Answer Any FIVE FULL Questions Mark

1.	Perform the following Conversions. (i) $(ABCD.EF)_{16} \rightarrow (?)_{10}$ (ii) $(165.45)_{10} \rightarrow (?\quad)_2$ (iii) $(1101110110.10011)_2 \rightarrow (?)_8$ (iv) $(245.AB)_{16} \rightarrow (?)_2$ (v) $(71.6)_8 \rightarrow (?)_{16}$	[10]
2.	a) Express the Boolean function F=A +B'C in sum of minterms, b) Write the truth table, symbol and Boolean expression for the following logic gates (i)NAND (ii) OR (iii) EXOR	[4+6]
3	Realize a full adder circuit using two half adders and an OR gate, write truth table and obtain expressions for sum and carry.	[10]
4	With a neat circuit diagram and waveforms explain the full wave bridge rectifier circuit.	[10]

5	With a neat circuit diagram and waveforms explain the Bi-phase full wave rectifier with capacitor filter.	[10]
6	What is regulated power supply? With neat block diagram, explain the working of DC power supply. Also mention the principal components used in each block.	[10]
7	a) Perform $(3250)_{10}$-$(72532)_{10}$ subtraction using 10's complement method.	[5]
	b) Given two binary numbers X = 1010100 and Y= 1000011, perform subtraction using 2's complements.	[5]
8.	a) Simplify the following expressions and realize using logic gates. F = BC+AC'+AB+BCD b) Prove the Boolean theorem A+BC = (A+B).(A+C)	[6+4]

IAT–1 10–MARK ANSWER SCHEME WITH STEPWISE MARKING

Q1. Number System Conversions (10 Marks)

(i) Convert base-16 to decimal → 2 marks (ii) Convert decimal to binary (integer + fractional) → 2 marks (iii) Convert binary to octal by grouping → 2 marks (iv) Convert hexadecimal to binary → 2 marks (v) Convert octal to hexadecimal through binary → 2 marks

Q2. Boolean Function & Logic Gates (10 Marks)

Truth table (4 rows) → 2 marks Identify minterms → 1 mark Write $\Sigma m(1,4,5,6,7)$ → 2 marks NAND truth table & symbol → 1.5 marks OR truth table & symbol → 1.5 marks XOR truth table & symbol → 2 marks

Q3. Full Adder using Half Adders (10 Marks)

Half Adder 1 operation → 2 marks Half Adder 2 operation → 2 marks Sum derivation $S = A \oplus B \oplus Cin$ → 2 marks Carry derivation $Cout = AB + Cin(A \oplus B)$ → 2 marks Full truth table → 2 marks

Q4. Full-Wave Bridge Rectifier (10 Marks)

Neat circuit diagram → 3 marks Positive half-cycle operation → 2 marks Negative half-cycle operation → 2 marks Output waveform → 2 marks Final DC expression → 1 mark

Q5. Center-Tap Rectifier with Capacitor Filter (10 Marks)

Circuit diagram → 3 marks Conduction in each half cycle → 2 marks Capacitor charging explanation → 2 marks Discharging & ripple → 2 marks Ripple formula → 1 mark

Q6. Regulated Power Supply (10 Marks)

Block diagram → 3 marks Transformer explanation → 1.5 marks Rectifier explanation → 1.5 marks Filter explanation → 1.5 marks Regulator explanation → 2.5 marks

Q7. Complements Subtraction (10 Marks)

(a) 10’s complement steps → 5 marks – Write numbers equal length → 1 – 10’s complement of subtrahend → 1 – Add to minuend → 1 – End-carry rule → 2 (b) 2’s complement steps → 5 marks – 1’s complement → 1 – Add 1 → 1 – Add numbers → 2 – Interpret final result → 1

Q8. Simplification & Theorem Proof (10 Marks)

Remove BCD using $BC(1+D)=BC$ → 2 marks Write reduced expression → 1 mark Factor to $A(B+C') + BC$ → 2 marks Final SOP form → 1 mark Prove $A + BC = (A+B)(A+C)$ → 4 marks

IAT -1 Solution

Q1. Number System Conversions

(i) $(ABCD.EF)_{16} \rightarrow (?)_{10}$

$= 10\times16^3 + 11\times16^2 + 12\times16^1 + 13\times16^0 + 14\times16^{-1} + 15\times16^{-2} = 43981.93359375_{10}$

(ii) $(165.45)_{10} \rightarrow (?)_2$

Integer part 165 = 10100101_2; Fractional part 0.45 = $0.0111001100..._2$; Hence $(165.45)_{10}$ = $(10100101.0111001100...)_2$

(iii) $(1101110110.10011)_2 = (1566.46)_8$

(iv) $(245.AB)_{16} = (1001000101.10101011)_2$

(v) $(71.6)_8 = (39.C)_{16}$ (verified by decimal equivalence 57.75_{10}).

Q2. Boolean Function and Gates

Given F = A + B'C. In SOP: F = Σm(1,4,5,6,7).

Truth table lists outputs =1 for minterms 1,4,5,6,7.

We compute B', $B' \cdot C$, then $F = A + (B'C)$.

Index	A	B	C	B'	B'·C	F = A + B'·C	Reason
0	0	0	0	1	0	0	A=0 and B'·C =0
1	0	0	1	1	1	1	B'=1 and C=1 → B'·C=1 ⇒ F=1
2	0	1	0	0	0	0	B'=0 ⇒ B'·C=0
3	0	1	1	0	0	0	B'=0 ⇒ B'·C=0
4	1	0	0	1	0	1	A=1 ⇒ F=1 (regardless of B,C)
5	1	0	1	1	1	1	A=1 ⇒ F=1
6	1	1	0	0	0	1	A=1 ⇒ F=1
7	1	1	1	0	0	1	A=1 ⇒ F=1

From the table, $F = 1$ for indices: **1, 4, 5, 6, 7**.

Gates summary:

- NAND gate: Y = (A·B)'.
- OR gate: Y = A + B.
- EXOR gate: Y = A⊕B = A'B + AB'.

SYMBOLS & TRUTH TABLES OF COMMON LOGIC GATES

AND GATE | OR GATE | NOT GATE | BUFFER

AND GATE

A	B	Output
0	0	0
0	1	0
1	0	0
1	1	1

OR GATE

A	B	Output
0	0	0
0	1	1
1	0	1
1	1	1

NOT GATE

A	$\overline{A}$
0	1
1	0

BUFFER

Input	Output
0	0
1	1

NAND GATE | NOR GATE | XOR GATE | XNOR GATE

NAND GATE

A	B	Output
0	0	1
0	1	1
1	0	1
1	1	0

NOR GATE

A	B	Output
0	0	1
0	1	0
1	0	0
1	1	0

XOR GATE

A	B	Output
0	0	0
0	1	1
1	0	1
1	1	0

XNOR GATE

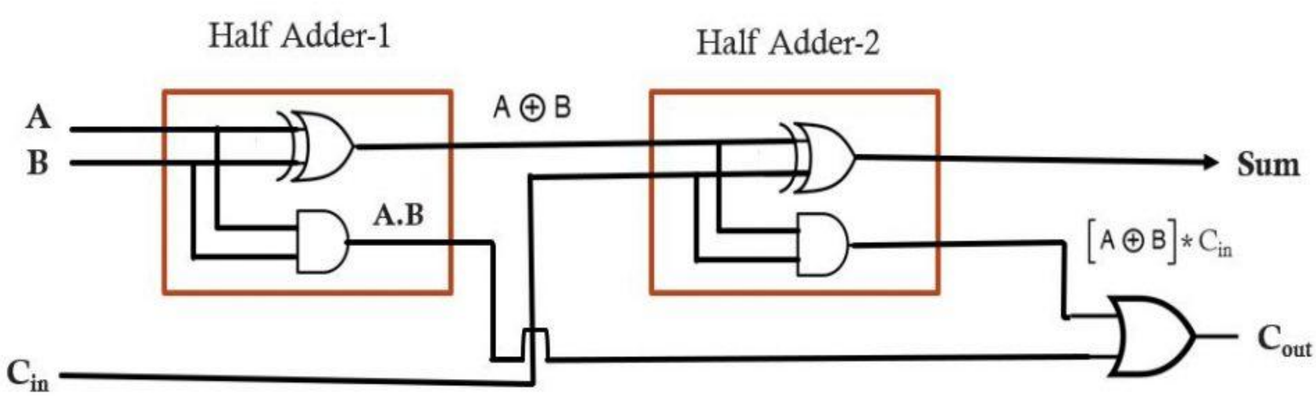
A	B	Output
0	0	1
0	1	0
1	0	0
1	1	1

Q3. Full Adder using Two Half Adders and OR Gate

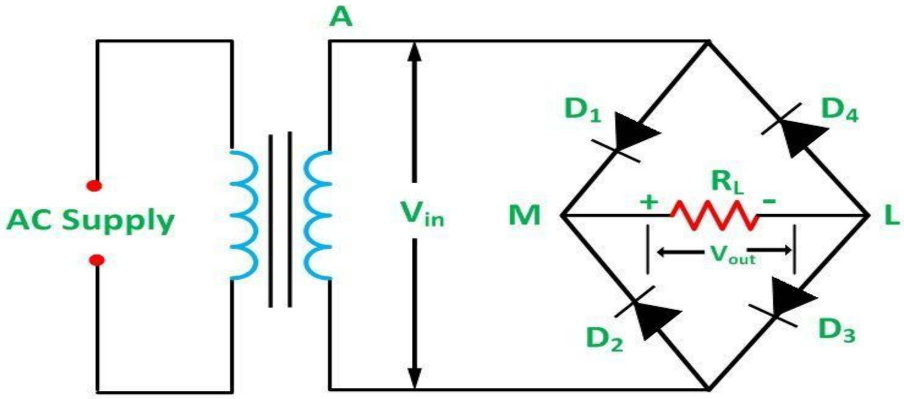
Step 1: HA1 → S1 = A⊕B, C1 = A·B.

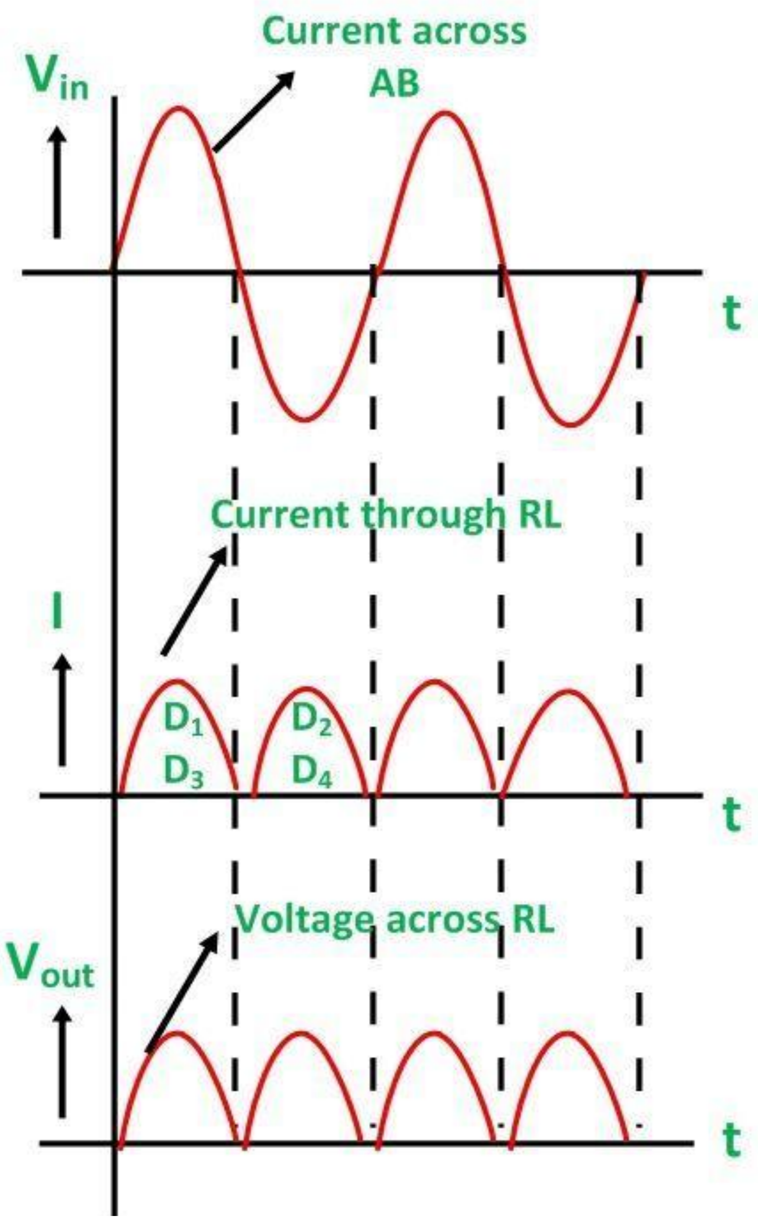
Step 2: HA2 → Inputs: S1, Cin → Sum = S1⊕Cin = A⊕B⊕Cin, C2 = S1·Cin.

Step 3: Cout = C1 + C2 = AB + Cin(A⊕B).



Q4. Full-wave Bridge Rectifier



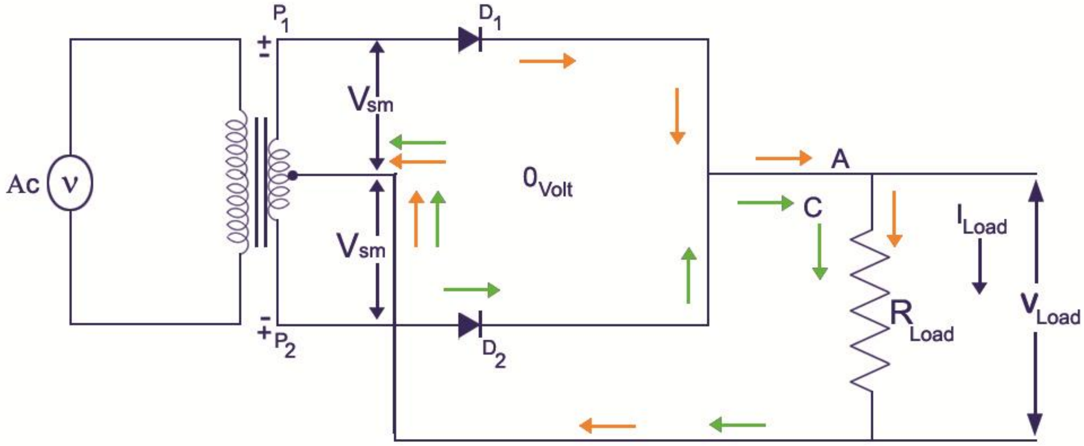


Four diodes in bridge configuration conduct alternately to produce full-wave rectified output across RL. Output frequency = 2× input frequency.

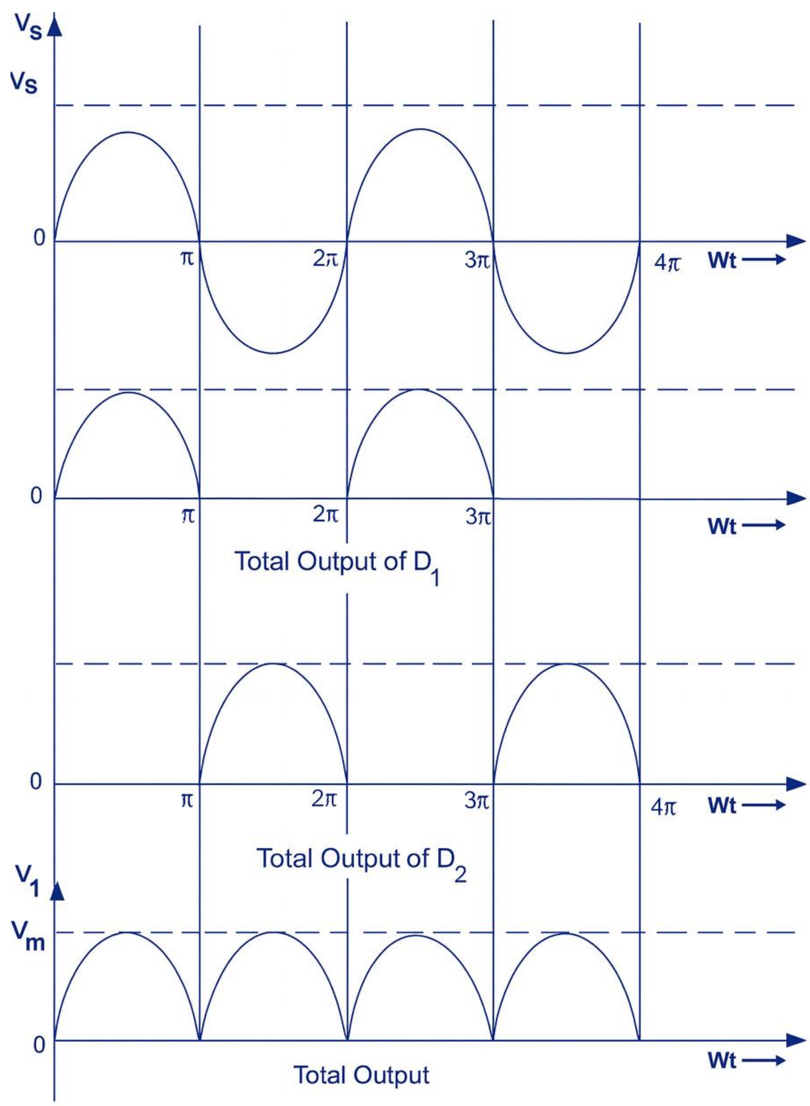
During positive half-cycle: D1, D4 conduct; during negative half-cycle: D2, D3 conduct.

Output ≈ $|V_m \sin(\omega t)| - 2V_d$.

Q5. Bi-phase (Center-tap) Full-wave Rectifier with Capacitor Filter



CENTRE - TAP FULL- WAVE RECTIFIER CIRCUIT



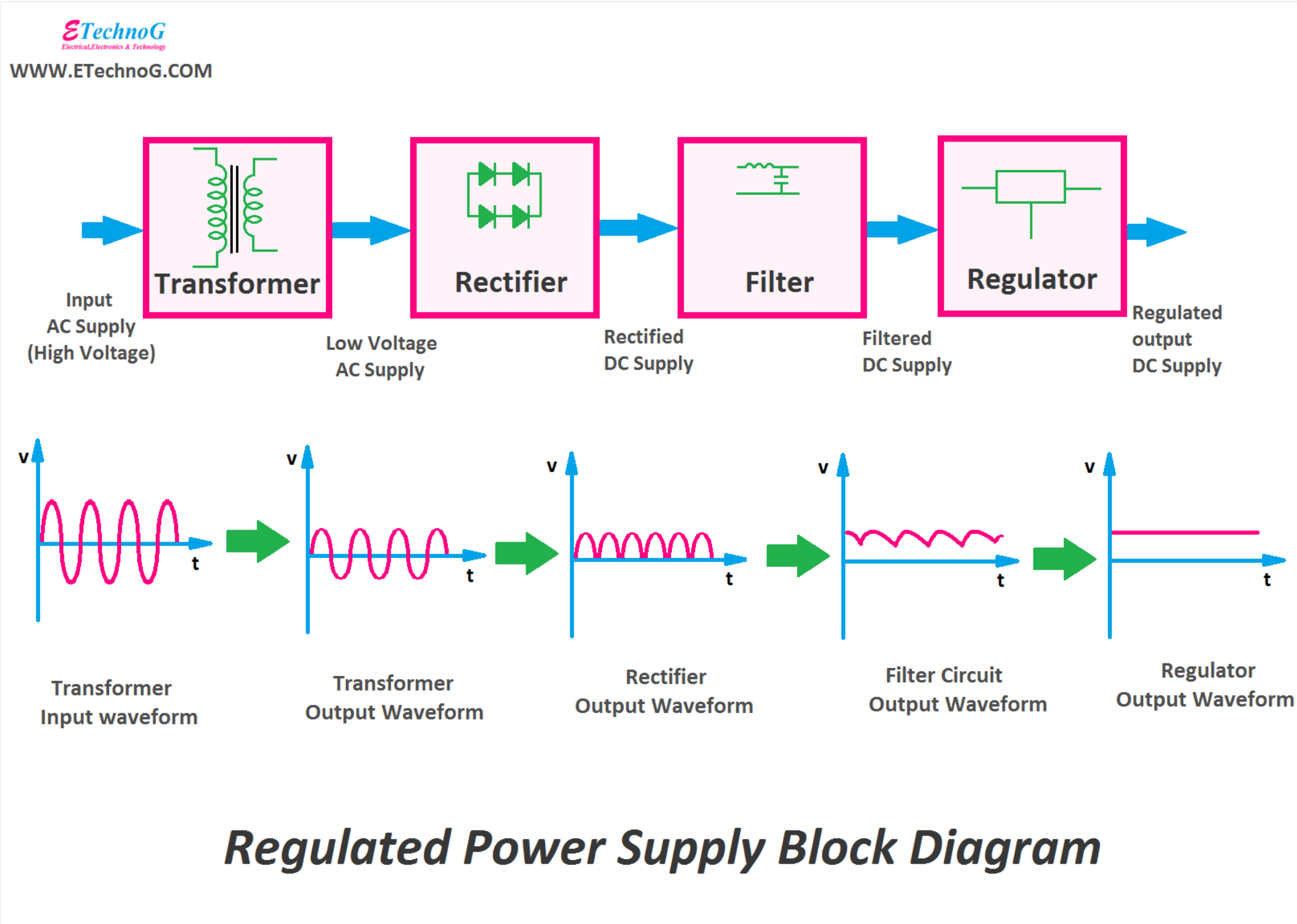
A center-tapped transformer and two diodes provide full-wave rectification. Each diode conducts on alternate half-cycles. The capacitor charges at peaks and discharges through RL to reduce ripple.

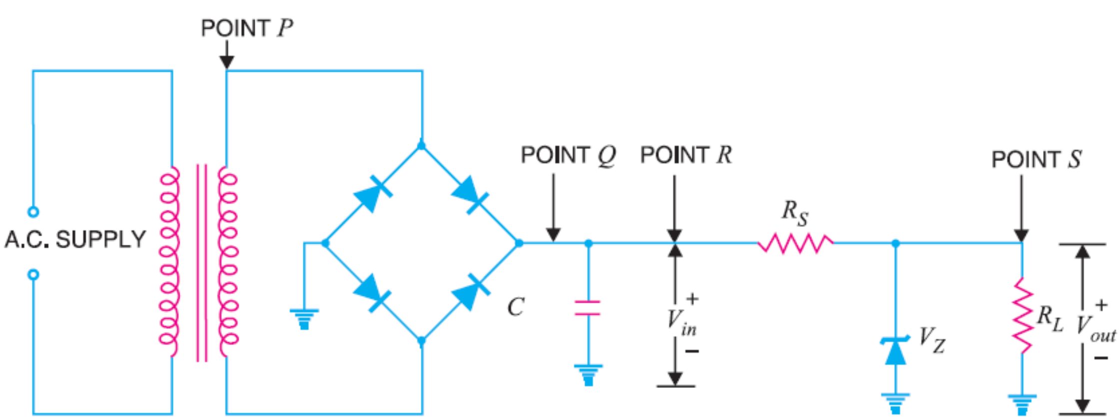
Ripple voltage ≈ $\Delta V = I_L/(2fC)$.

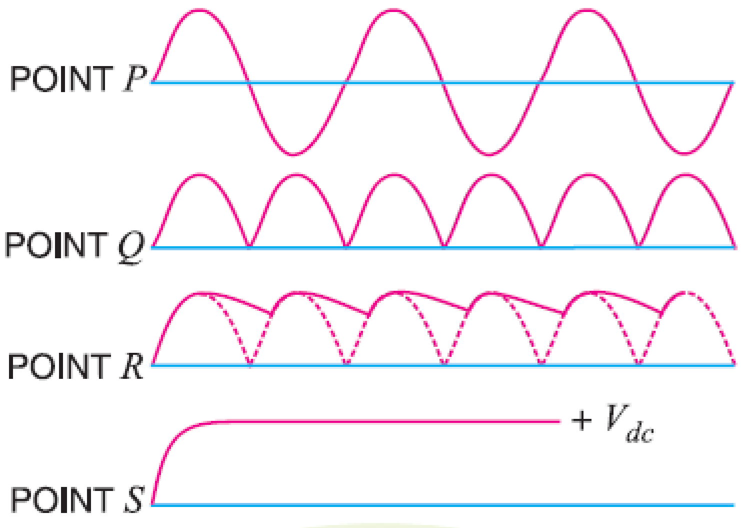
Q6. Regulated Power Supply

Definition: A regulated power supply maintains constant DC output despite line/load variations.

Blocks: Transformer → Rectifier → Filter → Regulator → Output.







Each block function:
• Transformer steps down AC.
• Rectifier converts AC to pulsating DC.
• Filter smooths the waveform.
• Regulator maintains constant voltage.
• Protection handles overload/short-circuit.

1. Transformer

The transformer is used to change the AC voltage level before further processing. In a regulated power supply, a step-down transformer reduces the mains voltage (230V AC) to a lower AC voltage such as 12V or 6V depending on the requirement. It works on electromagnetic induction and changes the voltage according to the turns ratio. Although useful for stepping down voltage, it is not mandatory—if high-voltage DC is needed, a transformer may be skipped.

2. Rectifier Circuit

The rectifier converts the AC voltage into pulsating DC. It uses diodes, which allow current to flow in only one direction. Both half-wave and full-wave rectifiers can be used, but the full-wave bridge or centre-tap design is preferred because it rectifies both halves of the AC cycle and gives higher efficiency with less power loss.

3. Filter Circuit

The filter removes ripples from the pulsating DC coming from the rectifier. Capacitor filters, LC filters, and π-filters are commonly used. A capacitor blocks DC and passes AC, so it smooths the output by bypassing AC ripple. Inductors, on the other hand, block AC and allow DC, and when combined with capacitors, they provide improved filtering performance.

4. Regulator Circuit

The regulator is the final and most important block that keeps the output voltage constant. It uses components like Zener diodes, IC regulators (78XX series), or LM317 to maintain a stable DC output despite variations in input voltage or load current. Series regulators place the control element in series with the load, while shunt regulators place it in parallel; series regulators are more efficient.

Q7. Subtraction using Complements

(a) $(3250)_{10} – (72532)_{10}$ via 10's complement method:

Subtrahend 72532 → 10's complement = 27468.
Add to minuend 03250 + 27468 = 30718 → no end carry → result = -69282.

(b) Binary subtraction: X=1010100, Y=1000011. Y's 2's complement = 0111101. Add: 1010100 + 0111101 = 10010001 → discard end carry → result $0010001_2 = 17_{10}$.

Q8. Boolean Simplification and Theorem Proof

(a) Simplify $F = BC + AC' + AB + BCD$
Step 1 — remove redundancy:

- Notice $BC + BCD = BC(1 + D) = BC$(since $1 + D = 1$).
  So $BCD$is redundant.

Thus $F = BC + AC' + AB$.
Step 2 — try factoring / reduction:
Option 1: Factor A:

$$F = AB + AC' + BC = A(B + C') + BC.$$

Option 2: Factor B:

$$F = AB + BC + AC' = B(A + C) + AC'.$$

No further reduction to two terms is possible without introducing additional variables — the expression with three product terms is minimal in SOP form (3 product terms). So a neatly factored (but equivalent) form is:

$$\boxed{F = A(B + C') + BC(\text{or})F = B(A + C) + AC'.}$$

Realization with logic gates (one clear implementation):

- Implement $C'$with an inverter.
- OR gate to compute $B + C'$.
- AND gate for $A \cdot (B + C')$.
- AND gate for $B \cdot C$.
- OR gate to combine the two AND outputs.

(b) Prove boolean theorem $A + BC = (A + B)(A + C)$
Algebraic expansion (straightforward):
Right side:

$$(A + B)(A + C) = A \cdot A + A \cdot C + B \cdot A + B \cdot C.$$

Use idempotent law $A \cdot A = A$and commutativity:

$$= A + AC + AB + BC.$$

Factor $A$from the middle two terms:

$$= A + A(C + B) + BC.$$

But $A + A(\text{anything}) = A$(absorption law). So:

$$= A + BC.$$

Hence:

$$(A + B)(A + C) = A + BC.$$

So the theorem is proven.