COMBINED FIRST AND SECOND SEMESTER B.TECH (ENGINEERING) DEGREE EXAMINATION

EN14107 – BASICS OF ELECTRICAL ELECTRONICS AND COMMUNICATION ENGINEERING

Section I (Basics of Electrical Engineering)

Part A

Answer any 4 questions

1) Derive the voltage and current relationships in a balanced star connection.
2) Discuss self inductance , mutual inductance
3) Explain principle of operation single-phase transformer
4) What are the different types of dc motor and applications
5) Explain the principle operation of synchronous generator

Part B

6) i) Derive the expressions for impedance, current and power factor in RLC series circuit.
   ii) State and explain Kirchoff's laws

OR

7

i) Define the terms
(i)time period
(ii)rms value
iii)average value
(iv)form factor
(v)peak factor in an ac circuit

ii) A resistance of 10Ω is connected in series with an inductance of 0.05 H and a capacitance of 300μF to a 100V supply. Calculate the value and phase angle of the current when the frequency is 50 Hz.

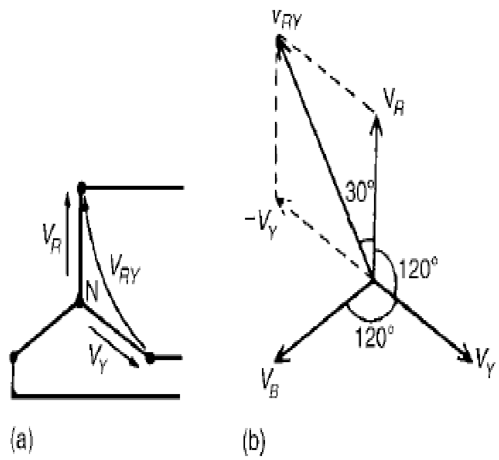
8)What are the different types of transformer and also derive an expression for the emf equation of transformer

OR

9) i) Explain the construction of a three phase induction motor

ii) Discuss a typical electrical power system

1)



$I_L = I_p$

$V_{RY} = V_R - V_Y$

$V_{RY} = \sqrt{3} V_R$,

2) **Inductance** is the name given to the property of a circuit whereby there is an e.m.f. induced into the circuit by the change of flux linkages produced by a current change. When the e.m.f. is induced in the same circuit as that in which the current is changing, the property is called **self inductance**, ***L***. When the e.m.f. is induced in a circuit by a change of flux due to current changing in an adjacent circuit, the property is called **mutual inductance**, ***M***.

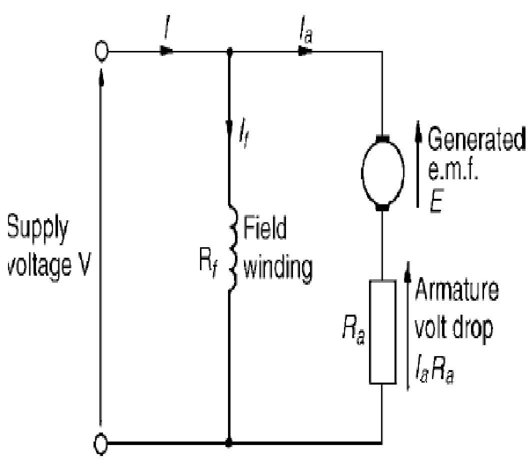
3) When the secondary is an open-circuit and an alternating voltage $V1$ is applied to the primary winding, a small current called the no-load current $I0$ — flows, which sets up a magnetic flux in the core. This alternating flux links with both primary and secondary coils and induces in them e.m.f.'s of $E1$ and $E2$ respectively by mutual induction. The induced e.m.f. E in a coil of N turns is given by
$E = -Nd\text{Ø}/dt$ volts where $d\text{Ø}/dt$ is the rate of change of flux. In an ideal transformer, the rate of change of flux is the same for both primary and secondary and thus $E1/N1 = E2/N2$, i.e. **the induced e.m.f. per turn is constant**.
Assuming no losses, $E1 = V1$ and $E2 = V2$. Hence $V1/N1 = V2/N2$ or $V1/V2 = N1/N2$ $V1/V2$ is called the **voltage ratio** and $N1/N2$ the **turns ratio**, or the **'transformation ratio'** of the transformer. If $N2$ is less

than $N1$ then $V2$ is less than $V1$ and the device is termed a **step-down transformer**. If $N2$ is greater then $N1$ then $V2$ is greater than $V1$ and the device is termed a **step-up transformer**. When a load is connected across the secondary winding, a current $I2$ flows. In an ideal transformer losses are neglected and a transformer is considered to be 100% efficient. Hence input power=output power, or $V1I1 = V2I2$, i.e. in an ideal transformer, the **primary and secondary volt-amperes are equal**.

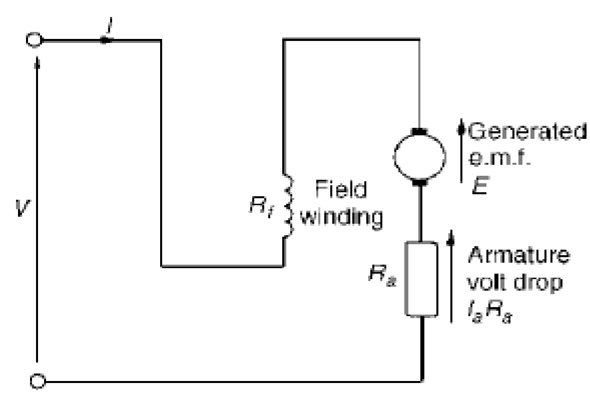
4) 1) Shunt-wound motor-constant speed applications,lathe etc

2)Series motor- high starting torque applications like cranes,hoist

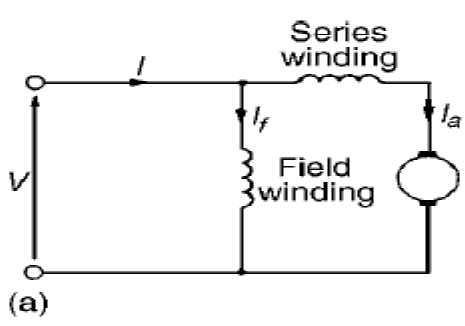
3)Compound motor



Shunt motor



series motor



Compound motor

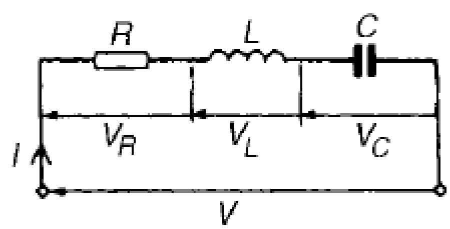
5)Working of synchronous generator is just reverse of dc generator. Here field magnet is rotating and armature is stationary. Rotating magnet cut the conductor and produces an emf on it depending upon the speed of revolution and number of poles.There are two types of synchronous generators salient pole type and non salient pole type synchronous generators.

6)i) In an a.c. series circuit containing resistance *R*, inductance L and capacitance *C*, the applied voltage *V* is the phasor sum of *VR*, *VL* and *VC* (see Figure 15.12). *VL* and *VC* are anti-phase, i.e. displaced by 180◦, and there are three phasor diagrams possible each depending on the relative values of *VL* and *VC*.

When XL > XC

$Z = \sqrt{[R2 + (XL - XC)2]}$

and $\tan \varphi = (XL - XC) / R$



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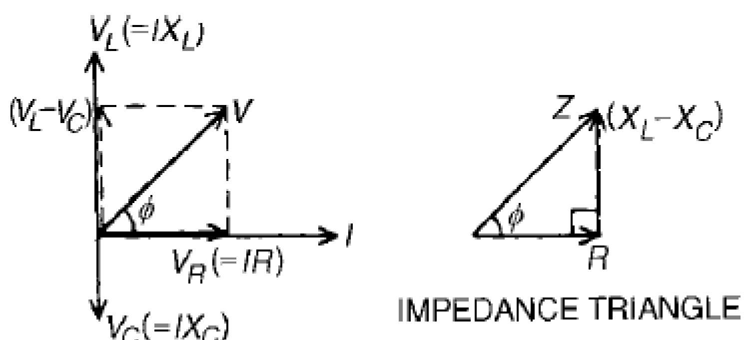

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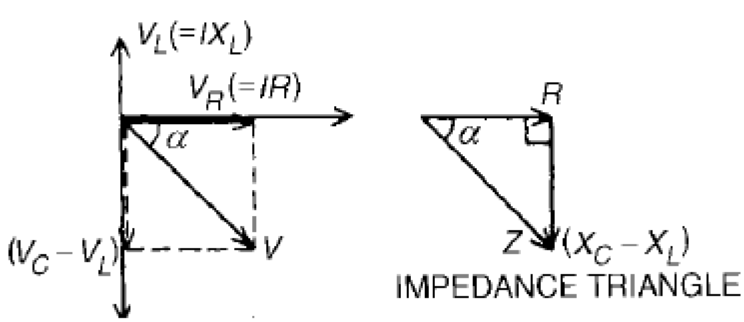


When $XC > XL$

$Z = \sqrt{[R2 + (XC - XL)2]}$

and tan $\alpha = (XC - XL)/R$

When $XL = XC$ the applied voltage $V$and the current I are in phase. This effect is called **series resonance**

ii) **Kirchhoff's Current Law (KCL):** KCL states that at any node (junction) in a circuit the algebraic sum of currents entering and leaving a node at any instant of time must be equal to zero. Here currents entering(+ve sign) and currents leaving (-ve sign) the node must be assigned opposite algebraic signs

Kirchhoff's Voltage Law (KVL): It states that in a closed circuit, the algebraic sum of all source voltages must be equal to the algebraic sum of all the voltage drops.

7) i) **peak value**-it is the maximum value of the wave either during positive half cycle or during negative half cycle

ii)**Average value**:- it is the dc value of a wave .In general average value of a wave form x(t) can b represented as $x_{avg} = 1/T \int_0^T x(t)dt$. Where T is the time period of the signal.

iii)**RMS value**:-Root Mean Square value.It is the capability of a sine wav in terms of heating power

iv) **Form factor**:-

FF=RMS value/ Average value

For a sin wave form factor is 1.11

v)**Time period**:-It is the time taken to complete one cycle

ii)

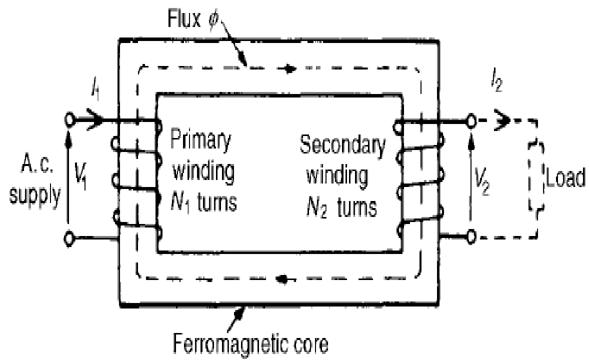
$\tan Ø = (X_L - X_C)/R$

$X_L = 2\pi f L$

$X_C = 1/\, 2\pi f C$

$Ø = \tan^{-1}(X_L - X_C)/R$

8) i) A transformer is a device which uses the phenomenon of mutual induction to change the values of alternating voltages and currents. A transformer consisting of two electrical circuits linked by a common ferromagnetic core. One coil is termed the **primary winding** which is connected to the supply of electricity, and the other the **secondary winding**, which may be connected to a load.

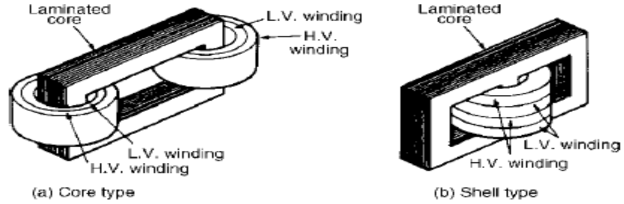


Transformer principle of operation

When the secondary is an open-circuit and an alternating voltage V_1 is applied to the primary winding, a small current called the no-load current I_0 — flows, which sets up a magnetic flux in the core. This alternating flux links with both primary and secondary coils and induces in them e.m.f.'s of E_1 and E_2 respectively by mutual induction. The induced e.m.f. E in a coil of N turns is given by

$E = -Nd\text{Ø}/dt$ volts where $d\text{Ø}/dt$ is the rate of change of flux. In an ideal transformer, the rate of change of flux is the same for both primary and secondary and thus $E_1/N_1 = E_2/N_2$, i.e. **the induced e.m.f. per turn is constant**. Assuming no losses, $E_1 = V_1$ and $E_2 = V_2$. Hence $V_1/N_1 = V_2/N_2$ or $V_1/V_2 = N_1/N_2$ V_1/V_2 is called the **voltage ratio** and N_1/N_2 the **turns ratio**, or the **'transformation ratio'** of the transformer. If N_2 is less than N_1 then V_2 is less than V_1 and the device is termed a **step-down transformer**. If N_2 is greater then N_1 then V_2 is greater than V_1 and the device is termed a **step-up transformer**. When a load is connected across the secondary winding, a current I_2 flows. In an ideal transformer losses are neglected and a transformer is considered to be 100% efficient. Hence input power=output power, or $V_1I_1 = V_2I_2$, i.e. in an ideal transformer, the **primary and secondary volt-amperes are equal**.

There are broadly two types of single-phase doublewound transformer constructions — the **core type** and the **shell type**, as shown in. The low and high voltage windings are wound as shown to reduce leakage flux



EMF equation of transformer

The magnetic flux set up in the core of a transformer when an alternating voltage is applied to its primary winding is also alternating and is sinusoidal. Let $\varnothing m$ be the maximum value of the flux and f be the frequency of the supply. The time for 1 cycle of the alternating flux is the periodic time T, where $T = 1/f$ seconds. The flux rises sinusoidally from zero to its maximum value in 1 /4 cycle, and the time for 1cycle is $1/4f$ seconds.

Hence the average rate of change of flux=4 $f \varnothing m$ Wb/s, and since 1 Wb/s=1 volt, the average e.m.f. induced in each turn=4 $f \varnothing m$ volts.

As the flux varies sinusoidally, then a sinusoidal e.m.f.
will be induced in each turn of both primary and secondary
windings.

For a sine wave, form factor =1.11

rms value = form factor × average value

= 1.11 × average value

Thus rms e.m.f. induced in each turn

$= 1.11 \times 4 f\varnothing m$ volts $= 4.44 f \varnothing m$ volts

Therefore, rms value of e.m.f. induced in primary,

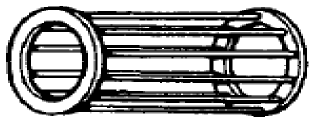
$\boldsymbol{E1 = 4.44 f \varnothing m N1}$ **volts**

and rms value of e.m.f. induced in secondary,

$\boldsymbol{E2 = 4.44 f \varnothing m N2}$ **volts**

9) i) The stator of a three-phase induction motor is the stationary part corresponding to the yoke of a d.c. machine. It is wound to give a 2-pole, 4-pole, 6-pole, ... rotating magnetic field, depending on the rotor speed required. The rotor, corresponding to the armature of a d.c. machine, is built up of laminated iron, to reduce eddy currents. In the type most widely used, known as a **squirrel-cage rotor**, copper or aluminium bars are placed in slots cut in the laminated iron, the ends of the bars being welded or brazed into a heavy conducting ring,. A cross-sectional view of a three-phase induction motor is shown in Figure. The conductors are placed in slots in the laminated iron rotor core. If the slots are skewed, better starting and quieter running is achieved. This type of rotor has no external connections which means that slip-rings and brushes are not needed. The squirrel-cage motor is cheap, reliable and efficient. Another type of rotor is the **wound rotor.** With this type there are phase windings in slots, similar to those in the stator.

The windings may be connected in star or delta and the connections made to three slip-rings. The slip-rings are used to add external resistance to the rotor circuit, particularly for starting , but for normal running the slip-rings are short circuited. The principle of operation is the same for both the squirrel-cage and the wound rotor machines.



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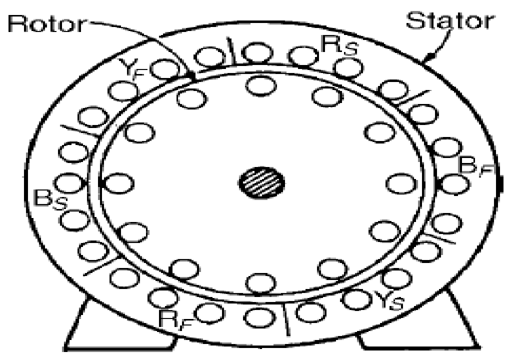

(b)