\omega t)|$ (d) $2\ V_m$

371. (d)

$\because$ It is a voltage doubler circuit.

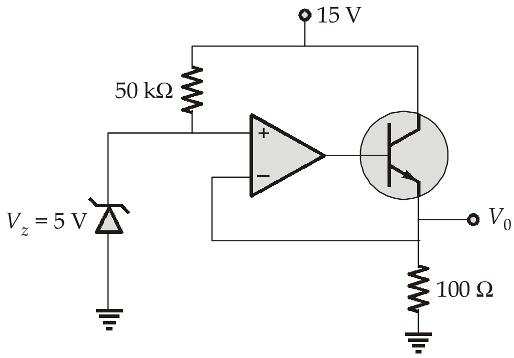
Q.372 Which of the following statements is **not** correct?

(a) MOSFETs have lower power dissipation than BJTs.
(b) MOSFETs requires lower area for the process of fabrication than BJTs.
(c) MOSFETs are less noise than BJTs.
(d) MOSFETs can drive a larger current than BJTs due to presence of majority carriers only.

372. (d)

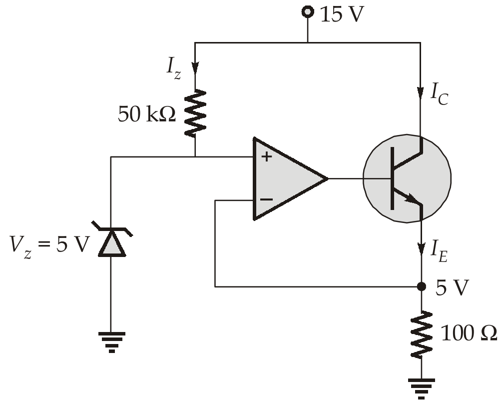
BJTs can supply more current than MOSFETs because the channel formed in the MOS is smaller than the channel in BJTs.

Q.373 If the op-amp in the circuit shown below is considered as an ideal op-amp then the value of current supplied by the 15 V battery is
(Assuming β of the transistor to be very large)



(a) 50.2 mA (b) 15 mA
(c) 0.5 mA (d) 65.2 mA

373. (a)



$$V_0 = 5\text{ V}$$

$$\therefore \quad I_E \approx I_C = \frac{5}{100} = 50\text{ mA}$$

$$I_Z = \frac{15-5}{50\text{ k}\Omega} = 0.2\text{ mA} \qquad \text{[Since, } \beta \text{ is very large]}$$

$$\therefore \quad I_{net} = 50 + 0.2 = 50.2\text{ mA}$$

Q.374 Diffusion potential across a p-n junction

(a) Decreases with increase in doping concentration

(b) Increases with decrease in band gap

(c) Does not depend on doping

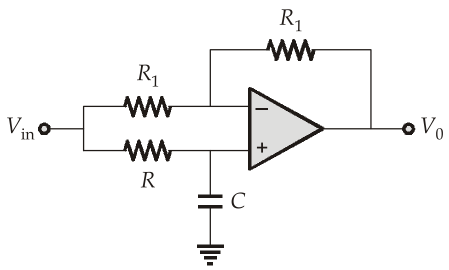
(d) Increase with increase in doping

374. (d)

$$V_j = V_T \ln\left(\frac{N_A N_D}{n_i^2}\right)$$

$\therefore$ V_j increases if N_A or N_D increases.

Q.375 In the figure shown below,



the maximum phase shift possible in output of the circuit is

(a) 60°

(b) 90°

(c) 180°

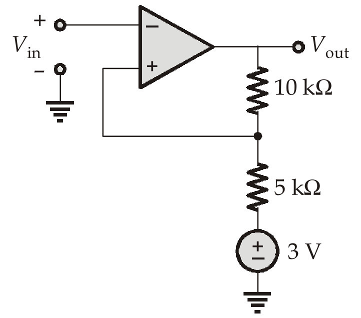
(d) 200°

375. (c)

The system represents an all pass filter thus the transfer function will be $T.F. = \frac{1-\tau s}{1+\tau s}$ thus

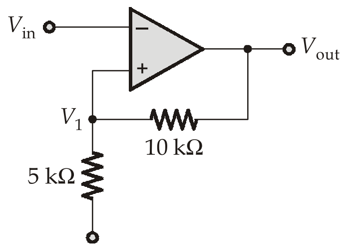
$$\text{Maximum phase shift} = -2\tan^{-1}(\omega\tau) = 2 \times 90^\circ = 180^\circ$$

Q.376 For the operational amplifier circuit shown, the output saturation voltage are ±15 V. The upper and lower threshold voltages for the circuit are respectively,



(a) +5 V and –5 V
(b) +7 V and –3 V
(c) +3V and –7 V
(d) +3 V and –3 V

376. (b)

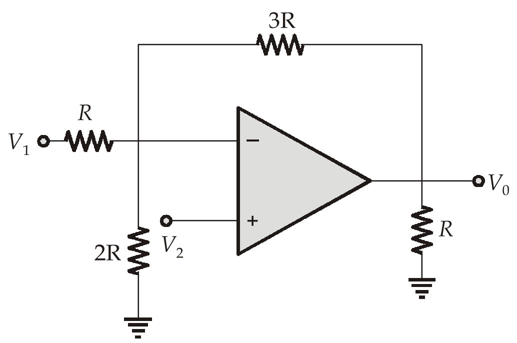


$$V_1 = \frac{3\times 10 + V_0 \times 5}{15} = \frac{6+V_0}{3}$$

$$V_{UT} = \frac{6+15}{3} = 7\text{ V}$$

$$V_{LT} = \frac{6-15}{3} = -3\text{ V}$$

Q.377 Assuming that the op-amp in the circuit shown is ideal,



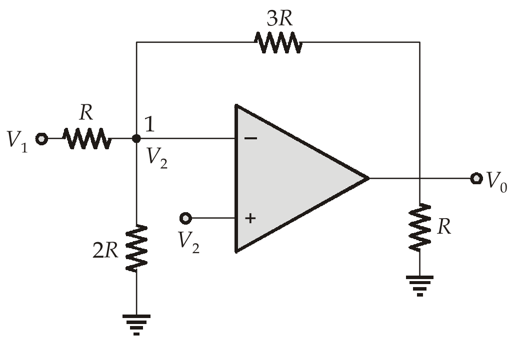
The output voltage V_0 is

(a) $\frac{5}{2}V_1 - 3V_2$
(b) $2V_1 - \frac{5}{2}V_2$
(c) $\frac{-3}{2}V_1 + \frac{7}{2}V_2$
(d) $-3V_1 + \frac{11}{2}V_2$

377. (d)

By applying KCL at node 1 we get,

$$\frac{V_2 - V_1}{R} + \frac{V_2}{2R} + \frac{V_2 - V_0}{3R} = 0$$



$$\frac{6V_2 - 6V_1 + 3V_2 + 2V_2 - 2V_0}{6R} = 0$$

$$11\ V_2 - 6V_1 - 2V_0 = 0$$

$$2V_0 = -6V_1 + 11\ V_2$$

$$V_0 = -3V_1 + \frac{11}{2}V_2$$

Q.378 To obtain very high input and output impedance in a feedback amplifier, the mostly used is

(a) Voltage-Series
(b) Current-Series
(c) Voltage-Shunt
(d) Current-Shunt

378. (b)

Current-Series feedback amplifier has very high input and very high output impedances.

Q.379 A small signal voltage amplifier in common emitter configuration was working satisfactorily. Suddenly its emitter-bypass capacitor (C_E) got disconnected, then its:

1. Voltage gain will decrease.
2. Voltage gain will increase.
3. Bandwidth will decrease.
4. Bandwidth will increase.

Which of the above statements are correct?

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

379. (a)

If the bypass capacitor is disconnected, then due to negative feedback, voltage gain will decrease and the BW will increase.

Q.380 Consider the following statements:

1. A current mirror can be used as an active load because it has low output AC resistance.
2. The gain of practical op-amp at high frequencies is less as compared to that of at medium frequencies.
3. In self bias circuit for CE amplifier, the base voltage is equal to supply voltage.

Which of the above statements are incorrect?

(a) 1 and 2
(b) 2 and 3
(c) 1 and 3
(d) None of these

380. (c)

Current mirror has high output AC resistance.

Practical op-amp behaves as low pass filter.

In self bias circuit, base voltage is less than the supply voltage.

Q.381 Consider the following statements regarding JFET:

1. The input impedance is low compared to BJT.
2. The internal noise is less because it is a unipolar device.
3. FET is not thermally stable when compared with BJT.

Which of the above statement(s) is/are correct?

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

381. (b)

- The input impedance is high because the input is always reverse biased.
- FET is thermally stable.

Q.382 Consider the following statements regarding oscillators:

1. The factors such as temperature and gain causes the drift of the oscillator frequency.
2. The ratio of change in phase to change in frequency $\left(\frac{d\phi}{d\omega}\right)$ decides the frequency stability of the oscillator.
3. Low value of $\left(\frac{d\phi}{d\omega}\right)$ indicates high frequency stability.

Which of the above statement(s) is/are correct?

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

382. (d)

High value of $\left(\frac{d\phi}{d\omega}\right)$ indicates high frequency stability.

Q.383 The solution to the system of equations is

$$\begin{bmatrix} 3 & 7.5 \\ -6 & 4.5 \end{bmatrix}\begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 6 \\ -90 \end{bmatrix}$$

(a) 12, –4
(b) –12, –4
(c) –12, 4
(d) 12, 4

383. (a)

$$\begin{bmatrix} 3 & 7.5 \\ -6 & 4.5 \end{bmatrix}\begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 6 \\ -90 \end{bmatrix}$$

$$\begin{bmatrix} 3 & 7.5 & 6 \\ -6 & 4.5 & -90 \end{bmatrix}$$

$R_2 \leftarrow R_2 + 2R_1$

$$\begin{bmatrix} 3 & 7.5 & 6 \\ 0 & 19.5 & -78 \end{bmatrix}$$

$$19.5y = -78$$

or $$y = -4$$

$$3x + 7.5y = 6$$

$$3x + 7.5(-4) = 6$$

$$3x = 36$$

$\Rightarrow$ $$x = 12$$

$\therefore$ $$\begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 12 \\ -4 \end{bmatrix}$$

Q.384 $\lim\limits_{x\to 0} \dfrac{\ln(1+5x)}{e^{7x}-1}$ is equal to

(a) 0

(b) $\dfrac{5}{7}$

(c) $\dfrac{3}{10}$

(d) 1

384. (b)

$$\lim_{x\to 0} \frac{\ln(1+5x)}{e^{7x}-1} \qquad \left(\frac{0}{0} \text{ indetermine form}\right)$$

Applying L' Hospitals rule

$$\lim_{x\to 0} \frac{\ln(1+5x)}{e^{7x}-1} = \lim_{x\to 0} \frac{5}{(1+5x)7e^{7x}} = \frac{5}{7}$$

Q.385 A bag contains 15 defective items and 35 non defective items. If three items are selected at random without replacement, what will be the probability that all three items are defective?

(a) $\dfrac{1}{40}$

(b) $\dfrac{13}{560}$

(c) $\dfrac{15}{34}$

(d) $\dfrac{12}{499}$

385. **(b)**

Probability of first item being defective,

$$P_1 = \frac{15}{50}$$

Probability of second item being defective,

$$P_2 = \frac{14}{49}$$

Probability of third item being defective,

$$P_3 = \frac{13}{48}$$

Probability that all three are defective,

$$P = P_1 P_2 P_3 = \frac{15}{50} \times \frac{14}{49} \times \frac{13}{48} = \frac{13}{560}$$

Q.386 One of the eigen vectors of matrix $\begin{bmatrix} 4 & 6 \\ 2 & 8 \end{bmatrix}$ is

(a) $\begin{bmatrix} -1 \\ 1 \end{bmatrix}$

(b) $\begin{bmatrix} 3 \\ 1 \end{bmatrix}$

(c) $\begin{bmatrix} 1 \\ 1 \end{bmatrix}$

(d) $\begin{bmatrix} 1 \\ 3 \end{bmatrix}$

386. **(c)**

The characteristic equation $[A - \lambda I] = 0$

i.e. $$\begin{bmatrix} 4-\lambda & 6 \\ 2 & 8-\lambda \end{bmatrix} = 0$$

or $$(4 - \lambda)(8 - \lambda) - 12 = 0$$

or $$32 - 8\lambda - 4\lambda + \lambda^2 - 12 = 0$$

$\Rightarrow$ $$\lambda^2 - 12\lambda + 20 = 0$$

$\Rightarrow$ $$\lambda^2 - 10\lambda - 2\lambda + 20 = 0$$

$\Rightarrow$ $$(\lambda - 10)(\lambda - 2) = 0$$

$\Rightarrow$ $$\lambda = 10, 2$$

Corresponding to $\lambda = 10$, we have

$$[A - \lambda I]x = \begin{bmatrix} -6 & 6 \\ 2 & -2 \end{bmatrix}\begin{bmatrix} x \\ y \end{bmatrix}$$

Which gives, $$-6x + 6y = 0$$

$\Rightarrow$ $$x = y$$

$$2x - 2y = 0$$

$\Rightarrow$ $$x = y$$

i.e. eigen vector $\begin{bmatrix}1\\1\end{bmatrix}$

Corresponding to $\lambda = 2$, we have

$$[A - \lambda I]x = \begin{bmatrix}2 & 6\\2 & 6\end{bmatrix}\begin{bmatrix}x\\y\end{bmatrix}$$

Which gives, $2x + 6y = 0$ i.e. eigen vector $\begin{bmatrix}-3\\1\end{bmatrix}$

Q.387 If $x = b(2 - \cos\theta)$ and $y = b(\sin\theta + \theta)$, then $\frac{dx}{dy}$ will be equal to

(a) $\tan\left(\frac{\theta}{2}\right)$

(b) $\cot\left(\frac{\theta}{2}\right)$

(c) $\sin\left(\frac{\theta}{2}\right)$

(d) $\cos\left(\frac{\theta}{2}\right)$

387. (a)

Given, $x = b(2 - \cos\theta)$, $y = b(\sin\theta + \theta)$

$$\therefore \quad \frac{dx}{d\theta} = b\sin\theta,$$

$$\frac{dy}{d\theta} = b(\cos\theta + 1)$$

$$\frac{dx}{dy} = \frac{dx/d\theta}{dy/d\theta} = \frac{b\sin\theta}{b(\cos\theta + 1)}$$

$$= \frac{2b\sin\left(\frac{\theta}{2}\right).\cos\left(\frac{\theta}{2}\right)}{b \times 2\cos^2\left(\frac{\theta}{2}\right)} = \tan\left(\frac{\theta}{2}\right)$$

Q.388 Four cards were drawn from a pack of 52 cards. The probability that they are a king, a queen, a jack and an ace.

(a) $\frac{512}{54145}$

(b) $\frac{64}{54145}$

(c) $\frac{256}{270725}$

(d) $\frac{64}{270725}$

388. (c)

$$\frac{4C_1 \cdot 4C_1 \cdot 4C_1 \cdot 4C_1}{52C_4} = \frac{4 \times 4 \times 4 \times 4}{(52 \times 51 \times 50 \times 49)/(4 \times 3 \times 2 \times 1)}$$

$$= \frac{4 \times 4 \times 4 \times 4 \times 3 \times 2}{52 \times 51 \times 50 \times 49} = \frac{256}{270725}$$

Q.389 For a given matrix $M = \begin{bmatrix} 12+9i & -i \\ i & 12-9i \end{bmatrix}$ where $i = \sqrt{-1}$, the inverse of matrix M is

(a) $\frac{1}{225}\begin{bmatrix} 12+9i & -i \\ i & 12-9i \end{bmatrix}$

(b) $\frac{1}{225}\begin{bmatrix} i & 12-9i \\ 12+9i & -i \end{bmatrix}$

(c) $\frac{1}{224}\begin{bmatrix} 12-9i & i \\ -i & 12+9i \end{bmatrix}$

(d) $\frac{1}{224}\begin{bmatrix} 12+9i & -i \\ i & 12-9i \end{bmatrix}$

389. (c)

Given matrix is $M = \begin{bmatrix} 12+9i & -i \\ i & 12-9i \end{bmatrix}$

$$\text{Determinant of } M = \begin{vmatrix} 12+9i & -i \\ i & 12-9i \end{vmatrix} = (12+9i)(12-9i) + i^2$$

$$= (12^2 - 9^2 i^2) + i^2$$

$$= 225 - 1$$

$$= 224$$

$\therefore$ Inverse of $M = M^{-1} = \frac{1}{|M|}(adj M)$

$$= \frac{1}{224}\begin{bmatrix} 12-9i & i \\ -i & 12+9i \end{bmatrix}$$

Q.390 At the point $x = 2$, the function

$$f(x) = \begin{cases} x^3 - 8 & 2 < x < \infty \\ x - 2 & -\infty < x \le 2 \end{cases} \text{ is}$$

(a) continuous and differentiable
(b) continuous and not differentiable
(c) discontinuous and differentiable
(d) discontinuous and not differentiable

390. (b)

$$\lim_{x \to 2^-} f(x) = \lim_{x \to 2^-} (x-2) = 0$$

$$\lim_{x \to 2^+} f(x) = \lim_{x \to 2^+} (x^3 - 8) = 0$$

Also $f(2) = 0$

Thus $\lim_{x \to 2^-} f(x) = \lim_{x \to 2^+} f(x) = f(2)$

$\therefore$ f is continuous at $x = 2$

and $Lf'(2) = 1$ and $Rf'(2) = 12$

$\therefore$ f is not differentiable at $x = 2$.

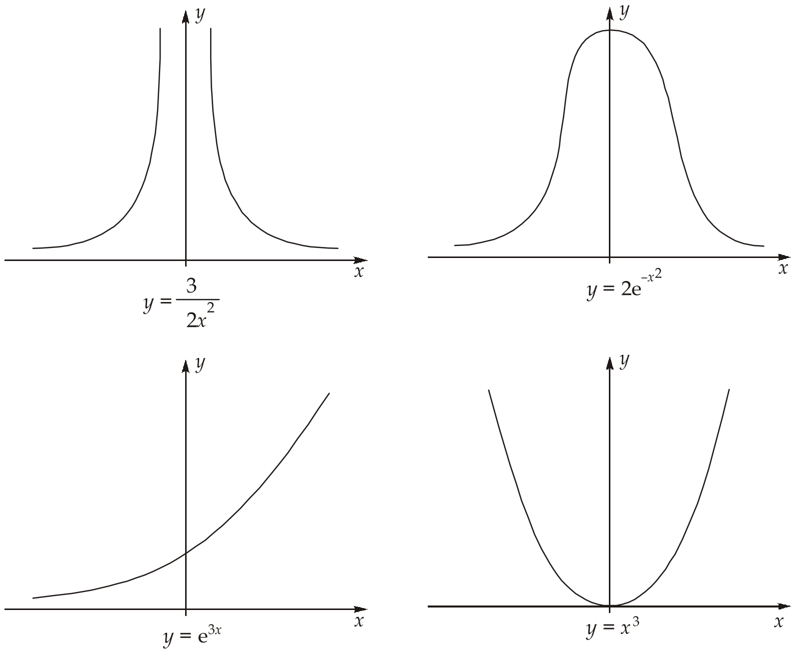
Q.391 Which one of the following functions is strictly bounded?

(a) $\dfrac{3}{2x^2}$ (b) $2e^{-x^2}$

(c) e^{3x} (d) x^3

391. (b)

From the graphs below, we can see that only $2e^{-x^2}$ is strictly bounded.



Q.392 Given that the determinant of the matrix $\begin{bmatrix} 2 & 6 & 0 \\ 4 & 12 & 8 \\ -2 & 0 & 4 \end{bmatrix}$ is –96, the determinant of the matrix $\begin{bmatrix} 4 & 12 & 0 \\ 8 & 24 & 16 \\ -4 & 0 & 8 \end{bmatrix}$ is

(a) – 192 (b) 384

(c) – 384 (d) – 768

392. (d)

$$D = -96 \text{ for the given matrix}$$

$$|A| = \begin{vmatrix} 4 & 12 & 0 \\ 8 & 24 & 16 \\ -4 & 0 & 8 \end{vmatrix} = 2^3 \begin{vmatrix} 2 & 6 & 0 \\ 4 & 12 & 8 \\ -2 & 0 & 4 \end{vmatrix}$$

(Taking 2 common from each row)

$\therefore$ $\text{Det}(A) = (2)^3 \times D$

$= 8 \times (-96) = -768$

Q.393 The value of $\lim_{x \to 4} \frac{(2x)^{1/3} - 2}{2x - 8}$ is

(a) $\frac{1}{3}$
(b) $\frac{1}{6}$
(c) $\frac{1}{24}$
(d) $\frac{1}{12}$

393. (d)

$$2x - 8 = 2h \quad \text{(say)}$$
$$\Rightarrow \quad 2x = 8 + 2h$$
$$\Rightarrow \quad x = 4 + h$$

$$\therefore \quad \lim_{h \to 0} \frac{(8+2h)^{1/3} - 2}{2h}$$

Above form is $\left(\frac{0}{0}\right)$ by putting the value $h = 0$

Applying L' Hospital rule $\lim_{h \to 0} \frac{\frac{1}{3}(8+2h)^{\left(\frac{1}{3}-1\right)} \times 2}{2}$

$$= \frac{1}{3}(8)^{-2/3} = \frac{1}{12}$$

Q.394 The modulus of the complex number $\left(\frac{6+8i}{1-2i}\right)$ is

(a) $2\sqrt{5}$
(b) $\sqrt{5}$
(c) $\frac{\sqrt{5}}{2}$
(d) $\frac{2}{\sqrt{5}}$

394. (a)

$$z = \frac{6+8i}{1-2i} = \frac{(6+8i)(1+2i)}{(1-2i)(1+2i)}$$
$$= \frac{-10+20i}{5} = -2 + 4i$$
$$|z| = \sqrt{(-2)^2 + (4)^2} = 2\sqrt{5}$$

Q.395 A continuous random variable X has a probability density function $f(x) = e^{-2x}$, $0 < x < \infty$. Then $P[X > 1]$ is

(a) 0.270
(b) 0.067
(c) 0.034
(d) 0.135

395. (b)

$$P[X > 1] = \int_1^\infty f(x)\,dx = \int_1^\infty e^{-2x}\,dx = \left.\frac{-e^{-2x}}{2}\right|_1^\infty$$

$$= -\left(\frac{e^{-2\infty}}{2} - \frac{e^{-2}}{2}\right) = \frac{e^{-2}}{2} = 0.067$$

Q.396 The differential equation $\frac{dy}{dx} = 0.75\,y^2$ is to be solved using the backward (implicit) Euler's method with the boundary condition $y = 1$ at $x = 0$ and with a step size of 1. What would be the value of y at $x = 1$?

(a) $\frac{3}{2}(\sqrt{2} \pm i)$ (b) $\frac{3}{2}(1 \pm \sqrt{2})$

(c) $\frac{2}{3}(1 \pm i\sqrt{2})$ (d) $\frac{3}{2}(2 \pm i)$

396. (c)

$$\frac{dy}{dx} = 0.75y^2 \qquad (y = 1 \text{ at } x = 0)$$

Iterative equation by backward (implicit) Euler's method for above equation would be

$$y_{k+1} = y_k + h_f(x_{k+1}, y_{k+1})$$

$$y_{k+1} = y_k + h \times 0.75\, y^2_{k+1}$$

$$\Rightarrow \quad 0.75\, hy^2_{k+1} - y_{k+1} + y_k = 0$$

Putting $k = 0$ in above equation

$$0.75hy_1^2 - y_1 + y_0 = 0$$

Since $y_0 = 1$ and $h = 1$

$$0.75y_1^2 - y_1 + 1 = 0$$

$$\Rightarrow \quad y_1 = \frac{1 \pm \sqrt{1^2 - 3}}{2 \times 0.75} = \frac{2}{3}(1 \pm i\sqrt{2})$$

Q.397 The inverse Laplace transform of $\frac{1}{(s^2 + s)}$ is

(a) $e^{-t} + 1$ (b) $e^{-t} - 1$

(c) $1 - e^{t}$ (d) $1 - e^{-t}$

397. (d)

$$\frac{1}{(s^2+s)} = \frac{1}{s(s+1)} = \frac{1}{s} - \frac{1}{s+1}$$

$$L^{-1}\left(\frac{1}{s^2+s}\right) = L^{-1}\left(\frac{1}{s}\right) - \left[L^{-1}\left(\frac{1}{s+1}\right)\right]$$

$$= 1 - e^{-t} \qquad \text{(Using standard formulae)}$$

Q.398 Find the Laplace transform of $t^2\, u(t-2)$

(a) $e^{-2s}\left[\frac{2}{s^3}+\frac{4}{s^2}+\frac{4}{s}\right]$

(b) $e^{-2s}\left[\frac{4}{s^3}+\frac{2}{s^2}+\frac{4}{s}\right]$

(c) $e^{-2s}\left[\frac{2}{s^3}+\frac{2}{s^2}+\frac{2}{s}\right]$

(d) $2e^{-2s}\left[\frac{1}{s^3}+\frac{2}{s^2}+\frac{1}{s}\right]$

398. (a)

$$t^2u(t-2) = [(t-2)^2 + 4(t-2) + 4]u(t-2)$$

$$= (t-2)^2\, u(t-2) + 4(t-2)u(t-2) + 4u(t-2)$$

$$L[t^2u(t-2)] = L[(t-2)^2\, u(t-2)] + L[4(t-2)u(t-2)] + L[4u(t-2)]$$

$$\Rightarrow e^{-2s}\left[\frac{2}{s^3}+\frac{4}{s^2}+\frac{4}{s}\right]$$

Q.399 If A is 3 × 3 matrix and Trace $A = 9$, $|A| = 24$ and one of the eigen values is 3, then sum of other eigen values is ________.

(a) 5

(b) 8

(c) 6

(d) 9

399. (c)

Given,

$$\text{Trace } A = 9$$

$$|A| = 24$$

$$\lambda_1 = 3$$

$$\lambda_1 + \lambda_2 + \lambda_3 = 9$$

$$\Rightarrow \quad 3 + \lambda_2 + \lambda_3 = 9$$

$$\Rightarrow \quad \lambda_2 + \lambda_3 = 6$$

Q.400 A second degree polynomial $f(x)$ has values of 1, 4 and 15 at $x = 0$, 1 and 2 respectively. If the integral $\int_0^2 f(x)dx$ is to be estimated by applying the trapezoidal rule to this data, then select the correct statements:

1. $\int_0^2 f(x)dx = 10$

2. $f(x) = 4x^2 - x + 1$

3. Error $= \frac{4}{3}$

4. Error $= \frac{-4}{3}$

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

400. (d)

$$f(0) = 1$$
$$f(1) = 4$$
and $$f(2) = 15$$

$$\int_0^2 f(x)dx = \frac{h}{2}(f_1 + 2f_2 + f_3) = \frac{1}{2}(1 + 2 \times 4 + 15) = 12$$

Also, $$f(x) = 4x^2 - x + 1$$

$$\int_0^2 f(x)dx = \int_0^2 (4x^2 - x + 1)dx$$

$$= \left(\frac{4x^3}{3} - \frac{x^2}{2} + x\right)_0^2 = \left(\frac{32}{3} - 2 + 2\right) = \frac{32}{3}$$

$$\text{Error} = \text{Exact} - \text{Approximate}$$

$$= \frac{32}{3} - 12 = \frac{-4}{3}$$

Q.401 The type of partial differential equation,

$$\frac{\partial^2 P}{\partial x^2} + \frac{\partial^2 P}{\partial y^2} + \frac{3\partial^2 P}{\partial x \partial y} + \frac{2\partial P}{\partial x} - \frac{\partial P}{\partial y} = 0 \text{ is}$$

(a) elliptic
(b) parabolic
(c) hyperbolic
(d) circular

401. (c)

Comparing the given equation with general form of second order partial differential equation

$$\frac{A\partial^2 P}{\partial x^2} + \frac{B\partial^2 P}{\partial y \partial x} + \frac{C\partial^2 P}{\partial y^2} + \frac{D\partial P}{\partial x} + \frac{E\partial P}{\partial y} + FP = g(x, y)$$

$$A = 1$$
$$B = 3$$
$$C = 1$$

$\Rightarrow$ $$B^2 - 4A\,C = 5 > 0$$

$\therefore$ PDE is hyperbolic.

Q.402 Value of $\frac{1}{7}$ is calculated using Newton-Raphson method, starting with $x = 0.2$; then the first two iterations will be

(a) 0.11, 0.1299
(b) 0.12, 0.1392
(c) 0.12, 0.1416
(d) 0.13, 0.1428

402. (b)

Let, $x = \frac{1}{7}$

$$\frac{1}{x} = 7$$

$$\frac{1}{x} - 7 = 0$$

$$f(x) = \frac{1}{x} - 7$$

$$f'(x) = \frac{-1}{x^2}$$

$$x_{k+1} = x_k - \frac{f(x_k)}{f'(x_k)} = x_k - \frac{\frac{1}{x_k} - 7}{\frac{-1}{x_k^2}} = x_k + (1 - 7x_k)x_k$$

$$x_{k+1} = 2x_k - 7x_k^2$$

Given initial value, $x_0 = 0.2$

$$x_1 = 2(0.2) - 7(0.2)^2 = 0.12$$

$$x_2 = 2(0.12) - 7(0.12)^2 = 0.1392$$

Q.403 Consider the sequence of instructions executed by an 8085 microprocessor.

1000 LXI SP, 37FD
1003 CALL, 1086
1006 POP, H

What are the contents of the stack pointer (SP) and the HL register pair on completion of execution of these instruction?

(a) SP = 37 FD, HL = 1083
(b) SP = 37 FB, HL = 1006
(c) SP = 37 FD, HL = 1006
(d) SP = 37 FB, HL = 1086

403. (c)

1000 LXI SP, 37FD, SP = 37FD

1003 CALL 1086

Stack stores the address of next instruction i.e. 1006 and stack pointer is decrement by two.

$SP \rightarrow$ 37 FB.

1006 POP H

HL $\rightarrow$ 1006

Stack pointer is again increment by two

SP $\rightarrow$ 37 FD

Q.404 Consider the following statements for 8085.

1. Higher order address bus is tri-stated during hold mode.
2. Lower order address bus is tri-stated during hold mode.
3. Higher order address bus is tri-stated during halt mode.
4. Lower order address bus is tri-stated during halt mode.

Which of the above statements are correct?

(a) 1 and 2 only
(b) 1 and 3 only
(c) 2 and 4 only
(d) All of these

404. (d)

Q.405 Consider the following sequence of instructions.

```
LXI H,   XX65H
MVI M,   FFH
INR M
HLT
```

What are the contents of zero flag (Z) and carry flag (CY) after the execution of instructions?

(a) $Z = 0, CY = 1$
(b) $Z = 1, CY = 0$
(c) $Z = 1, CY = 1$
(d) $Z = 1, CY =$ Unknown

405. (d)

LXI H, XX 65H

Flag resister value unknown

MVI M, FFH

INR M

Value of M is 00H

$\Rightarrow \quad Z = 1$

INR does not affect the carry flag.

Q.406 Execution of RSTn instruction causes the stack pointer be

(a) increment by two
(b) decrement by two
(c) remain unaffected
(d) none of these

406. (b)

RST instruction is equivalent to a one-byte call instruction.

Q.407 Which one of the following statement corresponding to execution of RIM instructions is **not** correct?

(a) It checks the status of all the interrupt.
(b) Content of SID pin is copied to MSB of accumulator.
(c) It is used to check the pending interrupt.
(d) It can handle interrupts and serial I/O.

407. (a)

It does not provide the status of the TRAP and INTR interrupt.

Direction (Q.408 to Q.410): The following items consists of two statements, one labelled as **Statement (I)** and the other labelled as **Statement (II)**. You have to examine these two statements carefully and select your answers to these items using the codes given below:

Codes:

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

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

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

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

Q.408 Statement (I): Operational amplifiers should have a high slew rate for good transient response.

Statement (II): Slew rate is the maximum rate of change of the output voltage of the operational amplifier when a large amplitude step is applied to its input.

408. (c)

Q.409 Statement (I): The bias stability of a self bias amplifier circuit can be improved by increasing the values of both the base resistor (R_B) and the emitter resistor (R_E).

Statement (II): The base resistor (R_B) provides the required voltage to the base terminal and the emitter resistor (R_E) provides negative feedback to the amplifier.

409. (d)

Bias stability of a self bias circuit can be improved by increasing the value of emitter resistor (R_E) only.

Q.410 Statement (I): Handshake signals are exchanged prior to data transfer between the fast responding microprocessor unit and slow-responding peripherals.

Statement (II): Micro processor unit and peripherals operate at different speed.

410. (a)

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