RPSC AEn-2024 Main Test Series | ELECTRICAL ENGINEERING | Test 16

Test Mode : • Offline • Online

Full Syllabus Test : Paper-II

DETAILED EXPLANATIONS

PART-A

1. **Solution:**

Absolute Units: An absolute system of units is defined as a system in which the various units are all expressed in terms of a small number of fundamental units. Absolute measurements do not compare the measured quantity with arbitrary units of the same type but are made in terms of fundamental units.

2. **Solution:**

Holes in the Disc: To prevent creeping two diametrically opposite holes are drilled in the disc; the disc will come to rest with one of the holes under the edge of a pole of the shunt magnet.

3. **Solution:**

In $4\frac{1}{2}$ digit voltmeter 0.7582 is displayed on 10 V range as

0	0	.7	5	8

.

In $3\frac{1}{2}$ digit voltmeter 0.7582 is displayed on 10 V range as

0	0	.7	5

.

4. Solution:

Effect of lag network.

- Grain crossover frequency: Decreases
- Bandwidth: Decreases
- Signal to noise ratio: Increases

5. Solution:

$$A = \begin{bmatrix} 0 & 1 \\ 0 & -2 \end{bmatrix}$$

State transition matrix $\phi(t) = e^{At}$

or,
$$\phi(t) = \mathcal{L}^{-1}[(sI - A)^{-1}]$$

$$[sI - A] = \begin{bmatrix} s & -1 \\ 0 & s+2 \end{bmatrix}$$

$$[sI - A]^{-1} = \frac{1}{s(s+2)}\begin{bmatrix} s+2 & 1 \\ 0 & s \end{bmatrix}$$

$$\phi(t) = \mathcal{L}^{-1}\left[(sI - A)^{-1}\right] = \mathcal{L}^{-1}\begin{bmatrix} \frac{1}{s} & \frac{1}{s(s+2)} \\ 0 & \frac{1}{s+2} \end{bmatrix}$$

$$\phi(t) = \begin{bmatrix} e^{-t} & \frac{1}{2}\left(e^{-t} - e^{-2t}\right) \\ 0 & e^{-2t} \end{bmatrix}$$

6. Solution:

The advantages of using free wheeling diode are:

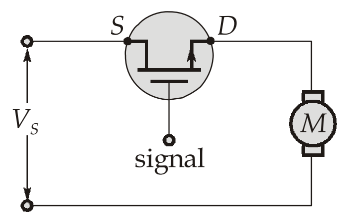
- Input power factor is improved.
- Load current waveform is improved and as a result load performance is better.
- As energy stored in L is transferred to R during the free wheeling period, overall converter efficiency improves.
- Free wheeling diode prevents the load voltage V_0 from becoming negative.

7. Solution:

PWM (Pulse Width Modulation) is an internal voltage control of inverter. In this method, a fixed dc input voltage is given to the inverter and a controlled output voltage is obtained by, adjusting the on and off periods of the inverter component.

8. Solution:

If the absence of signal, MOSFET normally operates as off switch. When we apply the signal to the gate terminal, a channel is formed between drain and source and MOSFET becomes ON and motor will starts operating.



9. Solution:

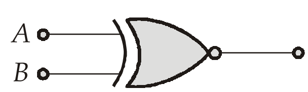
Applications:

1. Used as comparator
2. As a zero crossing detector
3. Used as voltage follower circuit
4. Used in active peak detector
5. Used in rectifier circuit
6. Used in S-H circuit

10. Solution:

The 'Ex-NOR' gate:

Symbol:



$Y = A \text{ XNOR } B$
$= \overline{A \text{ XOR } B}$
$= \overline{A \oplus B}$
$= A \odot B$

Boolean function of 2-input **Ex-NOR** operation is as,

$$Y = A \odot B$$

$$Y = AB + \bar{A}\bar{B}$$

Truth table:

Inputs		Outputs
A	B	$Y = A \odot B$
0	0	1
0	1	0
1	0	0
1	1	1

11. Solution:

$$f(A, B, C) = A + \bar{B}C$$

$A \backslash BC$	$\bar{B}\bar{C}$	$\bar{B}C$	BC	$B\bar{C}$
$\bar{A}$	0	1	0	0
A	1	1	1	1

$$\text{POS from } f = (A+C)(A+\bar{B})$$

Standard POS form.

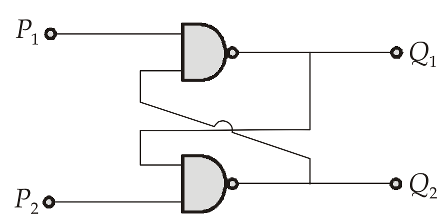
12. Solution:

The minimum value of 'R_L' for the zener diode to be a voltage regulator.

$$R_L = \frac{15}{i_{max}}, \qquad \text{where,} \quad i_{max.} = \frac{24-15}{27}$$

$$R_{L(min)} = 45\ \Omega$$

13. Solution:



When inputs (P_1, P_2) are (1, 1) then

P_1	P_2	Q_1	Q_2
1	1	0	1
1	1	1	0

The output, $\quad Q_1 = P_1\, P_2 \bar{Q}_2$ or $Q_2 = P_1\, P_2 \bar{Q}_1$

14. Solution:

In 8085 microprocessor, zero flag is used to indicate the result of arithmetic or logic operation of ALU is zero or non-zero. If the result is non-zero, then Z-flag will be zero (reset) and if the result is zero, then Z-flag will be 1 (set). Here 'MOV D, B' is not an ALU operation hence zero flag is not affected.

15. Solution:

MOV m, r — Move data from register (r) to memory whose address is in HL register pair.

INR r — Increment the content of register (r) by 1

16. Solution:

The addressing mode used in the instruction STAX *B* is register indirect. Because the content of accumulator is copied to a memory location whose address is given by content of register pair *BC*.

17. Solution:

Amplitude Modulation: "In amplitude modulation, the amplitude of the carrier is varied in accordance with the instantaneous value of amplitude of the modulating signal keeping the frequency and the phase constant"
Formally, AM is defined as the system of modulation in which the amplitude of the carrier is made proportional to the instantaneous amplitude of the modulating voltage.

18. Solution:

RLC	–	Rotate accumulator left
CMA	–	Complement accumulator.

19. Solution:

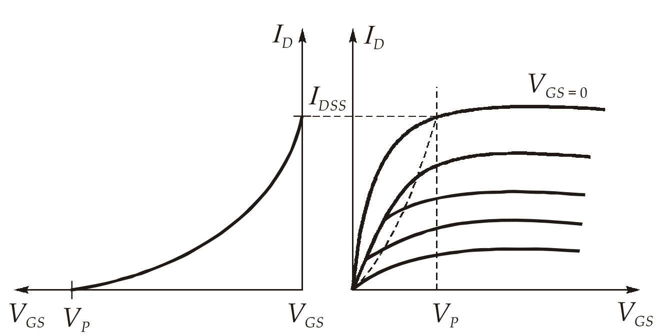
Modulation Index: Modulation index is defined as the ratio of modulating voltage to the carrier voltage i.e., modulation index,

$$m = \frac{V_m}{V_c}$$

The modulation index is a number lying between 0 and 1, and is very often expressed as a percentage and called the percentage modulation.
Practically, the value of m lies between 0.4 to 0.6.

20. Solution:

For a JFET, when 'V_{DS}' is increased 'I_D' also increases, same time depletion region also increases, channel width becomes small, the condition at which the channel is nearly dropped, is called pinch off. After the occurrence of pinch off, further increase of 'V_{DS}' does not increase (I_D). The voltage of 'V_{DS}' at which pinch off occurs, at voltage ($V_{GS} = 0$) is called pinch off voltage.



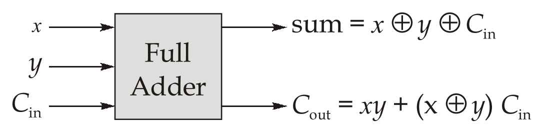
Another explanation:

The voltage of 'V_{GS}' beyond which drain current reduces for zero in saturation region. From definition second, pinch off voltage is negative for n-channel JFET.

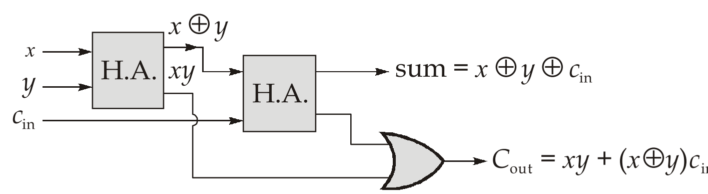
PART-B

21. Solution:

Full adder:



Using two half address, we can construct a full adder as below.



22. Solution:

Thousand is set at 4000 Ω and error

$$= \pm 4000 \times \frac{0.02}{100} = \pm 0.8\ \Omega$$

$$\text{For hundred error} = \pm 300 \times \frac{0.05}{100} = \pm 0.15\ \Omega$$

Similarly, $$\text{For ten error} = \pm 20 \times \frac{0.1}{100} = \pm 0.02\ \Omega$$

and $$\text{For unit error} = \pm 5 \times \frac{0.2}{100} = \pm 0.01\ \Omega$$

Hence, $$\text{Total error} = \pm (0.8 + 0.15 + 0.02 + 0.01)\ \Omega$$
$$= \pm 0.98\ \Omega$$

$$\%\ \text{Relative error} = \frac{0.98}{4325} \times 100 = 0.0226\%$$

23. Solution:

∵ Balance at 48.4 cm is corresponding to an emf of 1.016 V.

∴ Balance at 72 cm is corresponding to an emf of

$$\frac{1.016}{48.4} \times 72 = 1.5114\ \text{V}$$

∴ Balance at 66 cm is corresponding to an emf of

$$\frac{1.016}{48.4} \times 66 = 1.385 \text{ V}$$

$$\% \text{ error} = \frac{\text{Measured Value} - \text{True Value}}{\text{True Value}}$$

$$= \frac{1.40 - 1.385}{1.385} = 1.08\%$$

24. Solution:

PM signal is generated by modulating the phase of carrier signal with modulating signal or baseband signal.

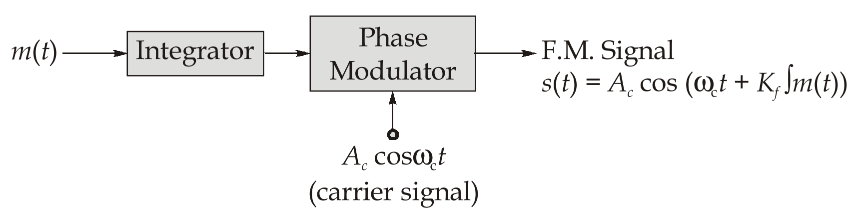
$$s(t)_{PM} = A_c \cos(\omega_c t + k_p.x(t))$$

where, $x(t)$ = modulating or baseband signal

Whereas FM signal is generated by the modulation of the frequency of carrier signal by baseband signal.

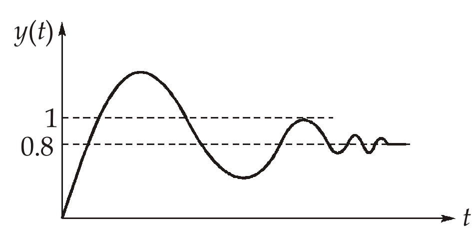
$$s(t)_{FM} = A_c \cos(\omega_c t + k_f \int x(t))$$

Generation of FM using PM:



25. Solution:

The given step response is below :



The steady state error, $e_{ss} = C - R = 1 - 0.8$

$e_{ss} = 0.2$ (for type = 0 and $K = 1$)

∴ For $e_{ss} = 0$, either type has to be 1 or $K = \infty$

Since $e_{ss} \propto \frac{1}{K}$

So, $K = \infty$

So, in order to make $e_{ss} = 0$, we have to increase gain (K) to infinite.

26. Solution:

$$\frac{C(s)}{R(s)} = \frac{s^2+3s+4}{s^2+4s+4} \qquad \text{[where } R(s) = (1/s)\text{]}$$

$$\therefore \quad C(s) = \frac{1}{s}\cdot\frac{s^2+3s+4}{s^2+4s+4} = \frac{1}{s}\left[1-\frac{s}{s^2+4s+4}\right]$$

$$= \left[\frac{1}{s}-\frac{1}{s^2+4s+4}\right] = \left[\frac{1}{s}-\frac{1}{(s+2)^2}\right]$$

Taking inverse Laplace transform of $C(s)$

$$\Rightarrow \quad L^{-1}[C(s)] = C(t) = 1 - te^{-2t}$$

On comparing with,

$$s^2+2\xi\omega_n s+\omega_n^2 = s^2 + 4s + 4$$

From the given equation,

$$2\,\xi\omega_n = 4$$

and $\omega_n = 2$

then, $\xi = 1$

Hence, the circuit is critically damped.

27. Solution:

$$1 + G(s)\,H(s) = 0$$

$$\Rightarrow \quad 1+\frac{10(1+Ts)}{s(1+0.5s)(1+0.2s)} = 0$$

$$\Rightarrow \quad 0.1s^3 + 0.7s^2 + s + 10 + 10Ts = 0 \quad \rightarrow \quad \text{Characteristic equation}$$

$$\Rightarrow \quad s^3 + 7s^2 + (10 + 100T)s + 100 = 0$$

By Routh-Hurwitz criteria,

s^3	1	$10+100T$
s^2	7	100
s^1	$\frac{70+700T-100}{7}$	
s^0	100	

For stable system,

we have $-30 + 700T \geq 0$

$$700\,T \geq 30$$

$$T \geq \frac{30}{700}$$

28. Solution:

Requirements for an SCR to be triggered by a gate pulse.

- SCR should be forward bias mode.
- A positive gate voltage between gate and cathode.
- The gate pulse width should be chosen to ensure that anode current rises above the latching current.

29. Solution:

For a step up chopper, $V_0 = \frac{V_s}{1-\delta}$

$\therefore \quad 600 = \frac{200}{1-\delta}$

$\therefore \quad \delta = \frac{2}{3}$

$\therefore \quad \delta = \frac{T_{ON}}{T} = \frac{2}{3} = \frac{T - T_{OFF}}{T}$

$\therefore \quad T_{OFF} = \frac{T}{3}$

$\therefore \quad T = 3 \times 50\ \mu\text{ sec} = 150\ \mu\text{ sec}$

and $\quad T_{ON} = T - T_{OFF} = 100\ \mu\text{sec}$

Now if desired output voltage is (300 V),

then $\quad V_0 = 300 = \frac{V_s}{1-\delta} = \frac{200}{1-\delta}$

$\therefore \quad \delta = \frac{1}{3}$

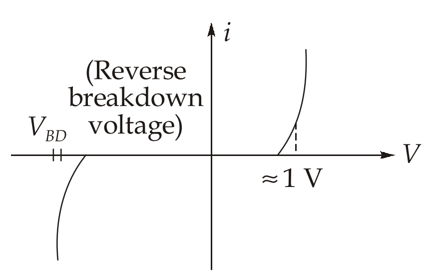
$\therefore \quad T_{ON} = \frac{T}{3} = \frac{150\ \mu\text{sec}}{3} = 50\ \mu\text{ sec}$

30. Solution:

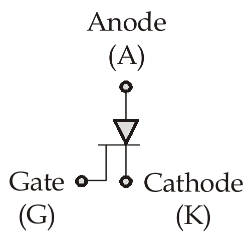
Power semiconductor devices can be classified into three categories according to their degree of controllability. The categories are :

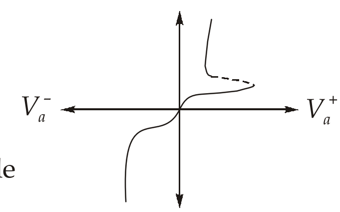
(a) Uncontrolled turn-on and off devices :

e.g. Diode : The on and off states of diodes are controlled by power circuit.

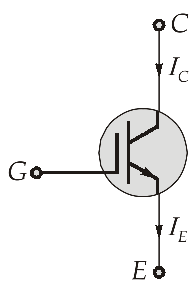


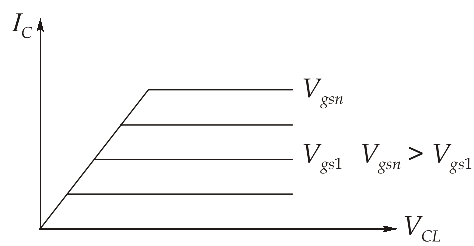
(b) Controlled turn-on and uncontrolled turn-off :
e.g. SCR (Silicon Controlled Rectifier)
SCR turned-on by a control signal and are turned-off by the power circuit.





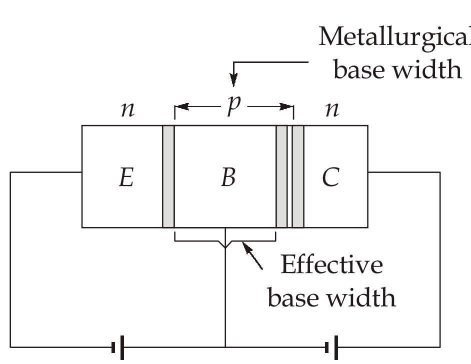
(c) Controlled turn-on and off characteristics :
e.g., Insulated-gate bipolar transistors
IGBT are turned-on and off by controlled signals.





31. Solution:

Early Effect: The transition region at a junction is the region of uncovered charges on both sides of the junction at the positions occupied by the impurity atoms. As the voltage applied across the CB junction increases, the transition region penetrates deeper into the collector and base. Since the doping in the base is ordinarily substantially smaller than that of the collector, the penetration of the transition region into the base is much larger than into the collector. As a result the electrical base width of the transistor is reduced in comparison to metallurgical base width. This modulation of the effective base width by the collector voltage is known as the **Early effect** after J.M. Early, who first interpreted it.



The decrease in base width with increasing reverse collector voltage has three consequences:

- There is less chance for recombination within the base region. Hence α increases with increasing $|V_{CB}|$.
- The concentration gradient of minority carriers is increased within the base. Since the hole current injected across the emitter is proportional to the gradient of minority carriers at emitter junction, then I_E increases with increasing reverse collector voltage.
- For extremely large voltages, base width may be reduced to zero causing voltage breakdown in the transistor. This phenomenon is known as **punch through** or **reach through.**

32. Solution:

8085 consists of 3 buses which are:

Address Bus: The address bus of 8085 consists of 16 parallel signal lines. On these lines the CPU sends out the address of the memory location that is to be written to or read from. If the CPU has N address lines, then it can directly address 2^N memory locations. When CPU reads data from or writes data to a port, it sends the port address out on the address bus.

Data Bus: In 8085 data bus consists of 8 parallel signal lines which are bidirectional. This means that the CPU can read data in from memory or from a port on these lines, or it can send data out to memory or to a port on these lines. Many devices in a system will have their outputs connected to the data bus, but only one device at a time will have its output enabled.

Control Bus: The CPU sends out signals on the control bus to enable the outputs of addressed memory devices or port devices. To read the byte of data from a memory location, the CPU sends out the memory address of the desired byte on the address bus and then sends out a memory read signal on the control bus. The memory read signal enables the address memory device to output a data word into the data bus. The data word from memory travels along the data bus to the CPU.

PART-C

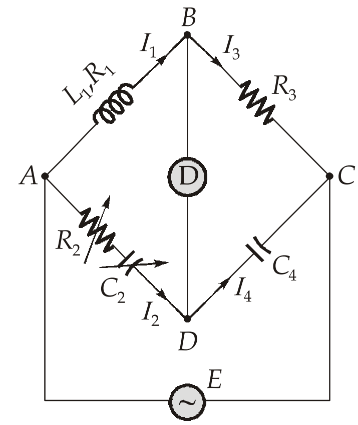
33. (i) Solution:

The Owen's bridge measures the value of a self-inductance in terms of a capacitance,

Let, $$Z_1 = R_1 + j\omega L_1; \quad Z_2 = R_2 + \frac{1}{j\omega C_2}$$

$$Z_3 = R_3; \qquad Z_4 = \frac{1}{j\omega C_4}$$

where, L_1 = Unknown self-inductance of resistance R_1
R_2 = Variable non-inductive resistance
R_3 = Standard non-inductive resistance
C_2 = Standard variable capacitance
C_4 = Standard fixed capacitance



Owen's Bridge

At balance, we have,

$$Z_1Z_4 = Z_2Z_3$$

$$(R_1 + j\omega L_1)\left(\frac{1}{j\omega C_4}\right) = \left(R_2 + \frac{1}{j\omega C_2}\right)(R_3)$$

$$\Rightarrow \quad \frac{R_1}{j\omega C_4} + \frac{L_1}{C_4} = R_2 R_3 + \frac{R_3}{j\omega C_2}$$

Separating and equating real and imaginary terms

$$\frac{L_1}{C_4} = R_2 R_3 \quad \Rightarrow \quad L_1 = R_2 R_3 C_4$$

$$\frac{R_1}{j\omega C_4} = \frac{R_3}{j\omega C_2} \quad \Rightarrow \quad R_1 = \frac{C_4}{C_2} R_3$$

33. (ii) Solution:

Difference between the Construction of PMMC and Dynamometer Instrument:

PMMC:

- **Moving Coil:** The moving coil is wound with many turns of enamelled or silk covered copper wire. The coil is mounted on a rectangular aluminium former which is pivoted on jewelled bearings. The coils moves freely in the field of a permanent magnet.
- **Control:** The coil is supported between two jewel bearings the control torque is provided by two phosphor bronze hair springs.
- **Damping:** Damping torque is produced by movement of the aluminium former moving in the magnetic field of the permanent magnet.
- **Pointer and Scale:** The pointer is carried by the spindle and moves over a graduated scale. The pointer is of light-weight construction and, apart from those used in some inexpensive instruments, has the section over the scale twisted to form a fine blade.

Dynamometer Instrument:

- **Moving Coil:** A single element instrument has one moving coil. The moving coil is wound either as a self-sustaining coil or else on a non-metallic former. A metallic former cannot be used as eddy currents would be induced in it by the alternating field. Both fixed and moving coils are air cored.

- **Control:** The controlling torque is provided by two control springs. These springs act as leads to the moving coil.
- **Damping:** Air friction damping is employed for these instruments and is provided by a pair of aluminium vanes attached to the spindle at the bottom. These vanes move in sector shaped chambers.
- **Pointer and Scale:** The scales are hand drawn, using machine sub-dividing equipment. Diagonal lines for fine sub-division are usually drawn for main markings on the scale.

34. (i) Solution:

$$L = (0.01 + K_1\,\theta)^2\,\mu\text{H}$$

$$\frac{dL}{d\theta} = 2(0.01 + K_1\,\theta)\,.\,K_1$$

$$\theta = \frac{1}{2}\cdot\frac{I^2}{K}\cdot\frac{dL}{d\theta}$$

$$\frac{\pi}{6} = \frac{1}{2}\cdot\frac{(1.5)^2}{K}\cdot 2\left(0.01 + K_1\,.\,\frac{\pi}{6}\right)\cdot K_1 \quad \text{...(i)}$$

$$\frac{\pi}{3} = \frac{1}{2}\cdot\frac{(4.5)^2}{K}\cdot 2\left(0.01 + K_1\,.\,\frac{\pi}{3}\right)\cdot K_1 \quad \text{...(ii)}$$

From equation (i) and (ii),

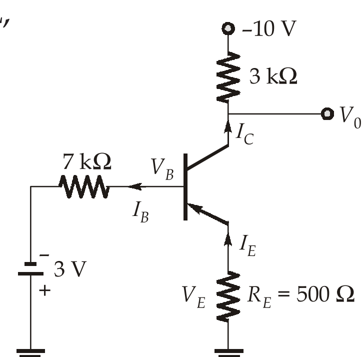
$$\frac{(\pi/6)}{(\pi/3)} = \frac{(1.5)^2}{(4.5)^2}\times\frac{(0.01 + K_1\cdot\pi/6)}{(0.01 + K_1\cdot\pi/3)}$$

$$(0.09 - 0.02) = K_1\left(\frac{2\pi}{6} - \frac{2\pi}{3}\right);\; K_1 = -8.355\times 10^{-3}$$

34. (ii) Solution:

1. Assuming the transistor in active mode, applying KVL,

$$-500\,I_E - V_{EB} - (7\text{ k}\Omega)I_B + 3 = 0$$



$$I_B = \frac{I_E}{\beta+1} = \frac{I_E}{101}$$

$$3 - 0.7 = \frac{7\times I_E}{101} + 0.5I_E$$

$$I_E = 4.04\text{ mA}$$

$$I_C = 0.99\times 4.04 = 4\text{ mA}$$

To find V_B :

$$V_B = R_e\,I_E - V_{EB}$$

$$V_B = -(0.5)\,(4.04) - 0.7 = -2.72\text{ V}$$

$$V_0 = -10 + R_C I_C = -10 + 3 \times 4 = 2 \text{ V}$$

So, collector base diode is also forward biased. Hence, what we have assumed is incorrect, so transistor is in saturation mode.

2. $$V_0 = 2 \text{ V}$$

35. (i) Solution:

Buck converter : Assuming continuous conduction

No data to check whether it is continous or discontinous

$$V_o = \alpha V_s$$

$$5 = \alpha.15$$

$$\alpha = \frac{1}{3}$$

$$\Delta I_L = \frac{\alpha(1-\alpha)V_s}{fL}$$

$$0.5 = \frac{\frac{1}{3}\left(1-\frac{1}{3}\right)\times 15}{10\times 10^3 L}$$

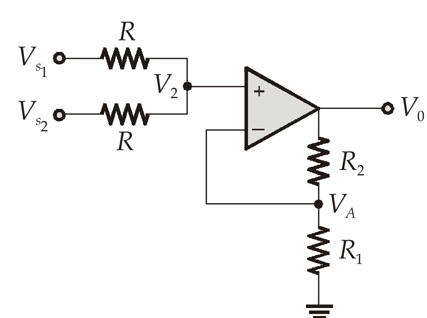
$$L = \frac{2}{3}\times\frac{2}{3}\times\frac{15}{10\times 10^3} \quad \Rightarrow \quad L = 0.66 \text{ mH}$$

$$\Delta V_0 = \frac{\Delta I_L}{8fC}$$

$$10 \times 10^{-3} \text{ V} = \frac{0.5}{8\times 10\times 10^3\times C}$$

$$C = \frac{0.5}{8\times 10\times 10^3\times 10\times 10^{-3}} = 625 \ \mu\text{F}$$

35. (ii) Solution:



$$V_2 = \frac{V_{s_1}+V_{s_2}}{2}$$

By virtual ground theory, $$V_2 = V_A$$

$$V_2 = \frac{V_{s_1}+V_{s_2}}{2} = V_A$$

$$V_A = \left(\frac{R_1}{R_1+R_2}\right)V_0$$

$\Rightarrow$ $$V_0 = \left(\frac{V_{s_1}+V_{s_2}}{2}\right)\left(\frac{R_2+R_1}{R_1}\right)$$

$$\Rightarrow \quad V_0 = \left(\frac{V_{s_1} + V_{s_2}}{2}\right)\left(1 + \frac{R_2}{R_1}\right)$$

If $\quad R_1 = R_2 = R$

$$\Rightarrow \quad V_0 = V_{s_1} + V_{s_2}$$

So mathematical operation performed is addition.

36. (i) Solution:

Capacitor C will charge upto maximum voltage of the ac source through load resistor R_L and discharge through resistor R.

$$\text{Discharge current} = I_d = \frac{V_m}{R} = \frac{\sqrt{2}\,V_s}{R}$$

$$I_d = 2 \text{ A}$$

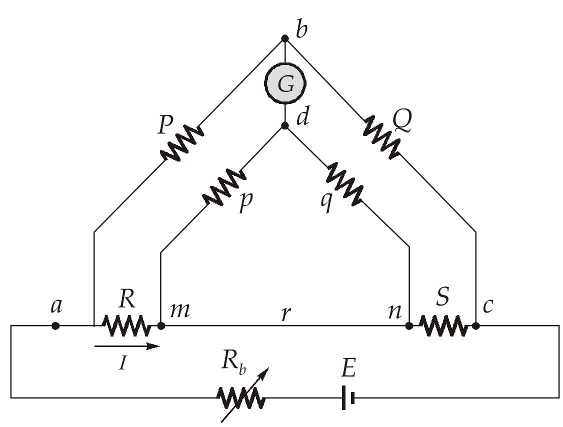
$$R = \frac{\sqrt{2}\,V_s}{I_d} = \frac{\sqrt{2} \times 100}{2} = 70.71\,\Omega$$

$$\left(\frac{dV}{dt}\right)_{\max} = \frac{0.632\,V_m}{R_L C}$$

$$\Rightarrow \quad C = \frac{0.632 \times \sqrt{2} \times 100}{10 \times 50} = 0.178\ \mu\text{F}$$

36. (ii) Solution:

Problem associated with the measurement of low resistances: Resistances having a value under 1 Ω is known as low resistances. The resistance of leads and contacts, though small, are appreciable in comparison in the case of low resistances.



Kelvin's Double Bridge :

The Kelvin's Double bridge incorporates the idea of a second set of ratio arms – hence the name double bridge and the use of four terminal resistors for the low resistance arms. The first of ratio arms is P and Q. The second set of ratio arms p and q is used to connect the galvanometer to a point d at the appropriate potential between points *m* and *n* to eliminate the effect of connecting lead of resistance *r* between the known resistance *R*, and the standard resistance *S*.

The ratio p/q is made equal to P/Q. Under balance conditions there is no current through the galvanometer, which means that the voltage drop between *a* and *b*, E_{ab} is equal to the voltage drop E_{amd} between *a* and *c*.

Now,
$$E_{ab} = \frac{P}{P+Q} \cdot E_{ac}$$

and
$$E_{ac} = I\left[R + S + \frac{(p+q)r}{p+q+r}\right] \quad ...(i)$$

and
$$E_{\text{amd}} = I\left[R + \frac{p}{p+q}\left\{\frac{(p+q)r}{p+q+r}\right\}\right]$$
$$= I\left[R + \frac{pr}{p+q+r}\right] \quad ...(ii)$$

For zero galvanometer deflection,

or
$$\frac{P}{P+Q} \cdot I\left[R + S + \frac{(p+q)r}{p+q+r}\right] = I\left[R + \frac{pr}{p+q+r}\right]$$

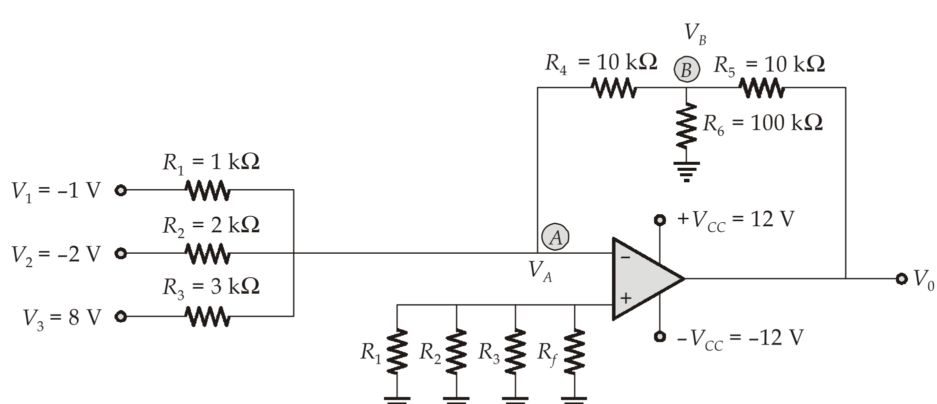
or
$$R = \frac{P}{Q} \cdot s + \frac{qr}{p+q+r}\left[\frac{P}{Q} - \frac{p}{q}\right] \quad ...(iii)$$

Now if $\frac{P}{Q} = \frac{p}{q}$ equation (iii) becomes

$$R = \frac{P}{Q} \cdot S$$

as the expression of *R* does not involve *r* hence the effect of *r* (contact resistance of leads) is eliminated.

37. (i) Solution:



Assuming ideal opamp and respective node voltages V_A and V_B,

$$A_{OL} = \infty$$

Hence, $V_d = 0$

$\therefore$ $V^+ = V^-$

Applying KCL at (A),

$$\frac{-1-V_A}{R_1} + \frac{-2-V_A}{R_2} + \frac{8-V_A}{R_3} = -\frac{V_B}{R_4}$$

As, $V_A = V^- = 0$, putting given values we get

$$\therefore \quad V_B = -\frac{20}{3}\text{ V} \quad \text{...(i)}$$

Applying KCL at B, $\frac{-V_B}{R_4} = \frac{V_B}{R_6} + \frac{V_B - V_0}{R_5}$

From equation (i), $V_B = -\frac{20}{3}$

Putting given values

$$\frac{20/3}{10\text{k}} = \frac{-20/3}{100\text{k}} + \frac{-20/3 - V_0}{10\text{k}}$$

$\therefore$ $V_0 = -14$ V

As V_0 exceeds the saturation voltage of opamp hence opamp works in saturation region.

Hence, $V_0 = -12$ V

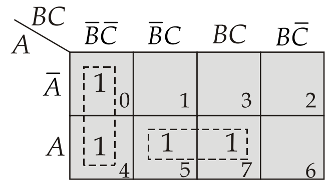
37. (ii) Solution:

Truth table for given function $Y(A, B, C)$

	A	B	C	$Y(A,B,C)$
0	0	0	0	1
1	0	0	1	0
2	0	1	0	0
3	0	1	1	0
4	1	0	0	1
5	1	0	1	1
6	1	1	0	0
7	1	1	1	1

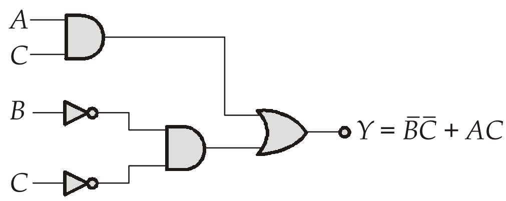
With the help of K-map

1.



$$f = \bar{B}\bar{C} + AC$$

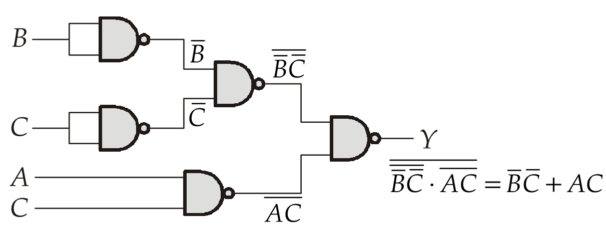
2. With the help of 2-input gate



3. With the help of 2-input NAND GATE

$$f = \bar{B}\bar{C} + AC$$

$$f = \overline{\overline{\bar{B}\bar{C} + AC}} = \overline{\overline{\bar{B}\bar{C}} \cdot \overline{AC}}$$



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