BASIC ELECTRICAL AND ELECTRONICS ENGINEERING [0BSES104]

Model answer

Q1 A

In a circuit, three resistors of 2Ω, 3Ω and 6Ω are connected in parallel. This combination is connected in series with a 4Ω resistor. Find the total resistance and the current when connected to a 12V supply.

Ans.

Given:

Parallel resistors: R1 = 2 Ω ,
R2 = 3 Ω , R3=6 Ω

Series resistor: R4 = 4 Ω

Supply voltage: V = 12 V

Step 1: Find equivalent resistance of the parallel combination

1 / Rp = 1 / R1 + 1 / R2 + 1 / R3

1 / Rp = 1 / 2 + 1 / 3 + 1 / 6

Find the common denominator (6):

1 / Rp = 3 + 2 + 1 / 6 = 6 / 6 = 1

Rp = 1 Ω

Equivalent resistance of parallel part = 1 Ω

Step 2: Add the 4 Ω resistor in series

R(total) = Rp + R4 = 1 + 4 = 5 Ω

Total Resistance = 5 Ω

Step 3: Find the total current using Ohm's Law

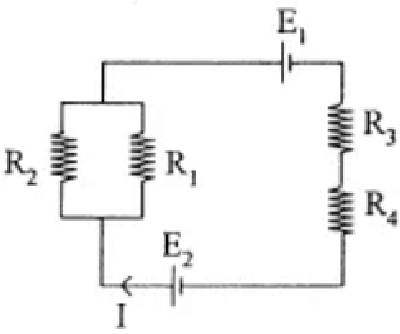
I = V / R(total)

I = 12 / 5 = 2.4 A

Total Current = 2.4 A

Q1 B

An electric circuit consists of four resistors, R1 = 12 Ohm, R2 = 12 Ohm, R3 = 3 Ohm and R4 = 6 Ohm, and are connected with a source of emf E1 = 6 Volt, E2 = 12 Volt. Determine the electric current flows in the circuit as shown in the figure below.



Ans.

Resistor 1 (R1) and resistor 2 (R2) are connected in parallel.

The equivalent resistor:

1/R12 = 1/R1 + 1/R2 = 1/12 + 1/12 = 2/12

R12 = 12/2 = 6 Ω

In this solution, the direction of the current is the same as the direction of clockwise rotation.

– I R12 – E1 – I R3 – I R4 + E2 = 0

– 6 I – 6 – 3I – 6I + 12 = 0

– 6I – 3I – 6I = 6 -12

– 15I = – 6

I = -6/-15

I = 2/5 A

Thus, current flowing through the circuit is 0.4 A.

Q1c **Explain following terms with formulae:**
i)Instantaneous value ii) Angular frequency iii)RMS Value iv)Average Value v)Form Factor vi)Peak Factor

Ans.

i)Instantaneous value: The value of voltage or current at any specific instant of time. v(t)=Vmsin(ωt). Instantaneous values of voltagesbat 0^o , 90^o , 270^o are 0, +Vm, -Vm respectively.

ii) Angular frequency: The angular displacement (in radians) per unit of time, or the rate of phase change. **Units:** Radians per second (rad/s). **Formula:** $\omega=2\pi f$ or $\omega=2\pi/T$..

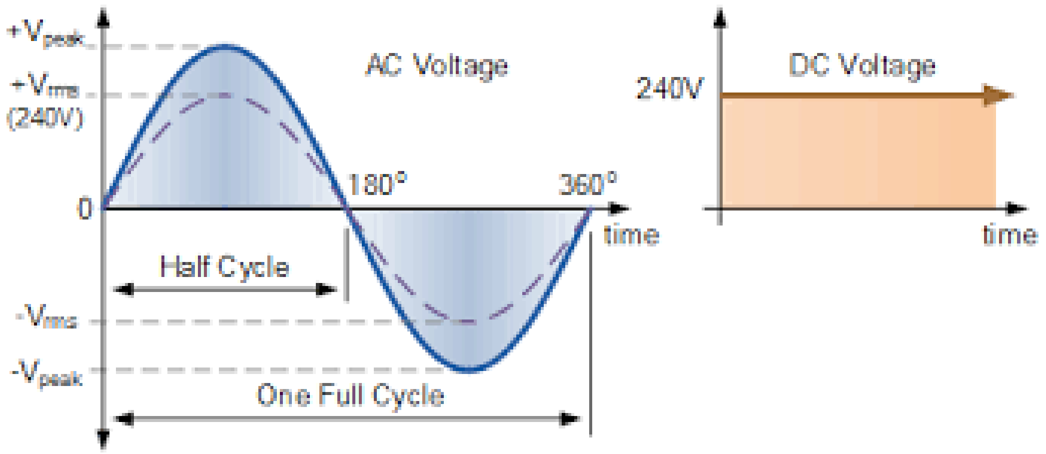
iii) RMS Value: (Root Mean Square) The effective or RMS value of an AC current is equal to the steady state or DC current that is required to produce the same amount of heat as produced by the AC current, provided that the resistance and time for which these currents flow are identical.

RMS value is called as 'heat producing component' of AC current.

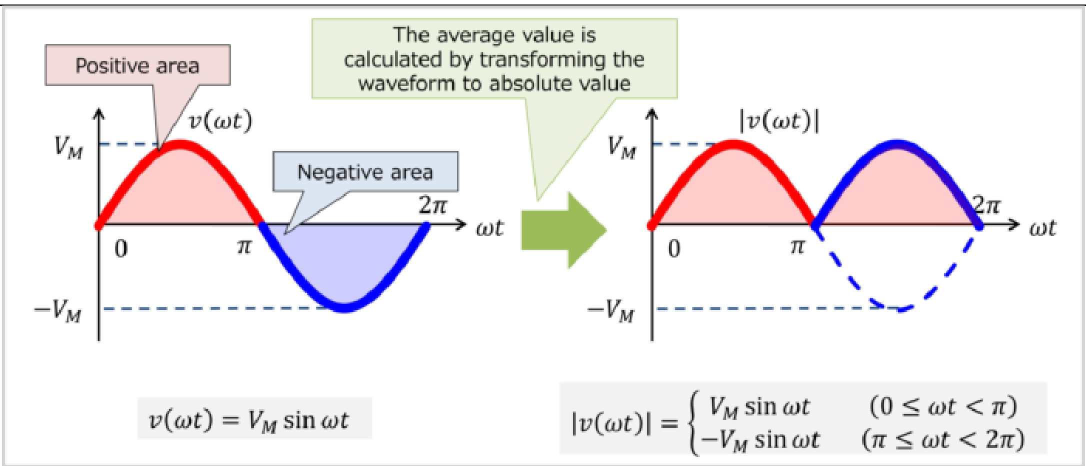
RMS value of sinusoidal waveform is equal to 0.707 times its peak value.

Irms=Im/√2 =0.707 Im

Vrms= Vm/ √2= 0.707 Vm



iv)Average Value: The average value of an AC quantity is equal to the average of all, the instantaneous values over a period of half cycle. The average value over a complete cycle is zero. Average value= 2/Π x Peak value = 0.637 × Peak value.



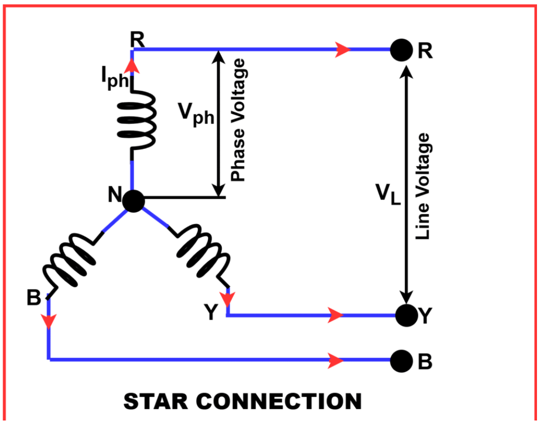
v)Form Factor:

Ratio of *RMS value* to *average value*.
Form Factor=Vrms / Vavg = 0.707 Vm/ 0.637 Vm
For sine wave, K_f = 1.11

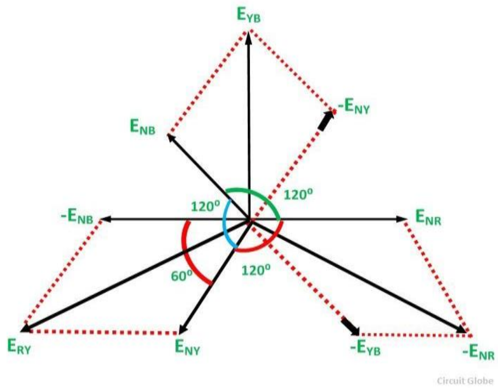
vi)Peak Factor:

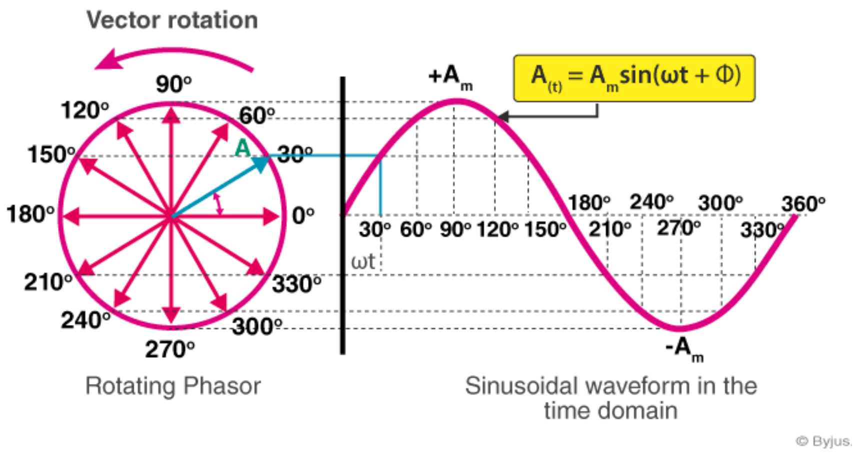
Also called Crest or amplitude factor.
Ratio of *peak value* to *RMS value*.
Peak Factor, Kp =Vm / Vrms= 1.414 = √2

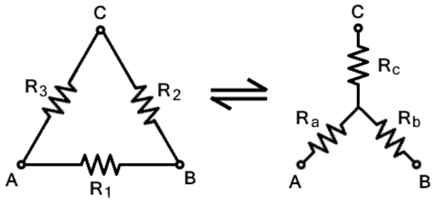
Q1d **Draw and explain 3-phase star connection with phasor diagrams.**
Ans.



A 3-phase star (Y) connection links one end of three windings to a common **neutral point**, with the other ends becoming line terminals (R, Y, B). Its phasor diagram shows three equal-magnitude phase voltages (Vph) (e.g., VAN,VBN,VCN) separated by **120°**, forming an equilateral triangle, representing voltages from each phase to the neutral. The line voltages (VL) are √3times the phase voltages and are 120° apart from each other, while phase currents (Iph) equal line currents (IL) in a balanced star system.

	 • **Star Connection:** One end of each phase winding connects to a neutral point (N); the other ends connect to lines (R, Y, B). • **Phasors:** Vectors representing AC voltage/current, showing magnitude (length) and phase (angle). • **Balanced System:** Equal voltage/current magnitudes and 120° phase separation between phases. • Phase Voltages (Vph): Draw three equal vectors (VAN,VBN,VCN) starting from a common origin (Neutral Point N), spaced 120° apart. • Phase Currents (Iph): Draw these vectors lagging or leading the phase voltages by the load's power factor angle (ϕ). In a balanced system, Iph magnitude is equal across phases. • Line Voltages (VL): Represent the voltage between any two lines (e.g., VAB). Found by vector subtraction ($VAN-VBN$). In a balanced system, line voltages are VL=3√Vph,and are 120° apart. • Line Currents (IL): In a balanced star, the line current is equal to the phase current (IL=Iph). • Line Voltage = √3 × Phase Voltage Line Current = Phase Current • This configuration ensures that even at high line voltages, each winding handles a lower phase voltage, which reduces insulation requirements.
Q2a	**A 100 Ω resistor is connected to a 220 V, 50 Hz ac supply.** **(a) What is the RMS value of current in the circuit?** **(b) What is the net power consumed over a full cycle?** **Ans.** **Given:** The resistance of the resistor R = 100 Ω The source voltage Vrms = 220 V The frequency of the supply f= 50 Hz. To determine the value of the current in the connection, we can use the following relation: Irms=Vrms/R Substituting values, we get I= 220/100 = 2.20 A Therefore, the RMS value of the current in the connection is **2.20 A** b) The total power consumed over an entire cycle can be calculated using the following formula: P = Vrms x Irms (or $P=Vrms^2/R$) Substituting values in the above equation, we get = 220 x 2.20 = 484 W Therefore, the total power consumed is **484 W.**

Q2b	**Explain about Single Phase AC circuit. Draw and explain Phasor representation of an alternating quantity.** **Ans.** **Single Phase AC circuit:** **Definition**: An AC circuit powered by a single sinusoidal voltage source, delivering power through two wires (live and neutral), commonly used for residential and small commercial loads like lights and appliances. The voltage and current follow a sine wave, changing polarity and magnitude continuously over time, with characteristics like frequency A phasor is a rotating arrow (vector) representing an alternating quantity (voltage, current) at a specific frequency, simplifying time-domain analysis. Alternating Current (AC) is a type of electric current that reverses its direction periodically in contrast to the Direct Current (DC) which flows in a single direction. We have read about electrical circuits which contain a resistor connected across an AC source, an inductor connected across an AC source, a capacitor connected across an AC source or the combination of any two or all three of these components connected across an AC source. We know that, in the device like a resistor, the current across the resistor is in phase with the voltage source. But for the devices like inductor or a capacitor, the current either lags or leads the voltage source to a certain value. This theory of phasors is used to relate the current and the voltage in the latter case. In this section, we will learn about the phasor diagrams in detail. **Phasor representation of an alternating quantity:**  A phasor is a vector that is used to represent a sinusoidal function. It rotates about the origin with an angular speed ω. The vertical component of phasors represents the quantities that are sinusoidally varying for a given equation, such as v and i. Here, the magnitude of the phasors represents the peak value of the voltage and the current. From the figure shown above, we can see the relation between a phasor and the sinusoidal representation of the function with respect to time. The projection of the phasor on the vertical axis represents the value of the quantity. For example, in the case of a current or a vector phasor, the projection of the phasor on the vertical axis, given by $v_m \sin\omega t$ and $i_m \sin\omega t$ respectively, gives the value of the current or the voltage at that instant. From the phasor diagram, it is easy to detect that one of two quantities are in the same phase. For example, if for a given circuit, the phasors for the voltage and the current are in the same direction for all instances, the phase angle between the voltage and the current is zero.
Q2c	**Convert the given delta network into star network. R1= 10Ω, R2=15Ω, R3=20Ω. Find Ra,Rb,Rc.**



Star Delta Conversion

Ans.
Calculate the total resistance in the Delta network:

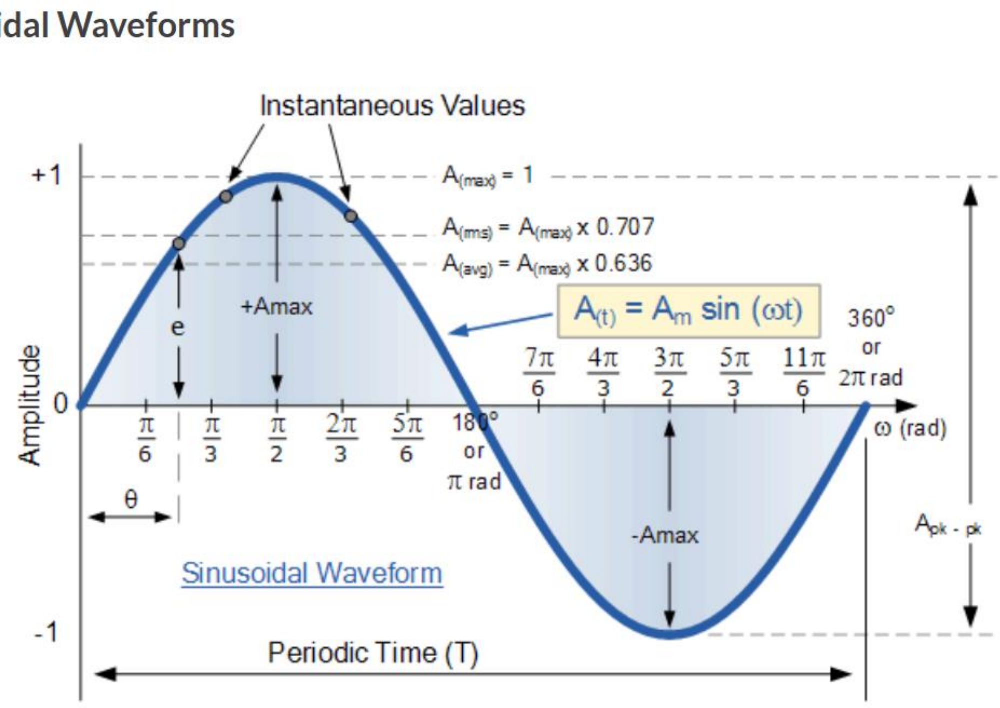
$$R_{total} = R1+R2+R3 = 10+15+20 = 45\Omega$$

To convert a Delta (Δ) network to an equivalent Star (Y) network, we use the following formulas for the resistances:

- For resistance R1 in the star network:
$$Ra = \frac{R1R3}{R1+R2+R3} = \frac{10\times 20}{45} = \frac{200}{45} = \mathbf{4.44\Omega}$$
- For resistance R2 in the star network:
$$Rb = \frac{R1R2}{R1+R2+R3} = \frac{10\times 15}{45} = \frac{150}{45} = \mathbf{3.33\Omega}$$
- For resistance R3 in the star network:
$$Rc = \frac{R2R3}{R1+R2+R3} = \frac{15\times 20}{45} = \frac{300}{45} = \mathbf{6.67\Omega}$$

Where R1, R2, and R3 are the resistances in the Delta configuration, and Ra, Rb, and Rc are the resistances in the Star configuration.

Q2d **Draw AC sinusoidal waveform and explain its various parameters in detail.**
Ans.



Parameters:
i) Waveform: The shape of the curve obtained by plotting the instantaneous values of voltage or current w.r.t. time is called as waveform. It is a graph of magnitude of a alternating quantity w.r.t. time.
The general equation for a sinusoidal waveform as a function of time is:

	$v(t)=V_m\sin(\omega t+\phi)$ Where, $v(t)$ is the **instantaneous value** of the signal at time, V_m is the **amplitude** (peak value), the maximum displacement from zero, ω is the **angular frequency** in radians per second and $\omega=2\pi f$, t is the time variable, ϕ is the **phase angle** (or phase shift) in radians or degrees. **ii) Cycle**: One complete set of positive and negative values of an alternating quantity is known as a Cycle. 1 Cycle=$2\Pi^c=360^O$. **iii) Frequency:** The number of cycles that occur in one second is called the frequency of the alternating quantity. It is denoted by 'f'. It is measured in Cycles/ sec or Hertz (Hz). f=1/T Hz. **iv) Time Period**: The time taken in seconds to complete one cycle of an alternating quantity is called its time period. It is denoted by 'T' sec. T= 1/f **v) Peak Value:** The maximum value (positive or negative) attained by an alternating quantity is called its peak value or Amplitude. It is denoted by 'Vm' for voltage, 'Im' for current. Peak voltage is the voltage measured from the baseline of an AC waveform to its maximum level +Vm or –Vm. **vi) Peak-to-Peak value:** It is the difference between positive peak and negative peak values. Vp-p=2Vm **vii) Phase:** The position of the waveform in its cycle at a given point in time relative to a reference point.
Q3a	**What is a single-phase AC circuit? What is the phase angle in AC circuits? Draw phasor diagram which shows relation between voltage and current for; i)Resistor ii)Inductor iii)Capacitor** **Ans.** **a) What is a Single-Phase AC Circuit?** A **single-phase AC circuit** is an electrical circuit that uses **one alternating voltage source** whose magnitude changes sinusoidally with time. -It has **two wires**: a **phase** (live) wire and a **neutral** wire. -The voltage varies as: -v(t) = Vmsin(ωt) It is used in homes, small loads, and lighting systems. **b) What is the Phase Angle in AC Circuits?** -The **phase angle (ϕ)** is the **angular difference between voltage and current waveforms** in an AC circuit. -If current is **in phase** with voltage → ϕ = 0° -If current **lags** voltage → ϕ is **positive** (inductive circuit) -If current **leads** voltage → ϕ is **negative** (capacitive circuit) Mathematically: $I=I_m\sin(\omega t-\phi)$ **c) Phasor Diagrams** Below are the **phasor diagrams** showing the voltage–current relationship in:

i) Pure Resistor (R)

In a purely resistive circuit:
-Voltage and current are **in-phase**
-Phase angle **ϕ = 0°**
Phasor Diagram: (They overlap; same direction)

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ii) Pure Inductor (L)

-In an inductive circuit:
-Current **lags** voltage by **90°**
-Phase angle **ϕ = +90°**
Phasor Diagram: (Current lags by 90°) or (Voltage leads current)

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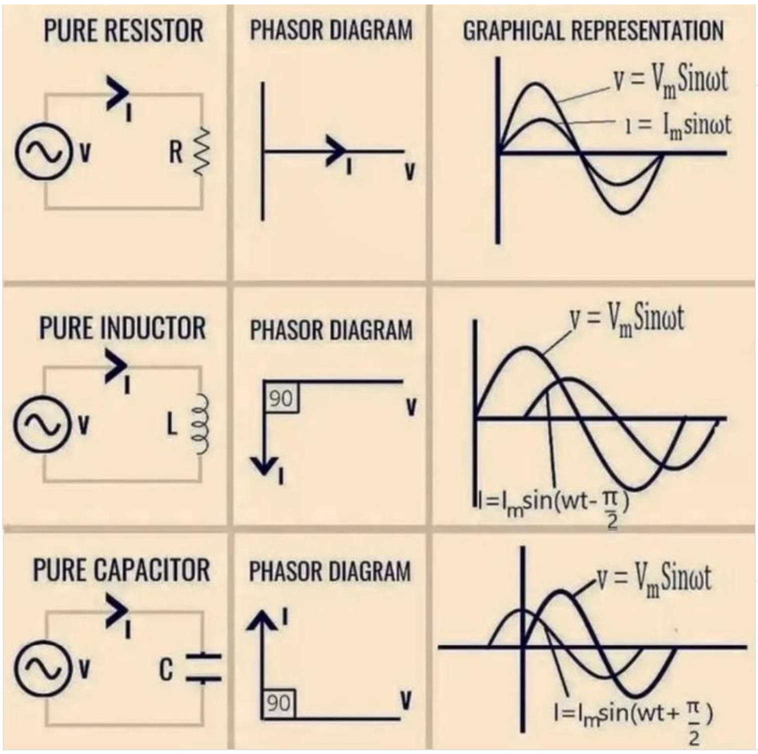
iii) Pure Capacitor (C)

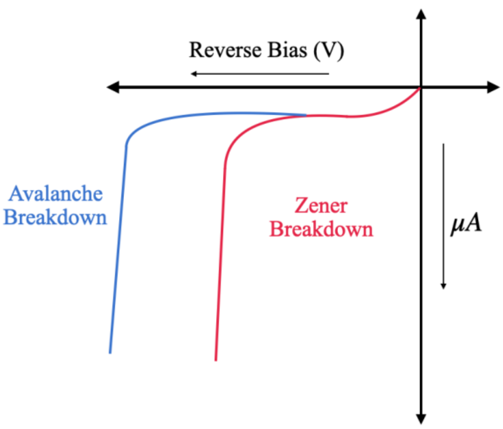
-In a capacitive circuit:
-Current **leads** voltage by **90°**
-Phase angle **ϕ = –90°**
Phasor Diagram: (Current leads by 90°)



Q3b **If V=141.4 sin(628t-Π/6) Volts, then Calculate:**

- **i)** **R.M.S. value**
- **ii)** **Maximum Value**
- **iii)** **Angular frequency**
- **iv)** **Frequency**
- **v)** **Form Factor**
- **vi)** **V at t=0.015 sec**

Ans.
Given:
V =141.4 sin (628t-Π/6)
Vrms=?
Vm=?
ω=?
f=?
form factor=?

	V=? at t=0.015 sec **Soln.** We have, V=141.4 sin (628t-Π/6) Compare it with, V=Vm sin (ωt-Ø) ∴ Max. voltage, Vm=**141.4 V**, Angular frequency, ω=**628 rad/sec**, Ø=Π/6 Vrms= Vm/√2 = 141.4/ √2 = **99.984 V ≈ 100V** We know that, ω=2Πf, ∴ frequency, f=ω/ 2Π = 628/ 2Π =**99.949 Hz ≈ 100 Hz** Form factor= RMS value/ Average value = 0.707 Vm/ 0.637 Vm = **1.11** Now, V(0.015)= 141.4 sin (628 x 0.015 – Π/6) 628 x 0.015 ≈ 9.42 radians. Convert values to degrees, ($\Pi^{C}=180^{O}$) 9.42 rad ≈ 540^{O} & Π/6 =30^{O} V(0.015)= 141.4 sin (540^{O} – 30^{O}) = 141.4 sin (510^{O}) ∵ sin(510^{O})= sin(360^{O}+150^{O})=sin(150^{O})=0.5 ∴ V(0.015)=141.4 x 0.5= 70.7 V V= **70.7 V**
Q4a	Explain the principle of Avalanche breakdown and Zener breakdown. **Ans.** **<u>Avalanche Breakdown</u>:** This type of breakdown occurs in the reverse biased condition. When we apply a large reverse voltage, the velocity of minority carriers will increase to a great extent. Thus gaining high kinetic energy. In their path, they collide with stationary atoms and give some kinetic energy to valence electrons present in covalent bonds. These electrons start breaking other covalent bonds and start creating more hole-electron pairs. These pairs start crossing the depletion region and contribute to a high reverse reverse biased current. These free electrons will be accelerated and they knockout some more valence electrons by means of collisions. This chain reaction is called Avalanche effect. The breaking of bond is an irreversible process, and the p-n junction is completely destroyed after an avalanche breakdown as large heat is generated near the junction beyond safety limits. So, Avanache breakdown is avoided. 

Zener Breakdown:

Zener Breakdown is a controlled way of creating breakdown in p-n junction diodes. The p-n junction has to be heavily doped so that the electrons in the valence bond of p-type region can jump easily to the conduction band of n-type region. This temporary breakdown occurs due to the high electric field which appear across narrow depletion region. This strong electric field pulls some valence electrons into conduction band by breaking covalent bonds. This large number of free electrons will constitute large reverse current through zener diode and breakdown occurs due to zener effect. As it does not contribute to a chain reaction, the effects of Zener breakdown is temporary. The breakdown voltage decreases with increase in junction temperature. This is known as Zener breakdown.

Q4b Draw the block diagram of a dc regulated power supply and explain role of each block.

Ans.

Today almost every electronic device needs a DC supply for its smooth operation and they need to be operated within certain power supply limits. This required DC voltage or DC supply is derived from single phase ac mains.

A regulated power supply can convert unregulated an AC (alternating current or voltage) to a constant DC (direct current or voltage). A regulated power supply is used to ensure that the output remains constant even if the input changes. A regulated DC power supply is also called as a linear power supply, it is an embedded circuit and consists of various blocks.

The regulated power supply will accept an AC input and give a constant DC output. Figure 1.23.1 below shows the block diagram of a typical regulated DC power supply

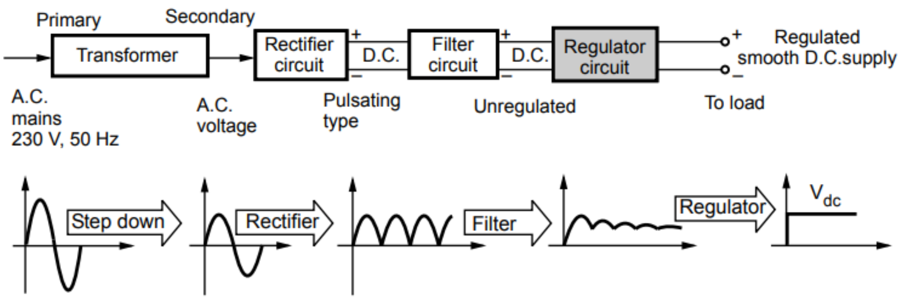


Fig. 1.23.1 Block schematic of regulated power supply with waveforms

The basic building blocks of a regulated DC power supply are as follows:

1. A step down transformer
2. A rectifier
3. A DC filter
4. A voltage regulator

Step Down Transformer

A step down transformer will step down the voltage from the ac mains to the required voltage level. The turn's ratio of the transformer is so adjusted such as to obtain the required voltage value. The output of the transformer is given as an input to the rectifier circuit.

Rectification

Rectifier is an electronic circuit consisting of diodes which carries out the rectification process. Rectification is the process of converting an alternating voltage or current into corresponding direct (DC) quantity. The input to a rectifier is ac whereas its output is unidirectional pulsating DC. Usually a full wave rectifier or a bridge rectifier is used to rectify both the half cycles of the ac supply (full wave rectification).

DC Filtration

The rectified voltage from the rectifier is a pulsating DC voltage having very high ripple

	content. But this is not we want, we want a pure ripple free DC. The basic filters used are; C, L,LC, $\pi - filter$ **Regulation** This is the last block in a regulated DC power supply. The output voltage or current will change or fluctuate when there is change in the input from ac mains or due to change in load current at the output of the regulated power supply or due to other factors like temperature changes. This problem can be eliminated by using a regulator. A regulator will maintain the output constant even when changes at the input or any other changes occur. Transistor series regulator, Fixed and variable IC regulators or a zener diode operated in the zener region can be used depending on their applications. IC's like 78XX and 79XX are used to obtained fixed values of voltages at the output. waveform. Hence a filter is used.
Q4c	In a centre tapped FWR, the rms half secondary voltage is 10V. Assuming ideal diodes and load resistance of R_L=2K Ω, Find: i)Peak current, ii)DC load voltage, iii)Ripple factor, iv)Rectifier Efficiency **Ans.** Given: Vs_{rms} =10V, FWR with centre tap, R_F= 0 Ω, Rs= 0 Ω, R_L= 2K Ω To Find: i) Im ii) $V_L$dc iii) Ripple factor iv) η i) Peak Current (Im): Im= Vm/(Rs+R_F+R_L) = √2 Vs_{rms}/(Rs+R_F+R_L)= √2 x 10/ 0+0+(2x10^3) =**7.07 mA** ii) DC load voltage ($V_L$dc): $V_L$dc = 2 Vm/π = 2√2 x10 / π = **9 Volts** iii) Ripple factor ($V_L$rms): $V_L$rms = $I_L$rms x R_L = Im /√2 x R_L = 7.07/ √2 x 2 = 10 Volts r = $\frac{[VLrms^2 - VLdc^2]^{1/2}}{VLdc} = \frac{[10^2 - 9^2]^{1/2}}{9}$ = **0.4843 or 48.43 %** iv) Rectification efficiency (η): $$\eta = \frac{8\ RL}{\pi^2(Rs + RF + RL)}$$ But, Rs= R_F= 0 Ω ∴ η =8/ π^2 = **0.8105 or 81.05%**
Q4d	**Convert the following Decimal numbers to equivalent Binary numbers:** **i) $(25)_{10}$** **ii) $(278)_{10}$** **iii) $(180)_{10}$** **Ans.** **i) 25**

Division by 2	Quotient	Remainder
25 ÷ 2	12	1
12 ÷ 2	6	0
6 ÷ 2	3	0
3 ÷ 2	1	1
1 ÷ 2	0	1

The division stops when the quotient is 0.
Now, read the remainders from bottom to top: **11001**.

Therefore, the decimal number 25 is **11001** in binary, often written with subscripts as $(25)_{10}=(11001)_2$

ii) 278

Division by 2	Quotient	Remainder	Binary Bit
278 ÷ 2	139	0	0 (LSB)
139 ÷ 2	69	1	1
69 ÷ 2	34	1	1
34 ÷ 2	17	0	0
17 ÷ 2	8	1	1
8 ÷ 2	4	0	0
4 ÷ 2	2	0	0
2 ÷ 2	1	0	0
1 ÷ 2	0	1	1 (MSB)

∴ $(278)_{10} = (100010110)_2$

iii) 180

Division by 2	Quotient	Remainder	Binary Bit
180 ÷ 2	90	0	0(LSB)
90 ÷ 2	45	0	0
45 ÷ 2	22	1	1
22 ÷ 2	11	0	0
11 ÷ 2	5	1	1
5 ÷ 2	2	1	1
2 ÷ 2	1	0	0
1 ÷ 2	0	1	1(MSB)

∴ $(180)_{10} = (10110100)_2$

Q5 A

What is Octal Number System? Give an example in detail. Write Octal Symbols.

Ans.

The octal number system is a **base-8 system** that uses eight symbols: the digits **0, 1, 2, 3, 4, 5, 6, and 7**. It is commonly used in computer science because each octal digit can represent a group of three binary

	digits (bits), making it a more compact way to represent binary numbers. The octal numbers, in the number system, are usually represented by binary numbers when they are grouped in pairs of three. For example, an octal number $(12)_8$ is expressed as $(001010)_2$ in the binary system, where 1 is equivalent to 001 and 2 is equivalent to 010. Octal Symbol / Binary equivalent: 0 = 000; 1 = 001; 2 = 010; 3 = 011; 4 = 100; 5 = 101; 6 = 110; 7 = 111 Note: Octal number system supports digits from 0 to 7. Beyond 7, such as 8 and 9 are not octal digits. For example, 19 is not an octal number.
Q5b	**How to convert Decimal number into Hexadecimal number? Give an example.** **Ans.** To convert decimal to hexadecimal, repeatedly divide the decimal number by 16, noting the remainder at each step. Continue dividing the quotient until you reach zero. Then, write the remainders from bottom to top, converting any remainders of 10-15 to their corresponding hexadecimal letters (A-F). **Steps for converting a decimal number to hexadecimal** 1. **Divide by 16**: Take the decimal number and divide it by 16. Record the quotient and the remainder. 2. **Repeat division**: Take the new quotient and divide it by 16. Record the new quotient and remainder. 3. **Continue until zero**: Keep repeating this process until the quotient becomes 0. 4. **Convert remainders to hex**: If any remainder is 10 or greater, convert it to its hexadecimal equivalent: $10 = A, 11 = B, 12 = C, 13 = D, 14 = E, 15 = F$ 5. **Write the result**: Read the remainders from the bottom up to form the hexadecimal number. **Example:** Convert 4768 from decimal to hexadecimal Step 1: 4768/16=298 with a remainder of 0. Step 2: 298/16=18 with a remainder of 10 (which is A) in hex. Step 3: 18/16=1 with a remainder of 2. Step 4: 1/16=0 with a remainder of 1. Step 5: Read the remainders from bottom to top: (1,2,A,0). The hexadecimal equivalent of $(4768)_{10}$ is $(12A0)_{16}$.
Q5 C	**Convert the following Hexadecimal numbers to equivalent Decimal numbers:** i) $\mathbf{(7CF)_{16}}$ ii) $\mathbf{(1DA6)_{16}}$ iii) $\mathbf{(5BC)_{16}}$ **Ans.** i) $(7CF)_{16}$ F is in position 0 (16^0) and has value of 15. C is in position 1 (16^1) and has value of 12. 7 is in position 2 (16^2) and has value of 7. $= (7 \times 16^2)+(12 \times 16^1)+(15 \times 16^0)$ $=(7 \times 256)+(12 \times 16)+(15 \times 1)$ =1792+192+15 =1999 The decimal equivalent of $(7CF)_{16}$ is **1999.**

Octal Symbol	Binary equivalent
0	000
1	001
2	010
3	011
4	100
5	101
6	110
7	111

	ii) $(1DA6)_{16}$ 6 is in position 0 (16^0) and has value of 6 A is in position 1 (16^1) and has value of 10. D is in position 2 (16^2) and has value of 13. 1 is in position 3 (16^3) and has value of 1. $= (1 \times 16^3)+(13 \times 16^2)+(10 \times 16^1)+(6 \times 16^0)$ $=(1 \times 4096)+(13 \times 256)+(10 \times 16)+(6 \times 1)$ =4096+3328+160+6 =7590 The decimal equivalent of $(1DA6)_{16}$ is **7590.** iii) $(5BC)_{16}$ C is in position 0 (16^0) and has value of 12. B is in position 1 (16^1) and has value of 11. 5 is in position 2 (16^2) and has value of 5. $=(5 \times 16^2)+(11 \times 16^1)+(12 \times 16^0)$ $=(5 \times 256)+(11 \times 16)+(12 \times 1)$ =1280+179+12 =1468 The decimal equivalent of $(5BC)_{16}$ is **1468.**
Q6 A	**How many types of number systems are there? Explain each number system in detail** **Ans.** There are several number systems, but four primary types dominate: **Decimal (Base-10)** for everyday use, **Binary (Base-2)** for computers (0s & 1s), **Octal (Base-8)** for grouping binary digits, and **Hexadecimal (Base-16)** for more compact binary representation (0-9, A-F). Each system uses different bases (radix) and sets of digits, with positional value determining a number's magnitude, but the core concept of representing quantities remains the same. **1. Decimal Number System (Base-10)** • **Digits:** Uses ten digits: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9. • **Base:** 10. • **Explanation:** The system we use daily, where each position's value is a power of 10 (e.g., in 123, it's $1 \times 10^2 + 2 \times 10^1 + 3 \times 10^0$) **2. Binary Number System (Base-2)** • **Digits:** Uses two digits: 0 and 1. • **Base:** 2. • **Explanation:** Fundamental to computers, representing ON (1) and OFF (0) states; values are powers of 2 (e.g.,$1011_2 = 1 \times 2^3+0 \times 2^2+1 \times 2^1+1 \times 2^0=11_{10}$) **3. Octal Number System (Base-8)** • **Digits:** Uses eight digits: 0, 1, 2, 3, 4, 5, 6, 7. • **Base:** 8. • **Explanation:** Often used as a shorthand for binary, grouping three binary digits (e.g.,000_2 to 111_2 map to 0_8 to 7_8) **4. Hexadecimal Number System (Base-16)** • **Digits:** Uses 16 symbols: 0-9 and A (10), B (11), C (12), D (13), E (14), F (15). • **Base:** 16. **Explanation:** Another compact form for binary, grouping four binary digits; widely used in computing for memory addresses and colors.
Q6b	**Convert the following Decimal numbers to equivalent Octal numbers:** **i)** $(560)_{10}$ **ii)** $(786)_{10}$ **iii)** $(0.52)_{10}$ **Ans.**

The decimal numbers can be converted to octal numbers using repeated division for the integer parts and repeated multiplication for the fractional parts.

i) To convert 560 to octal, repeatedly divide the integer by 8:

- 560÷8=70

with a remainder of **0**

- 70÷8=8

with a remainder of **6**

- 8÷8=1

with a remainder of **0**

- 1÷8=0

with a remainder of **1**

Reading the remainders from bottom to top, we get:
$(560)_{10}=(1060)_8$

ii) To convert 786 to octal, repeatedly divide the integer by 8:

- 786÷8=98

with a remainder of **2**

- 98÷8=12

with a remainder of **2**

- 12÷8=1

with a remainder of **4**

- 1÷8=0

with a remainder of **1**

Reading the remainders from bottom to top, we get:

$(786)_{10}=(1422)_8$

iii) To convert the fractional part 0.52 to octal, repeatedly multiply the fraction by 8 and record the integer part:

- 0.52×8=4.16(Integer part: **4**)
- 0.16×8=1.28 (Integer part: **1**)
- 0.28×8=2.24 (Integer part: **2**)
- 0.24×8=1.92 (Integer part: **1**)
- 0.92×8=7.36 (Integer part: **7**)

Reading the integer parts from top to bottom, we get an approximation:

$(0.52)_{10} \approx (0.41217)_8$

Q6c **Convert the following binary numbers to hexadecimal:**

(a) 1010110110111

(b) 10110111011011

(c) 0110101100

(d) 100101101110

Ans.

(a) 1010110110111

Grouping in bits of 4:

0001 0101 1011 0111

Binary Number	Equivalent Hexadecimal

0111	7
1011	B (11)
0101	5
0001	1

Therefore, $(1010110110111)_2$ = **$(15B7)_{16}$**

(b) 10110111011011
Grouping in bits of 4:
0010 1101 1101 1011

Binary Number	**Equivalen Hexadecimal**
1011	B (11)
1 01	D (13)
1101	D (13)
0010	2

Therefore, $(10110111011011)_2$ = **$(2DDB)_{16}$**

(c) 0110101100
Grouping in bits of 4:
0001 1010 1100

Binary Number	**Equivalent Hexadecimal**
1100	C (12)
1010	A (10)
0001	1

Therefore, $(0110101100)_2$ = **$(1AC)_{16}$**

(d) 100101101110

Grouping in bits of 4:

1001 0110 1110

Binary Number	**Equivalent Hexadecimal**
1110	E (14)
0110	6
1001	9

Therefore, $(100101101110)_2$ = $\mathbf{(96E)_{16}}$