Q.2 a. List the properties possessed by the lines of magnetic flux.

Answer:

Electric circuits	**Magnetic circuits**
Similarities in electric and magnetic circuits	
Current flows in the circuit	Flux is assumed to flow
The path of current is called electric circuit.	Path of flux is called magnetic circuit.
Current flows due to e.m.f.	Flux flows due to m.m.f.
Flow of current is restricted by resistance of the circuit.	Flow of flux is restricted by reluctance of the circuit.
Current = e.m.f./resistance	Flux = m.m.f./reluctance
resistance R = l/σA	Reluctance S = l/μA
Dissimilarities in electric & magnetic circuits	
Current actually flows in the circuit	Flux does not flow, it is only assumed to flow for finding out certain magnetic effects.
Energy is needed till the current flows	Energy is needed only to create the magnetic flux
Resistance of the circuit is independent of the current.	Reluctance of the circuit changes with the magnetic flux.

b. A steel ring of 25 cm mean diameter and of circular section 3 cm in diameter has an air gap of 1.5 mm length. It is wound uniformly with 700 turns of wire carrying a current of 2 A. Calculate
(i) magnetomotive force (ii) flux density
(iii) magnetic flux (iv) reluctance
(v) relative permeability of steel ring.
Neglect magnetic leakage and assume that iron path takes about 35 percent of the total magnetomotive force.

Answer:

If a conductor carrying s current of I is placed in a uniform magnetic field of flux density B wb/m^2. If experiences a mechanical force that depends upon the magnitude of current, the length of the conductor and flux density of the magnetic field. The direction of this force can be determined by fleming's left and rule.

Consider a conductor of length l meter carrying a current of I ampere and placed in a uniform magnetic field of flux density B wb/m^2, making an angle of θ with the direction of the field. The mechanical force experience by the conductor is directly proportional to,

(i) Current flowing in the conductor I.
(ii) Length of the conductor ι.
(iii) Flux density of the uniform magnetic field B, and
(iv) Since of the angle between the conductor and the uniform magnetic field, θ hence f = BIdι sin θ

In general, for any element current of length dI , the force experienced is given by,

dF = BIdι sin θ

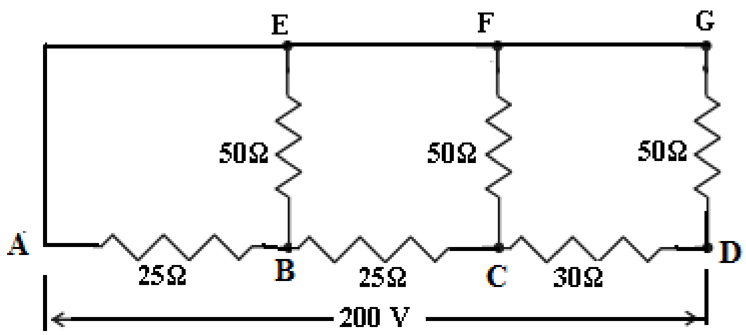
Electrical motors producing mechanical power, work basically on this principle. As such, the above relationship is very useful in the study of electrical engineering.

Based upon the direction of the flux and the direction of current in the conductor, the direction of the force can be determine by applying “Fleming left rule”

Q.3 a. State and explain Thevenin’s theorem with example.

Answer: Page Number 28-29 of Text Book I

b. In the circuit shown in figure find the current drawn by the circuit, when it is connected across a 200V DC supply.



Answer:

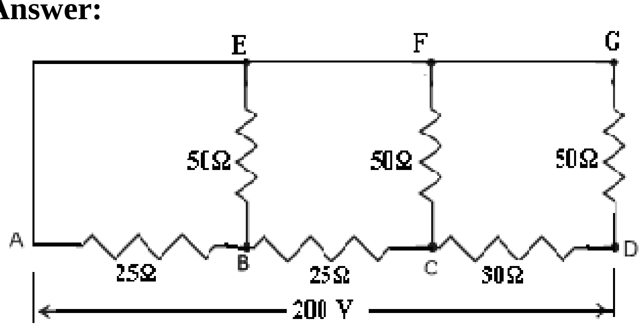


Fig -1

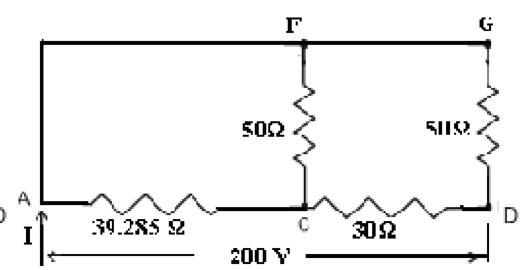


Fig-2

In the Circuit Resistance R_{AB} and R_{BE} are in parallel and thus their equivalent resistance is given by

R_1 = 20 x 50 / (20+50)

= 14.285 ohms

Now the resistance R_1 and R_{BC} are in series, hence their equivalent resistance is

R_2 = 14.285 +25

= 39.285 ohms

with the above simplification , the circuit shown in fig 1 , can be represented by the circuit given in fig 2.

In fig 2 the resistance R_{AC} and R_{CF} are in parallel and their equivalent resistance is given by,

R_3 = 39.285 x 50 / (39.285+50)

= 21.99 ohms

Now resistance R_3 and R_{CD} are in series, thus their equivalent resistance is
$R_4 = 21.99 + 30$
$= 51.99$ ohms
Now the two resistance R_4 and R_{DG} are in parallel , and as such the resultant resistance of the complete circuit between the point A and D is given by,
R = 51.99 x 50 / (51.99+50)
= 25.487 ohms
Voltage applied to the circuit is 200V
Applying Ohms Law
I = 200/25.487
7.846 A
Hence current drawn by the circuit is 7.846 A.

Q.4 a. Derive EMF equation of DC Generator.

Answer:

<u>EMF equation of Generator</u>. The average emf generated by the armature of a dc generator (voltage across the brushes of different polarity) is equal to the sum of the emfs of all the conductors connected in series in one parallel path. If the total conductor on the armature of a dc machine is Z, then the number of conductors connected in series in one parallel path will be Z/A. where A is the number of parallel paths in the armature winding.

Hence the emf generated by one parallel path,
E_g = Average emf per conductor x Z/A
$= e_{av} \times Z / A$
And the emf generated by the armature = emf generated by one of the parallel paths of the armature winding
$= e_{av} \times Z / A$ ----------(1)
Also, the average emf generated by one conductor = flux cut per second (according to faradays second law of induction)
If Φ is the air gap flux per pole in webers and P the total number of poles in the machine , then the total flux cut by one conductor in completing one revolution of armature = P Φ
Flux cut by one conductor per second = P Φ x(N/ 60)
Where N is the speed of the machine in rpm
Hence emf generated by one conductor of the armature = (P Φ N / 60) x V ------------(2)
Combining (1) and (2) , emf generated by the armature of a dc machine,
$E_g = (P \Phi N / 60) \times (Z / A) = (P \Phi N Z / 60 A) \times (V)$ ------------(3)
For a lap wound armature, the number of parallel paths in the armature winding is equal to the number of poles in the machine. Hence emf generated for lap wound armature
$= (P \Phi N Z / 60 P) = (\Phi N Z / 60) \times V$ --------------(4)
For a wave wound armature, the number of parallel paths in the armature winding is equal to two, irrespective of the number of poles in the machine.
Thus emf generated for wave wound machines

$= (P\ \Phi\ N\ Z / 60 \times 2) = (P\ \Phi\ N\ Z / 120) \times V$ -----------------(5)

The expressions given for the induced emf in eqns (3,4 and 5) hold equally for generators and motors, because it is quite immaterial whether the motion of the armature is due to the mechanical prime mover or due to action of machine as a dc motor.

In the case of a dc motor , however, the emf so induced is known as back emf , because the induced emf acts in a direction opposite to the applied voltage.

Hence back emf for dc motor = $(P\ \Phi\ N\ Z / 60\ A) \times V$

b. A 6-pole, lap wound armature has 840 conductors and flux per pole of 0.018 wb. Calculate the emf generated, when the machine is running at 600 rpm.

Answer:

Number of poles , P = 6

The winding on the armature is lap type, hence the number of parallel paths in the armature winding,

A =6

Flux per pole , Φ = 0.018Wb

Speed of rotation , N = 600 rpm

Number of conductors on armature, Z = 840

Emf generated, $E_g = (P\ \Phi\ N / 60) \times (Z / A) = (6 \times 0.018 \times 600 \times 840) / (60 \times 6)$

= 151.2 V

Q.5 a. Derive the emf equation of a single phase transformer. What is the voltage transformation ratio?

Answer:

EMF equation of a single phase transformer.

Let B_m = Maximum flux density in the transformer having.

A = Core area.

N_1 = Number of turns on the primary winding.

N_2 = Number of turns on the secondary winding.

V_1 = Applied voltage to side-1(hereafter called h.t. side).

E_1 = rms value of the back e.m.f in side-1(h.t side).

E_2 = back e.m.f in side-2 (l.t. side).

The quadrature (magnetizing) component of primary no-load current is responsible for the core flux and it lags the primary voltage by 90^0 Obviously the core flux Φ will also be a sinusoid of same frequency 'f ' but with a 90^0 phase shift. Hence Φ can be expressed as $\Phi = \Phi_m \cos 2\pi ft$.

Hence the instantaneous value of the induced e.m.f (back e.m.f) in the primary winding will be

$e_1 = -N_1\ d\varphi/dt = 2\pi f \varphi_m N_1 \sin 2\pi ft = E_{1m} \sin 2\pi ft$ Volts.

$E_1 = E_{1m}/\sqrt{2} = 2\pi f \varphi_m N_1/\sqrt{2} = 4.44 f\ \varphi_m N_1$ volts.

Since $\varphi_m/A = B_m$

$E_1 = 4.44f\, B_m\, AN_1$

Similarly $E_2 = 4.44f\, B_m\, AN_2$

Voltage transformation ratio

The ratio of secondary voltage to the primary voltage is called as Voltage transformation ratio

i.e $V_2/V_1 = K$ (Voltage transformation ratio)

For an ideal transformer

Input VA = Output VA

$V_1I_1 = V_2I_2$

or $V_2/V_1 = I_1/I_2 = K$

if N_1 is the nos. of turns in primary winding and N_2 is the nos. of turns in Secondary winding

then the voltage per turn of primary $= V_1/N_1$

voltage per turn of Secondary$= V_2/N_2$

So, $V_2/N_2 = V_1/N_1$

Or $V_2/V_1 = N_2/N_1 = K$

Transformer rating in KVA.

In transformer core loss depends on voltage and copper loss dependents on current. Therefore, transformer rating is in KVA.

b. A single phase transformer has 350 primary and 1050 secondary turns. The net cross- sectional area of the core is $55cm^2$. If the primary winding be connected to a 400V, 50 Hz single phase supply. Calculate:
(i) the maximum value of the flux density in the core
(ii) the voltage induced in the secondary winding.

Answer:

(i.) Voltage applied to the primary = 400V

Induced emf in the primary E_p =Voltage applied to the primary = 400V

Number of turns in the primary $N_p = 350$

Net cross-sectional area $A_i = 55\ cm^2 = 55 \times 10^{-4}\ m^2$

Frequency of the supply f =50 Hz

Induced emf in the primary is given by

$$E_p = 4.44\ f\ B_m\ A_i\ N_p$$

$$400= 4.44 \times 50 \times B_m \times 55 \times 10^{-4} \times 350$$

Maximum value of fux density density in the core,

$$B_m = 400/ (4.44 \times 50 \times 55 \times 10^{-4} \times 350)$$

$$= 0.93 \text{ tesla } (wb/m^2)$$

ii.) Number of turns in the secondary winding, N_s =1050

For the transformer,

$$E_s / E_p = N_s / N_p$$

Voltage induced in the secondary winding, $E_s = E_p \times (N_s / N_p)$

$$= 400 \times (1050/350)$$

$$= 1200V$$

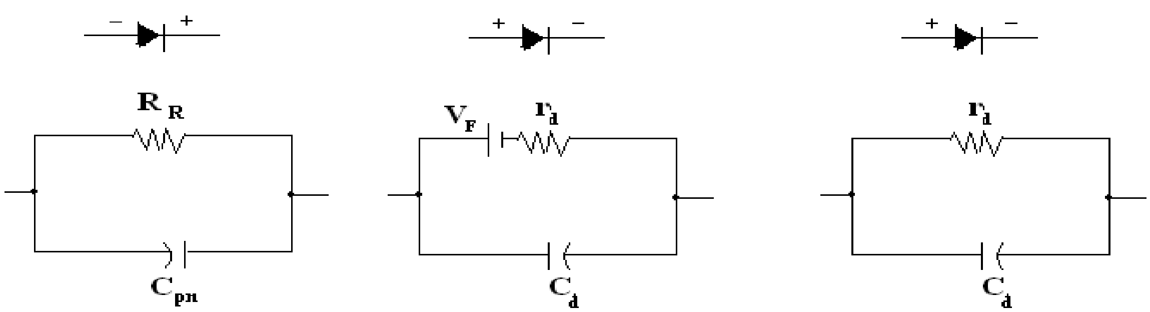
Q.6 a. Draw and explain AC equivalent circuits of a diode.

Answer:

Approximate equivalent circuit of a diode.

A reverse biased diode can be simply represented by the high reverse resistance R_R inParallel with the depletion layer capacitance C_{pn} (as in figure a). the equivalent circuit for a forward biased diode consists of the dynamic resistance r_d in series with a voltage cell representing V_F . To allow for the effect of the diffusion capacitance, C_d is included in parallel to give the complete equivalent circuit as shown in figure (b).

The complete equivalent circuit for the forward biased diode may be modified into an a.c. equivalent circuit, which can be used for diodes that are maintained in a forwardbiased condition while subjected to small variations in I_F and V_F. The ac equivalent circuit is created simply by removing the voltage cell representing V_F from the complete equivalent circuit as shown in figure c.



(a) Equivalent circuit for a reverse-biased diode

(b) Equivalent circuit for a forward-biased diode

(c) AC equivalent circuit for a forward-biased diode

Equivalent circuits (or models) for reverse-biased and forward-biased diodes.

Q.7 a. Write a note on zener diode voltage regulator

Answer: Page Number 108 of Text Book II

b. Explain series and shunt clipper circuits with diagram and waveforms.

Answer: Page Number 116-117 of Text Book II

Q.8 b. With the help of circuit diagrams, compare the base bias, collector-to-base bias and voltage-divider biasing circuits.

Answer: Page Number 203-204 of Text Book I

Q.9 a. Explain half power points.

Answer:

<u>Half –Power Points</u>

A typical graph of amplifier output voltage or power plotted versus frequency. The frequency scale is logarithmic. The output normally remains constant over a middle range of frequencies and falls off at low and high frequencies. The gain over this middle range is termed the mid frequency gain. The low frequency and high frequency at which the gain falls by 3dB are designated f_1 and f_2 respectively. This range (from f_1 to f_2) is

normally considered the useful range of operating frequency for the amplifier, and the frequency difference ($f_2 – f_1$) is termed the amplifier bandwidth (BW).
Frequencies f_1 and f_2 are termed the half – power points, or the 3dB points. This is because, the power output is -3dB from its normal level when p_2 is half p_1. when the amplifier output is expressed as a voltage on the graph of frequency response, the 3 dB points (f_1 and f_2) occur when v_2 is 0.707 v_1

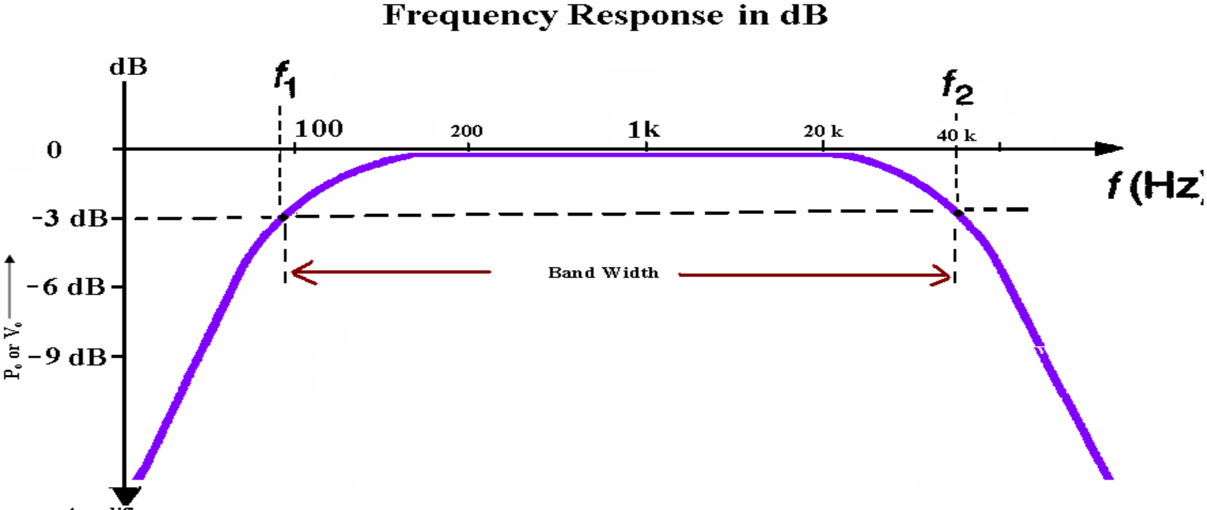


Fig. The output voltage and output power of an amplifier normally remain constant over a middle band of signal frequencies and fall off at high and low frequencies.

b. What are the advantages of negative feedback on an amplifier?

Answer:
Advantages of negative voltage feedback.
The following are the advantages of negative voltage feedback in amplifiers.
Gain stability:
An important advantage of negative voltage feedback is that the resultant gain of the amplifier can be made independent of transistor parameters or the supply voltage variation.
$A_{vf} = A_v / 1+ A_v m_v$
For negative feedback in an amplifier to an effective, the designer deliberately makes the product A_v m_v much greater than unity. Therefore in the above relation, 1 can be neglected as compared to A_v m_v and the expression becomes:
$A_{vf} = A_v / A_v m_v$
$= 1 / m_v$
It may be seen that the gain now depends only upon feedback fraction m_v I.e., on the characteristics of feedback circuits.

Reduces non-linear distortion.
A large signal stage has non-linear distortion because its voltage gain changes at various points in the cycle. The negative voltage feedback reduces the non linear distortion in large signal amplifiers.
Improves frequency response.

As feedback is usually obtained through a resistive network, therefore, voltage gain of the amplifier is independent of signal frequency. The result is that voltage gain of the amplifier will be substantially constant over a wide range of signal frequency.

Increases circuit stability.

The output of an ordinary amplifier is easily changed due to variations in ambient temperature, frequency and signal amplitude. This changes the gain of the amplifier, resulting in distortion. However, by applying negative voltage feedback, voltage gain of the amplifier is stabilized or accurately fixed in value.

Increases input impedance and decreases output impedance.

The negative voltage feedback increases the input impedance and decreases the output impedance of amplifier. Such a change is profitable in practice as the amplifier can then serve the purpose of impedance matching.

TEXT BOOKS

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2. Electronic Devices and Circuits, David A Bell, Fourth Edition, PHI (2006).