REF. NO. : EX/PE/PE/H/T/316B/2024

NAME OF THE EXAMINATION: B.E. POWER ENGINEERING THIRD YEAR FIRST SEMESTER - 2024

SUBJECT: ADVANCED TOPICS IN ELECTRICAL MACHINES (HONS.)

TIME: 3 HOURS FULL MARKS: 100

Attempt *ALL QUESTIONS*

1. *Choose the correct option for any TEN (10) questions*: (10@1 = 10)

(i) The main diagonal elements in the impedance matrix of a Kron's primitive machine contain [CO1]
   a) only self-inductance and resistance
   b) self-inductance and mutual inductance
   c) resistance and mutual inductance
   d) only mutual inductance

(ii) In 3-phase to 2-phase transformation (a, b, c, to α, β) , the impedance per phase of the equivalent 2-phase system as compared to the 3-phase system are different when [CO1]
   a) both number of turns and current are transformed identically
   b) only current is transformed
   c) only number of turns is transformed
   d) both (b) and (c)

(iii) The 2-axis generalized equivalent model of a 3-phase squirrel cage type induction machine consists of: [CO1]
   a) three coils, one in stator and two in rotor
   b) four coils, two in stator and two in rotor
   c) five coils, two in stator and three in rotor
   d) six coils, three in stator and three in rotor

(iv) The cooling time constant is usually _____ when a machine cools down owing to _____ ventilating conditions as compared to during heating. (Fill in the blanks) [CO2]
   a) smaller ; better
   b) larger ; poorer
   c) smaller ; poorer
   d) larger ; better

(v) Electric machine frame surfaces are painted with dull metallic paints: [CO2]
   a) to enhance heat radiation
   b) to reduce heat generation
   c) to enhance heat convection
   d) to enhance heat conduction

(vi) Chose the correct sequence of heat transfer during transformer cooling: [CO2]
   1. oil carries heat by conduction and convection
   2. heat generated in the core and winding is conducted to oil
   3. heat is dissipated to the atmosphere by radiation
   4. heat is generated inside the transformer due to various losses
   5. heat dissipates out of the tank surface by convection due to air flow
   a) 4-1-2-5-3
   b) 4-1-2-3-5
   c) 4-2-3-1-5
   d) 4-2-1-3-5

(vii) Which of the following coolant may be used to cool rotating machines: [CO2]
   a) Carbon monoxide
   b) Water
   c) Helium
   d) Oxygen

(viii) BIL of an electrical equipment is defined as: [CO3]
   a) The minimum withstand voltage level of the equipment before the lightning impulse over-voltage gets discharged through surge protecting devices
   b) The minimum withstand voltage level of the equipment after the lightning impulse over-voltage gets discharged through surge protecting devices
   c) The maximum withstand voltage level of the equipment after the lightning impulse over-voltage gets discharged through surge protecting devices
   d) The maximum withstand voltage level of the equipment before the lightning impulse over-voltage gets discharged through surge protecting devices

(ix) Voltage surges or transients in power system can be caused by: [CO3]
   a) Resonance
   b) Circuit breaker contact bouncing
   c) Sudden change of load

d) Ground fault

(x) Parameters used to define an impulse generated in the laboratory are: [CO3]
a) energy content
b) front time
c) number of repetitions per second
d) frequency

(xi) Short circuit test on a transformer is generally performed with its LV winding shorted because that will enable: [CO4]
a) Low range ammeter to be used for performing the measurements on HV side
b) Low range voltmeter to be used for performing the measurements on HV side
c) Reduced power losses during the test thereby restricting temperature rise
d) More than one of the above reasons

(xii) Insulation resistance of an induction motor is independent of: [CO4]
a) Magnitude of test voltage
b) Thickness of the insulation
c) Measurement temperature
d) Motor current rating

Q2 Answer any TWO (2) questions (2@10 = 20) **[CO1]**

(a) Discuss the fundamental assumptions required to use the primitive machine. State the various limitations of the generalized theory of electrical machines.

(b) Derive the transformations for currents between a rotating balanced 2-phase (α, β) winding and a pseudo-stationary 2-phase (d, q) winding. Assume equal turns on all coils.

(c) From the generalized mathematical model show that the no-load armature terminal voltage of a separately excited dc generator is given by $E_{a0} = M_d \omega_{r0} I_f$. The symbols used have their usual meaning.

Q3 Answer any TWO (2) questions (2@10 = 20) **[CO2]**

(a) Derive the equation of temperature rise with time in electric machine under steady load and assuming it to be of homogeneous construction. Hence derive expressions for final steady state temperature rise and heating time constant.

(b) Describe in brief the hydrogen cooling method for large turbo-alternators. What are the advantages of hydrogen cooling over air cooling?

(c) The initial temperature rise of a transformer is 25^0 C after one hour and 37.5^0 C after two hours of starting from cold condition. Calculate its final steady state temperature rise and the heating time constant. If its temperature falls from the final steady state value to 40^0 C in 2.5 hours when disconnected, calculate its cooling time constant. The ambient temperature is 30^0 C.

Q4 Answer any TWO (2) questions (2@10 = 20) **[CO3]**

(a) Discuss the processes how atmospheric lightning can cause voltage and current surges in transmission line.

(b) What do you understand by "50 kV, 1.2/50" lightning impulse wave? What are switching surges? How are they generated in a power system?

(c) Discuss in brief the different lightning surge protecting devices used in transformers.

Q5 Answer any TWO (2) questions (2@10 = 20) **[CO4]**

(a) Draw the schematic diagram of a lightning impulse generator for laboratory testing of transformers. Describe the steps to be followed for performing lightning impulse test on a transformer.

(b) List the different routine tests and type tests performed on an induction motor. Describe the methods for determination of temperature rise of an induction motor.

(c) . List the different routine tests to be performed on a transformer. Discuss any ONE method for performing turns ration test on a transformer

Q6 Write short notes on any TWO (2) (2@5 = 10)

(a) Use of the concept of generalized theory of electrical machine to study the effects of sudden short circuit at armature terminals on d-axis current of a synchronous generator **[CO1]**

(b) Why it is not desirable to have air voids inside a block of solid insulation? **[CO2]**

(c) Methods of protection of motors from switching surges **[CO3]**

(d) Back-to-back test on a transformer for estimation of its temperature rise **[CO4]**

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