Electrical Machines (I)

Second Semester (2017)

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* Summary *

CHAPTER(1):

1) Why we study the magnetic field Because it is fundemental for operation of Transformers & Machines.

2) If the generated ϕ cut or link another conductor a voltage will induce in it. This is the principle of Transformer Action.

3) State the generator action If the conductor cut or move through a magnetic field a voltage will be induced in the conductor.

4) The current carrying conductor in a magnetic field will experience a force. This is the basic of Motor Action.

5) The path of flux that we care for it is mean path.

6) The Typical values of μ_r is 2000–6000

7) The unit of the relactance is A.t/Wb.

8) Why the air gap between stator & Rotor should be small as it possible just a clearance to make rotation possible since air has very high $\mathcal{R}$.

9) Name a reason state that why KVL & KCL approximate relations in Magnetic ccts due to leakage flux.

10) What is the Leakage flux it is the flux flow in the surrounding air around the core.

11) What is the fringing field it is the extra effective area around the air gap which make the area of the air gap larger than area of the core.

12) The point separated the saturation region & linear region is to be called Knee point.

13) Magnetization curve state the relation between
Ø vs. Ni OR B vs. H.

14) How many hysteresis loop represented by one cycle of i one.

15) Hyteresis Losses defined as $\frac{\text{Total energy lost}}{\text{Volume of ferromagnetic material} * \text{Number of cycles.}}$

16) Energy lost in magnetic material defined as the difference between Energy supplied by the source to magnetic material & Energy Returned to the supply.

17) The current flow within the core & flows in circular direction is called Eddy Current.

18) Name a way that allow us to reduce the eddy losses by manufacturing the core of laminations between which there is an insulating material in order to reduce ie.

19) What is the position of the laminations they are installed parallel to flux direction.

20) What is the definition of the stacking factor it is the ratio of volume of ferromagnetic material & the Total volume of the core.

21) What is the core losses it is the summation of the hysteresis losses & the eddy losses.

22) state Faraday's Law $e = -N \frac{d\phi}{dt}$ and What is the need for the negative sign to introduce the pinciple of finding the polarity of e.

23) In Electrical Machines, Magnetic Field is produced by Electromagnets.

24) What is the Yoke It is the part through which magnetic flux Return.

CHAPTER (2):

25) What is the Transformer it is a device or equipment which can be used to step-up or step-down a voltage or current.

26) What is the power Transformer the transformer that can be used in the process of transmitting & distributing electrical energy with minimum losses.

27) Transformer that can be used in measuring High voltages Voltage Intrument Transformer.

28) Power Transformer is constructed from Core & A number of windings.

29) Types of core core type & shell type.

30) It is a 3-leg Core shell type.

31) Transformer at the power station used to step-up voltage for transmission Unit Trans.

32) Substation Transformer This is at the end of a transmission line used to step-down voltage.

33) Transformer used to step-down voltage for various consumers Distribution Trans.

34) Transmission Levels in Jordan are 132KV & 400KV.

35) Mention the assumptions of the Ideal Trans. Assumed to be Lossless & No leakage flux.

36) What is the Law used to determine polarity of e_p Lenz's Law.

37) " " " principle " " " " " e_s Dot Convention.

38) Draw a flow diagram stating what happen when a load connected to Transformer

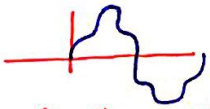
i_s is going to flow → will generate ϕ_s → ϕ_s oppose the main ϕ so Resultant flux will be reduced → e_p will decrease → i'_p ↑ by amount (i_{p_L}) to produce mmf to oppose that are produced from i_s To maintain same flux in the core.

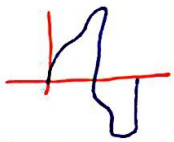
39) What is the Linkage flux it is the Total flux produced by i' in each turn alone defined by $\lambda = \sum_{i=1}^{N} \phi_i$

40) What is the Mutual flux it is the flux that just passing through the core.

41) What is the Exitation Current it is the current in the primary winding at No load condition.

42) Exitation Current has Two functions To generate flux (i_m) & To supply or account for core losses (i_c)

43) What is the shape of the magnetization current distorted current 

44) What is the shape of the exitation current distorted 

45) The expression of i_{ext} has odd harmonics in case of (+ve) & (-ve) cycles are Identical.

46) In Real Transformer we take into account Electrical Losses in primary & secondary windings, Core losses & leakage flux.

47) What is the case that the branch (X_m//R_c) can be shifted to the input in the real transformer when $I_{ext} << i_{PL}$. & the voltage drop in R_p & L_p is very small.

48) Why we evaluate the Transformer parameters since these parameters are required in the process of transformer analysis.

49) When the O/C Test done, then one can find the following parameters R_c & X_m.

50) From S/C Test, one can find R_{eq} & X_{eq}.

51) What is the PU system it is the system that the basic quantities V, I, Z & S are not expressed by units of voltage, current, ohm & VA BUT they are expressed as a Fraction of a reference or Base value.

52) What is the PU value it is the ratio between Actual value & the Base value.

53) What is the advantages of PU system ① simplify the process of solving system with many transformer. ② R&X have the same range of values in generators & Transfomers. ③ simplify solution for 3-ph system.

54) R_{eq} & X_{eq} are the same irrespective of the side reflection.

55) What is the Voltage Regulation This is a measure to indicate the amount of voltage drop at the load due to Z_{eq} of the transformer.

56) The procedure of finding voltage regulation is indicated by using the concept of phasor diagram.

57) Type of reflection usually used to find VR reflection to secondary.

58) Ferranti Effect: it is the increasing in voltage occurring at the receiving end of along Transmision Line above the voltage at the sending end.

59) Auto transformer is used when the voltage ratio is around 1.

60) Construction of Auto Trans. 2 coils electrically connected with polarity aiding.

61) What is the factor related to increase in apparent power when convert from Conventional trans. to Auto trans. $\frac{Nse+Nc}{Nse}$

62) What is the inrush Current it is the case when the primary will draw a very high current >> Irated when V=0 at t=0 this high current called inrush current, This transient condition may occur when transformer is energized.

63) Why we need the 3-ph transformer since electrical energy is generated, transmitted & distributed in 3-ph AC voltage.

64) The 3 single-phase Transformer is called 3-ph Transformer Bank.

65) 3-ph Transformer could be constructed from: using 3 1-ph Transformer or a single core with 3 pairs of windings.

66) The advantage of 3-ph Trans. Bank over single core is each unit in the Bank could be replaced individually in the event of trouble.

67) The advantage of using single 3-ph Lighter, cheaper, smaller & slightly more efficient.

68) Advantages of AutoTrans.: give more apparent power & it is very advantageous to build transformers with nearly voltages as Auto transformer.

69) Disadvantages of AutoTrans.: losing the electrical isolation & the reduction in effective PU imdedance when we convert to Auto trans.

70) HV is represented by Capital letters, LV by small Letters.

71) Vector group indicate the phase shift between HV & LV, with group (1, 2, 3 & 4) corrispond to (0, 180°, -30°, 30°).

72) In +ve seq. terminal markings are made in such away HV leads LV by $+30°$.

73) Effictive turns Ratio indicate the Ratio between line voltages where $a = V_{LL}/V_{LL}$.

74) In Conventional Test, it indicates that in o/c LV is primary & Rated voltage applied. and in s/c HV is primary & Rated current is applied.

CHAPTER (3):

75) Machines are classified as Generators OR Motors.

76) Fundemental of Machines Magnetic Field / Conductors / Relative motion between them.

77) The induced voltage is found by the concept of RHR.

78) What is Commulation internal AC induced voltage converted to DC voltage by means of commutator segments is contact with fixed brushes.

79) Armature Windings defined as: the windings in which a voltage is induced in case of generator, or the windings into which a current is applied in the case of Motor.

80) in one sequance, the span between coil sides of each sides of each phase 180°, the span between phases 120°.

81) in 2 sequance, the span between coil sides 90°, span between phases 60°.

82) In synch. Gen. field winding is located at the Rotor. & the Armature winding is located at the Stator.

83) The Field current is supplied from DC source to field windings through sliprings & Brushes.

84) How the voltage induced in synch gen. the flux in the field windings cut or link the flux in the Armature windings.

85) What we do to apply RHR on the synch. Gen. The field is the stator & the observer sit on the Rotor & lookat the Armature windings.

86) We assumed the flux is sinusoidal which is Not, this is taken into account by pitch factor.

87) We assumed the turns are concentrated in a pair of slots which is Not, this taken into account by Distribution Factor.

88) Define the pole Pitch it is the distance between two adjacent poles.

89) The span is measured in mechanical degree or electrical degree.

90) Full pitch coil: if a coil is under the center of s-pole, & its other side under the center of adjacent N-pole.

91) Fractional Pitch coil: the coil's pitch is less than the full pitch.

CHAPTER(4):

92) Mention the two types of Rotor Cylindrical type & Salient type.

93) Salient type is classified when Rotor has more than 2-poles.

94) Cylindrical type is classified when Rotor has just 2-poles.

95) What is the Armature Reaction (A.R) the flux produced by Armature current effect the main flux produced by field current causing its reduction, since $E = K\phi\omega$ then E will be reduced.

96) What is the synch. Reactance (X_s) it is the summation of the Armature Reactance & the Reactance that represent Armature Reaction.

97) if we kept V_ϕ & I_a constant & vary pf of load, then the relation of generated voltage between the various load $|E_L| > |E_R| > |E_C|$

98) if we kept E constant & vary I_a, then the relation of phase voltage between the various load $|V_\phi|_L < |V_\phi|_R < |V_\phi|_C$

99) How we maintain V_ϕ at a constant value since $V_\phi = E - I_a Z_{eq}$ $I_a \uparrow \Rightarrow I_a Z_{eq} \uparrow$, we must increase E, since $E = K\phi\omega$ & we can't increase the freq. so we increase $\phi \uparrow$ by increasing I_F by reducing the variable resistance in the field cct.

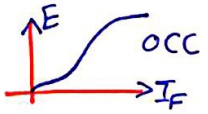
100) When the angle between E & V_ϕ equal 90° this gives us maximum output power & this case called Static Stability Limit.

101) The practical value for the angle between E & V_ϕ 20°–30°

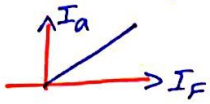
102) From DC Test, one can measure the DC armature resistance.

103) From o/c & s/c Test, one can obtain o/c ⇒ E_A & s/c ⇒ I_a
⇒ $Z_{eq} = E_A/I_a$, & we find the synch. Reactance from Z_{eq}.

104) What is the shape of OCC:



105) What is the shape of SCC:



106) Define the short circuit ratio it is the ratio between the field current which produces Rated voltage at o/c & the field current which produces Rated armature current at s/c.

107) What is the Alone Generator it is the generator which operating on its own.

108) What is the Advantages of parallel operation:
More reliable & more economical from operation point of view.

109) How the parallel operation happen when a generator connected in parallel with another generator or connected in parallel with a power system.

110) What are the conditions of parallel operation:
① freq. of G_2 should be slightly higher than G_1.
② Same magnitude & phase of voltages.
③ Same sequance.

111) How to test to Know if same voltages by means of voltmeter.

112) What are the methods to test for sequance
① Induction Motor (if Both same direction of rotation, then same seq.).
② 3-bulb method (if three bulbs Light up & dim-down together, then same seq.)

113) What would you do if the induction motor wasn't rotating in same direction for both generators reverse the connection of 2-phases in G_2.

114) Why f_2 should be slightly higher for stability resons.

115) Mention another name for the parallel operation synchronization.

116) As the load on the gen. ↑ the speed ↓; this decrease isn't alinear, we made it Linear by using a governor mechanism.

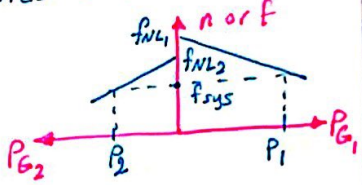
117) the unit of the slop in the frequancy-power relationship is MW/HZ.

118) What can be done by the governor the No-load set point can be shifted, the characteristics can be shifted up or down.

119) Application for the power-freq relationship it can be used to find load sharing between parallel generators.

120) the relation between Q & V is made linear By means of voltage regulator.

121) What is the Housing Diagram it is a diagram state the power sharing between 2 generators, we draw their characteristics Back-to-Back.



122) What is the infinite system it is a large power system whose freq. & voltage doesn't change by the amount of power supplied to it or taken from it.

123) In DC Machines → field windings are located at the stator.
→ Armature windings are located at the Rotor.

124) DC Machines are classified into separately excited Machine & self-excited DC Machine.

I_F is supplied from external DC source.

I_F depends on residual magnetism in the poles of the machine.

125) Self-excited machines classified into:
shunt DC Machines, series DC Machines, Compound DC Machines.

126) Compound DC Machines classified into long shunt & short shunt compound DC Machines.

127) If the series field aid shunt field the machines is called Commulative Compomed Machine.

128) If the series field apposes shunt field the machines is called Differential Compound Machine.

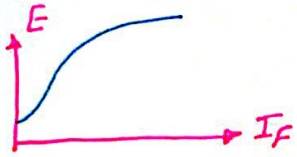
129) Types of Armature Winolings lap windings & Wave windings.

130) Type of Armature Windings that used for:
→ Low voltage & High Current Application Lap windings.
→ High voltage & Low Current Application wave windings.

131) The induced voltage in DC Machines → if generator E is called generated voltage.
→ if Motor E is called Back EMF.

132) The Total Torque in → DC Motor is called Developed or Generated Torque.
→ DC gen. is called Opposing or Retarding Torque.

133) For DC gen., in separately excited gen. at No load, what is the shape of
a) No load char.



b) load char.

134) In separately excited DC generator at load char.
There are Two Types of drop voltage drop represented by $I_L R_a$
& the Armature Reaction.

135) De-orientation for the resultant flux caused by Armature Flux.

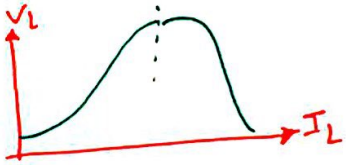
136) Build-up of voltage happen due to Residual Magnetism.

137) What is the shape of Build up of voltage

138) What are the causes of failure to Build-up:
① lack of Residual Mugetism. ② Field windings connected in away to cancel Residual Magnetism.
③ open circuit in the field or Armature windings.

139) What is the shape of the self excited DC gen. at load condition (a) in case of shunt gen.

(b) In case of series gen:



(c) in case of compound gen:

140) Depending on the amount of aiding, what are the 3 possible characteristics:

① over compound

② Flat compound.

③ Under compound

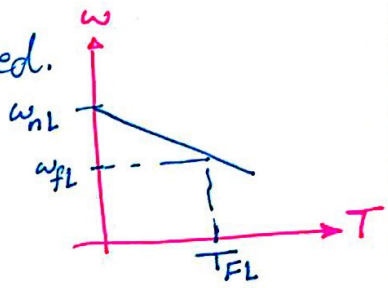
141) In DC Motor the electrical losses represented by field cct losses & Armature cct losses.

142) What are the methods of controlling the speed of shunt Motor:

① Armature Control by varying the applied voltage.
② Field control by varying the flux.
③ Varying Armature cct resistance (Ra).

143) Why we must not open the shunt field cct suddenly since I_f become equal to Zero, so $\phi = 0$ & by the speed equation $\omega = \frac{V - I_a R_a}{K\phi}$ ω reach ∞ value, so the motor will fly over.

144) The relation between the speed & the Torque: when the Torque increased the speed decreased.



145) What is the solution for the Armature Reaction:

By eliminate or Reduce ϕ_a By using interpoles.

146) What is the function of the interpoles:

interpoles generate flux opposing ϕ_a, which reduce ϕ_a.

147) How we connect the interpoles they are connected in series with Armature windings.