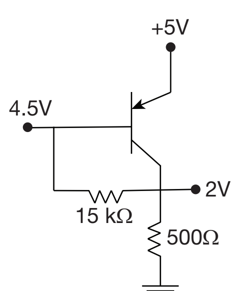
Analog Circuits Test 2

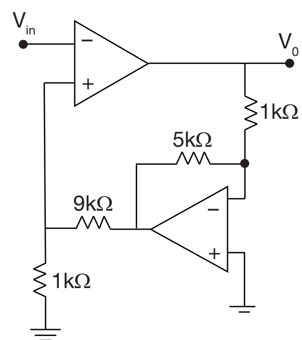
Number of Questions: 35 **Time: 90 min.**

Directions for questions 1 to 35: Select the correct alternative from the given choices.

1. The purpose of resistance in the emitter circuit of a transistor amplifier is to
   (A) provide base – emitter bias
   (B) limit the maximum emitter current
   (C) is sensitive to changes in β
   (D) limit the change in I_E.
2. The purpose of emitter capacitor across R_E is to
   (A) reduce noise in the amplifier
   (B) protect the transistor
   (C) avoid voltage gain drop
   (D) provide biasing
3. What is the effect of cascading the amplifier stages?
   (1) Increases voltage gain
   (2) Increases current gain
   (3) Decreases the bandwidth
   (4) Increases the bandwidth
   (A) (1), (2) and (3) (B) (1), (2) and (4)
   (C) (2) and (3) only (D) (1) and (3) only
4. What are the effects of cascode amplifier stages?
   (1) Low input impedance
   (2) High input impedance
   (3) Wideband amplifier
   (4) Narrow band amplifier
   (A) (1) and (3) only (B) (2) and (3) only
   (C) (1) and (4) only (D) (2) and (4) only
5. When a transistor is used in switching mode then what is the turn – on time?
   (A) Sum of delay time and rise time
   (B) Sum of rise time and fall time
   (C) Sum of delay time and storage time
   (D) Sum of rise time and storage time
6. A Bipolar junction transistor works in three regions.
   (1) Cut – off (2) Active
   (3) Saturation
   If BJT is to be used in amplifier circuit, the region it works in is/are
   (A) (2) only (B) (1), (2) and (3)
   (C) (1) and (3) only (D) (2) and (3) only
7.

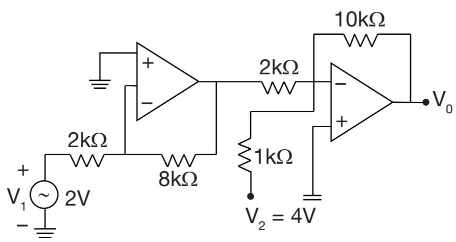


The value of β is
   (A) 24 (B) 25
   (C) 26 (D) 27
8. For the circuit shown in figure, the voltage gain $\left(\frac{V_0}{V_i}\right)$ is



   (A) $\frac{-1}{2}$ (B) 1
   (C) –2 (D) 4
9. Calculate the CMRR (In dB) for the circuit measurements of V_d = 1mV, V_0 = 100mV, and V_c = 0.5mV, V_0 = 20μV
   (A) –6 (B) 68
   (C) 74 (D) 80
10. Which one of the following oscillators is well suited for the generation of wide range audio – frequency waves?
   (A) Hartley oscillator
   (B) Wein – bridge oscillator
   (C) Colpitt's oscillator
   (D) Crystal oscillator
11. An amplifier has a d. c power supply of 15 V and draws a current of 12 mA. It produces an output of 8 V peak across load resistance of 500 Ω for a signal frequency of 2 KHz. What will be the it's a. c power output?
   (A) 64 mW
   (B) 0.256 W
   (C) 32 mW
   (D) 72 mW
12. An amplifier using BJT has two identical stages each having a lower cut – off frequency of 60 Hz due to coupling capacitor. Then the lower cut – off frequency of the overall amplifier is nearly.
   (A) 48.2 Hz
   (B) 38 Hz
   (C) 100 Hz
   (D) 93 Hz

13.



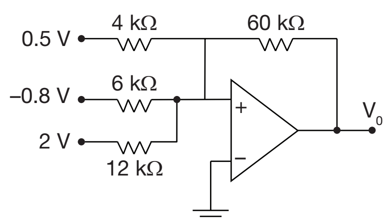
The resulting output V_0 is

(A) zero (B) –40 V
(C) –10 V (D) –8 V

14. The tuned collector oscillator circuit used in the local oscillator of a radio receiver makes use of an LC tuned circuit with L_1 = 50μH, and C_1 = 250pF. Then the frequency of oscillators is

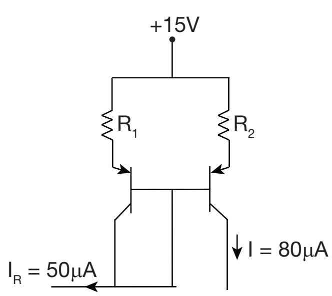
(A) 14.23 KHz (B) 1.423 MHz
(C) 284 MHz (D) 1.5 MHz

15. The output voltage V_0 is



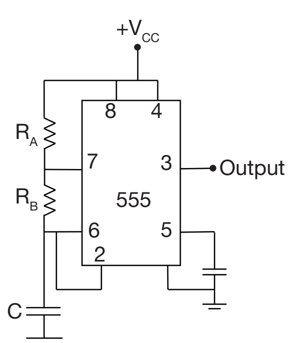
(A) 9.5 V (B) –8.23 V
(C) 12 V (D) –9.5 V

16. If V_{EB} = 0.7 V, and β = 100. Then the ratio of $\frac{R_2}{R_1}$ would be



(A) 1.6 (B) 1.2
(C) 0.5 (D) 0.625

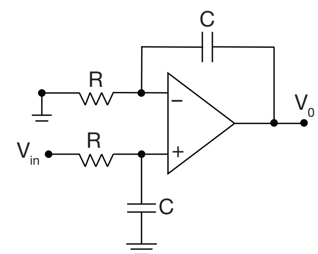
17.



If R_A = 4.5kΩ, R_B = 1.5kΩ and C = 1μF, then the output frequency of the 555timer would be

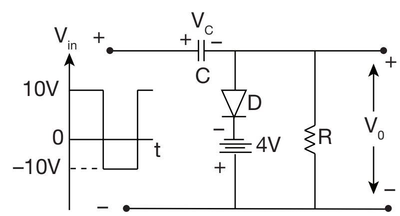
(A) 193.33 KHz
(B) 193.33 Hz
(C) 200 Hz
(D) 2 KHz

18. The op – amp circuit shown in the given figure is

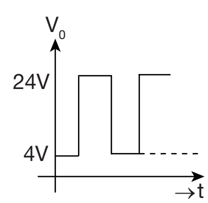


(A) a high pass circuit
(B) a band – pass circuit
(C) a low pass circuit
(D) an – all pass circuit

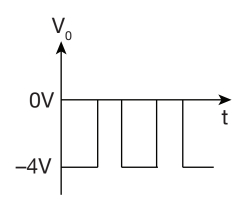
19. Determine V_0 for the network of figure shown below,



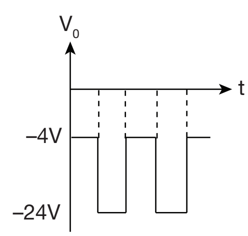
(A)



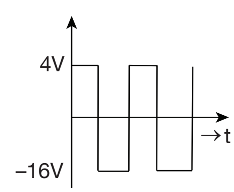
(B)



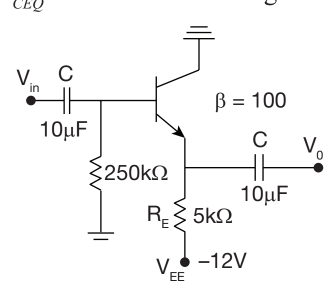
(C)



(D)

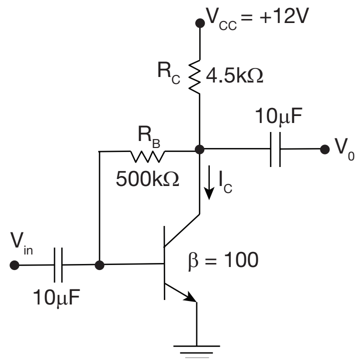


20. Determine V_{CEQ} for the network of figure.



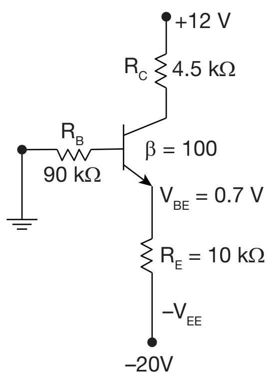
(A) 7.425 V (B) 3.75 V
(C) 4.425 V (D) 5.25 V

21.



The collector to Emitter voltage is ____________
(A) 6.623 V (B) 5.37 V
(C) 7.23 V (D) 4.8 V

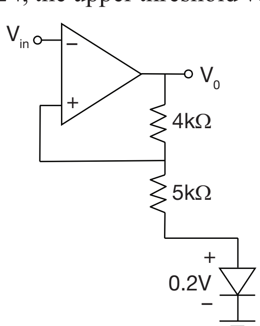
22. For the emitter bias circuit shown in the figure, find the operating point of the circuit?



(A) 12.5V, 1.5 mA (B) 6.335V, 1.77 mA
(C) 7.35V, 1.77 mA (D) 6.5V , 1.5 mA

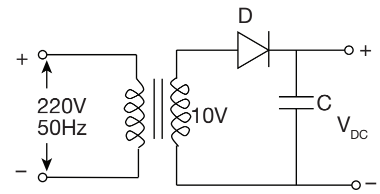
23. In a current amplifier, with A = 1000 and β = 0.25, the input resistance is 100Ω before negative feedback is applied. After negative feedback is applied it's input resistance will be
(A) 0.4Ω (B) 251Ω
(C) 150Ω (D) 100Ω

24. The Schmitt trigger circuit is shown in the below figure. If V_{sat} = ±12V, the upper threshold voltage would be



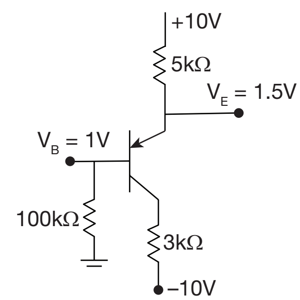
(A) 1.38 V (B) 1.02 V
(C) 13.8 V (D) –15 V

25. In the rectifier circuit shown in figure. The minimum peak – inverse – voltage (PIV) rating of the diode is



Consider diode D is ideal.
(A) 10 V (B) $20\sqrt{2}$ V
(C) $10\sqrt{2}$ V (D) 20V

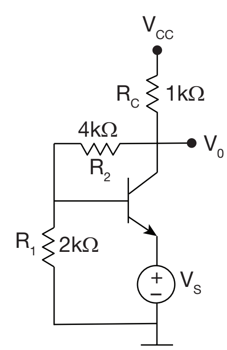
26. A circuit using the BJT is shown in the below figure, the value of β is, if the transistor is operating in the active region.



(A) 150 (B) 170
(C) 169 (D) 165

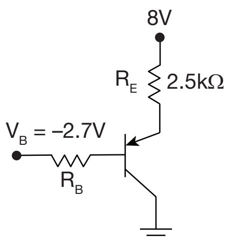
27. Calculate the ripple of a capacitor filter for a peak rectified voltage of 25V, with C = 30μF, and a load current of 40μA.
(A) 16.46% (B) 5.24%
(C) 11.63% (D) 32.92%

28. The type of feedback network and feedback factor for the amplifier shown below is



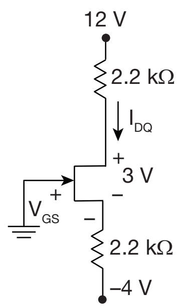
(A) Voltage series, β = 1/3
(B) Voltage shunt, β = 3
(C) Current shunt, β = 1/3
(D) Current series, β = 3

29. For the circuit shown below the value of R_B such that the quiescent voltage is 2.5 V, assume β = 75 and V_{BE} = 0.7 V



(A) 125 kΩ (B) 225 kΩ
(C) 155 kΩ (D) 93 kΩ

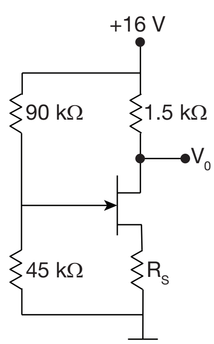
30.



The common – gate configuration has V_{DS} = 3 V and V_P = –5 V. Then the gate – to – source voltage V_{GS} is

(A) –6.5 V (B) 3.5 V
(C) 4.25 V (D) –2.5 V

31. The voltage – divider bias configuration shown in the below figure.

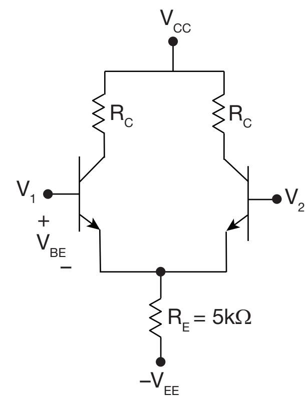


If V_D = 8V and V_{GSQ} = –4 V, then the value of R_S is

(A) 1.25kΩ (B) 1.75kΩ
(C) 1.5 kΩ (D) 2 kΩ

Common data for questions 32 and 33:

Differential amplifier shown in figure, uses a transistor with β = 125 and is biased at I_{CQ} = 80 µA.



32. Determine the value of R_C if $|A_{DM}|$ = 500.

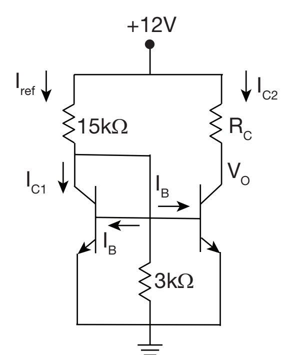
(A) 150 kΩ (B) 125 kΩ
(C) 200 kΩ (D) 160 kΩ

33. The common mode – rejection ratio (CMRR) of the differential amplifier is

(A) 32.25 (B) 32.25 dB
(C) 40 dB (D) 50

Statement for linked answer questions 34 and 35:

For the circuit shown in figure, consider V_{BE} = 0.7V; V_T = 26 mV and β = 125.



34. Determine the currents I_{C1} and I_{C2}

(A) I_{C1} = 0.511 mA; I_{C2} = 0.73 mA
(B) $I_{C1} = I_{C2}$ = 0.511 mA
(C) I_{C1} = 0.753 mA, I_{C2} = 0.511 mA
(D) $I_{C1} = I_{C2}$ = 0.753 mA

35. If V_0 = 8 V, then the value of collector resistance R_c would be

(A) 7.827 kΩ (B) 5.31 kΩ
(C) 7 kΩ (D) 4.32 kΩ

Answer Keys

1. D	**2.** C	**3.** D	**4.** B	**5.** A	**6.** A	**7.** A	**8.** C	**9.** B	**10.** B
11. A	**12.** D	**13.** A	**14.** B	**15.** D	**16.** D	**17.** B	**18.** C	**19.** C	**20.** C
21. A	**22.** B	**23.** A	**24.** A	**25.** B	**26.** C	**27.** A	**28.** A	**29.** C	**30.** D
31. B	**32.** D	**33.** A	**34.** B	**35.** A					

Hints and Explanations

1. Choice (D)

2. For *D. C* analysis R_E advantage it improves the stability. But *A. C* analysis R_E decrease the gain.

∴ Capacitor across R_E it eliminates the R_E effect

∴ Short circuit parallel to R_E Choice (C)

3. Effects of cascading amplifier is

(1) Voltage gain $A_v = A_{V1} \cdot A_{V2}$

∴ It is increases

(2) Current gain equal to unity

(3) BW decreases

∴ f_ℓ and $f_H \downarrow$ Choice (D)

4. (1) Cascode amplifier (CE – CB) gives the high input impedance

(2) It is providing high frequency performance of CB

(3) It is also used as wide band amplifier Choice (B)

5. $T_{on} = t_d + t_r$ Choice (A)

6. Choice (A)

7. From the given circuit

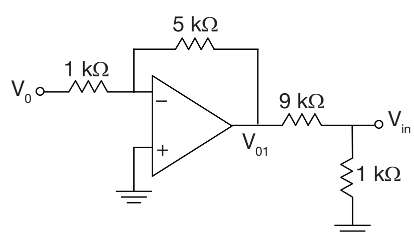
$$I_C = \frac{2}{500} = 4 \text{ mA}$$

$$I_B = \frac{4.5-2}{15} \text{ mA} = 0.1666 \text{ mA}$$

$$I_C = \beta\, I_B$$

$$\beta = \frac{I_C}{I_B} = 24$$ Choice (A)

8. Applying virtual GND concept and redrawing the given circuit.



$$V_{01} = \frac{-R_f}{R_1} . V_0$$

$$V_{01} = -5V_0$$

$$V_{in} = \frac{1K}{10K} \times V_{01}$$

$$V_{in} = \frac{-1}{2} V_0$$

$$\frac{V_0}{V_{in}} = -2$$ Choice (C)

9. From the given data

$V_d = 1\text{mV}$, $V_{od} = 100$ mV

$V_c = 0.5$ mV, $V_{oc} = 20\ \mu$V

But CMRR $= 20\log_{10} \frac{A_d}{A_c}$

We know $V_{od} = A_d \cdot V_d$

$$A_d = \frac{100mV}{1mV} = 100$$

$$A_c = \frac{V_\infty}{V_c} = \frac{20\times10^{-6}}{5\times10^{-4}}$$

$$A_c = 4 \times 10^{-2} = 0.04$$

$$\text{CMRR in dB} = 20\log\left\{\frac{100}{0.04}\right\} = 68 \text{ dB}$$ Choice (B)

10. Audio frequency oscillators (<20 KHz)

(1) RC – phase shift

(2) Wein bridge

RF oscillators (> 20 KHz)

(1) Colpitt's oscillator

(2) Crystal oscillator

(3) Hartly oscillator

(4) Clapp oscillator

……………..etc Choice (B)

11. $$P_{0a.c} = \frac{(V_0/\sqrt{2})^2}{R_L}$$

$$= \frac{V_0^2}{2R_L} = \frac{(8)^2}{2\times500} = 64 \text{ mW}$$ Choice (A)

12. We know $f_\ell^1 = \dfrac{f_\ell}{\sqrt{2^{1/n}-1}}$

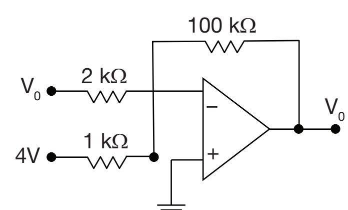
Where $n = 2$ and $f_1 = 60$Hz

$$f_\ell^1 = \frac{60}{\sqrt{2^{\frac{1}{2}-1}}} = 93.226\text{Hz}$$

$$f_\ell^1 \approx 93\text{Hz}$$

And $f^1_H = f_H . \sqrt{2^{\frac{1}{n}} - 1}$ Hz Choice (D)

13.



The o/p voltage of 1[st] stage is V_{01}

$$V_{01} = \frac{-8}{2}\times 2 = -8\text{volts}$$

Redrawing the given circuit

$V_0 = -5 \times (-8) - 10 \times 4 = 40 - 40 = 0$V

Choice (A)

14. Frequency of oscillation , $f = \dfrac{1}{2\pi\sqrt{L_1C_1}}$

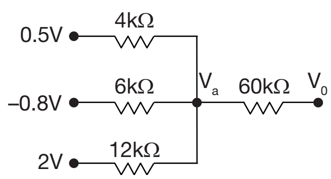
$$f = \frac{1}{2\pi\sqrt{50\times10^{-6}\times250\times10^{-12}}}$$

$$= \frac{1\times10^{+8}}{2\pi\sqrt{125}} = 1.426 \text{ MHz}$$ Choice (B)

15. Applying virtual GND concept

$V+ = V- = 0V$

$\therefore$ Redrawing given circuit



Applying *KCL* at node Va

$$\frac{V_a-0.5}{4K}+\frac{V_a+0.8}{6K}+\frac{V_a-2}{12K}+\frac{V_a-V_0}{60K}=0$$

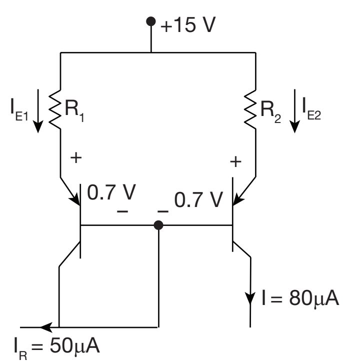
But $V_a = 0V$

$-0.5 \times 15 + 0.8 \times 10 - 2 \times 5 - V_0 = 0$

$-V_0 = +7.5 + 10 - 8 = 0$

$V_0 = -9.5$ V Choice (D)

16. Redrawing the given circuit



We know $I_E \approx I_C$

$$I_{E2} = I = \frac{15-0.7}{R_2}$$

$$R_2 = \frac{14.3}{80}\times10^6\,\Omega$$

$R_2 = 178.75$ KΩ

Applying *KVL* to the input loop

$I_{E1} = I_C + I_B$

$I_R \approx I_{E1}$

$$50\times10^{-6} = \frac{15-0.7}{R_1}$$

$R_1 = 286$ KΩ

$$\frac{R_2}{R_1} = 0.625$$ Choice (D)

17. Given circuit indicates an Astable multi vibrator

We know $T = t_{\text{high}} + t_{\text{low}}$

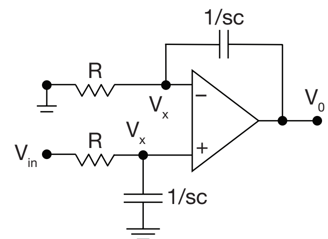
Both R_A and R_B are in charging path, but only R_B is In the discharge path.

$\therefore \quad T = 0.69\,(R_A + 2R_B)C$

$$\therefore \quad f = \frac{1}{T} = \frac{1.45}{(R_A+2R_B)C}$$

$$f = \frac{1.45}{(4.5+3)\times1\times10^{-3}} = 193.33 \text{ Hz}$$ Choice (B)

18.



$$V_x = \frac{1}{sC}\times\frac{V_{in}}{R+1/sC}$$

$$V_x = \frac{V_{in}}{1+sRC}$$

Apply virtcual GND concept

$V+ = V- = V_x$

$$\frac{V_x}{R}+\frac{V_x-V_0}{1/sC}=0$$

$$Vx\left[\frac{1}{R}+sC\right] = sCV_0$$

$$V_x[1+RCs] = sRCV_0$$

$$V_{in} = \text{sRCV}_0$$

$$\frac{V_0(s)}{V_{in}(s)} = \frac{1}{sRC}$$

The transfer function indicates LPF Choice (C)

19. For a +Ve cycle

Diode D $\rightarrow$ ON

$V_0 = -4$ Volts

Voltage across capacitor

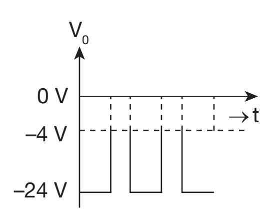
$10 - V_C + 4 = 0$

$V_C = 14$V

for a $- V_e$ cycle

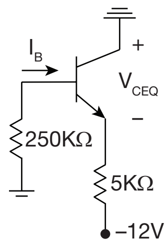
$D \rightarrow$ OFF

$\therefore \quad V_0 = -10 - 14 = -24$ V



Choice (C)

20. Redrawing the given circuit
for $D.C$ analysis $C \to$ Open circuit



$$I_B = \frac{12-0.7}{250+101\times 5} mA = 15\ \mu A$$

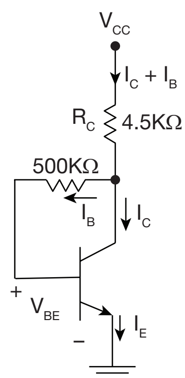
Applying KVL to O/P loop.

$-V_{CEQ} - I_E \cdot R_E + 12 = 0$

$V_{CEQ} = 12 - 101 \times 15 \times 10^{-6} \times 5 \times 10^3$

$= 4.425$ Volts Choice (C)

21. Redrawing given circuit



$$I_B = \frac{V_{CC} - V_{BE}}{R_B + (1+\beta)R_C}$$

$$= \frac{12-0.7}{500+454.5} \text{ mA}$$

$= 11.83\mu$A

$I_C = \beta \cdot I_B = 1.183$ mA

$V_{CE} = V_{CC} - (I_B + I_C) \cdot R_C$

$= 12 - 5.378$

$= 6.623$ Volts Choice (A)

22. We know $I_C \approx I_E$

$$\therefore \quad I_C = \frac{V_{EE} - V_{BE}}{R_E + R_B/\beta} = \frac{20-0.7}{10+0.9} \text{ mA}$$

$I_C = 1.77$ mA

Applying KVL to the output loop

$12 - 4.5 \times 1.77 - V_{CE} - 10 \times 1.77 + 20 = 0$

$V_{CE} = 6.335$ Volts

Q – Point $(V_{CE}, I_C) = (6.335\text{V}, 1.77 \text{ mA})$

Choice (B)

23. From the given data

$A = 1000$; $\beta = 0.25$

$R_i = 80\Omega$

$1 + A\beta = 1 + 1000 \times 0.25 = 251$

Current amplifier

$i/p \Rightarrow$ current source

$o/p \Rightarrow$ current source

i.e, it is a current shunt amplifier

$\therefore$ $R_i \Rightarrow$ decreases

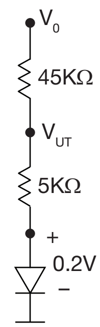
$R_0 \Rightarrow$ increases

$$\therefore \quad R_{if} = \frac{R_i}{1+A\beta} = \frac{100}{251} \approx 0.4\Omega$$ Choice (A)

24. Max. output $V_0 = \pm V_{sat} = \pm 12$V

If $V_{in} = V_{UT}$, redrawing the given circuit.

$V_+ = V_- = V_{UT}$



Applying nodal analysis at node V_{UT}

$$\frac{V_{UT} - V_0}{45K} + \frac{V_{UT} - 0.2}{5K} = 0$$

$V_{UT} - V_0 + 9V_{UT} - 1.8 = 0$

$10V_{UT} = V_0 + 1.8$

But $V_0 = +V_{sat} = +12$V

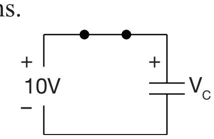
$V_{UT} = 1.38$ Volts Choice (A)

25. During +Ve half cycle

$D \to$ ON

$\therefore$ Voltage across capacitor

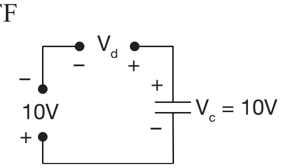
$V_C = 10$Vrms.



$\therefore$ $V_C = 10V_{rms}$.

During –Ve half cycle

$D \to$ OFF



PIV $= V_d = (10 + 10)V_{rms}$

$= 20\sqrt{2}$ volts. Choice (B)

26. $$I_E = \frac{V_{CC} - V_E}{R_E}$$

$$= \frac{10-1.5}{5} \text{ mA} = 1.7\text{mA}$$

$$I_B = \frac{V_B}{R_B} = \frac{1}{100} \text{ mA} = 0.01 \text{ mA}$$

But we know $I_E = I_B + I_C$

$I_E = (1 + \beta) . I_B$

$(1 + \beta) = \frac{I_E}{I_B}$ $I_E/I_B = 170$

$\beta = 169$ Choice (C)

27. We know $r = \frac{V_{r(rms)}}{V_{dc}} = \frac{2.4I_{dc}}{C.V_{dc}} \times 100\%$

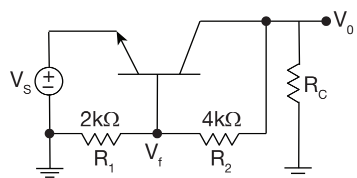
But $V_{dc} = V_m - 4.17\frac{I_{dc}}{C}$

$= 25 - 4.17 \times \frac{40 \times 10^{-6}}{30 \times 10^{-6}} = 19.44\text{volts}$

$r = \frac{2.4 \times 40 \times 10^{-6}}{30 \times 10^{-6} \times 19.44} \times 100\%$

$r = 16.46\%$ Choice (A)

28. Consider the given CB – amplifier with A. C equivalent



From the given circuit

i/p source voltage (Sereis) variable

o/p source voltage

∴ Voltage series feedback (or) voltage amplifier

$\beta = \frac{V_f}{V_0} = \frac{R_1}{R_1 + R_2} = \frac{2}{2+4} = 1/3$ Choice (A)

29. Given

$V_{ECQ} = 2.5V$

$I_E = \frac{8 - 2.5}{2.5}$ mA = 2.2 mA

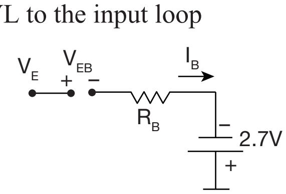
$I_E = I_B + I_C$

$I_E = I_B[1 + \beta]$

$I_B = 28.94\mu A$

Given $V_E = 2.5$ V

Applying KVL to the input loop



$V_E - V_{EB} - I_B R_B + 2.7 = 0$

$2.5 - 0.7 + 2.7 = I_B R_B$

$R_B \le \frac{4.5}{I_B} = 155.4545\ K\Omega$

$R_B = 155$ KΩ Choice (C)

30. Applying *KVL* to the output loop

$12 - 2.2K\Omega . I_D - V_{DS} - 2.2K\Omega . I_D + 4 = 0$

$16 - 3 = 4.4 \times 10^3 \times I_D$

$I_D = \frac{13}{44}$ mA = 2.9545mA

Applying KVL to the input loop

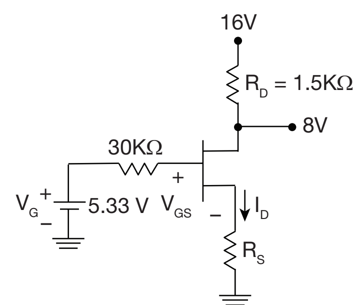
$-V_{GS} - 2.2K . I_D + 4 = 0$

$V_{GS} = 4 - 2.2 \times 2.9545 = -2.5$ V Choice (D)

31. $V_G = \frac{45}{90+45} \times 16 = 5.333$ V

$R_G = (45K \| 90K) = 30K\Omega$

Redrawing the given circuit



$I_D = \frac{16-8}{1.5}$ mA

$I_D = 5.333$mA

From the input loop

$V_{GS} = V_G - I_D . R_S$

$R_S = \frac{V_G - V_{GS}}{I_D} = \frac{9.333}{5.333}$ kΩ

$R_S = 1.75$ kΩ Choice (B)

32. Given $I_{CQ} = 80\mu A$

$g_m = \frac{I_{CQ}}{V_T} = \frac{80 \times 10^{-6}}{25.6 \times 10^{-3}} = 30125$ m℧

But $A_{DM} = -g_m . R_C$

$R_C = \frac{|A_{DM}|}{g_m} = \frac{500}{3.125}$KΩ

$R_C = 160$ KΩ Choice (D)

33. From the given data

$I_{CQ} = 80\ \mu A$

$V_T \approx 26$ mV

$g_m = \frac{I_{CQ}}{V_T} = 3.125$ m℧

$\text{CMRR} = \left|\frac{A_{DM}}{A_{CM}}\right| = 1 + 2g_m . R_E$

$= 1 + 2 \times 3.125 \times 10^{-3} \times 5 \times 10^3$

$= 1 + 31.25 = 32.25$ Choice (A)

34. From the given data

$\beta = 125$ and $V_{BE} = 0.7$ V

Applying KVL to the input loop

$V_{CC} - R_{C1} I_{ref} - V_{BE} = 0$

$$I_{ref} = \frac{V_{CC} - V_{BE}}{R_{C1}} = \frac{12 - 0.7}{15} \text{ mA} = 0.753 \text{ mA}$$

But $I_{ref} = I_{C1} + 2I_B + I_R$

$$I_R = \frac{V_{BE}}{3\text{K}\Omega} = \frac{0.7}{3} \text{ mA}$$

$I_R = 0.233$ mA

$$I_{ref} - I_R = I_{C1}\left[1 + \frac{2}{\beta}\right]$$

$$\frac{0.5199 \times 10^{-3}}{1.016} = I_{C1}$$

$I_{C1} = 0.511$ mA

But $I_{C1} = I_{C2}$ (Due to mirror effect)

$I_{C1} = I_{C2} = 0.511$ mA Choice (B)

35. Applying KVL to the output loop

$V_{CC} - I_{C2} R_C - V_0 = 0$

$$R_C = \frac{V_{CC} - V_0}{I_{C2}} = \frac{4}{0.511} \text{ k}\Omega = 7.827 \text{ k}\Omega$$ Choice (A)