Birla Institute of Technology and Science, Pilani
Mid Semester Exam (I Semester 2023-24)
Electrical Machines (EEE/INSTR/ECE F211) Open Book
Date: 14/10/2023 Duration: 90 Minutes Max Marks: 75

[Assume suitable data, if necessary]

Q.1 A 100 kVA, 50 Hz, 440/11000V, single-phase transformer is tested to have an efficiency of 98.5% when supplying full load current at 0.8 pf lagging, and an efficiency of 99% when supplying half of full load current at unity pf. During the operation on a day this transformer is loaded as follows:

12 hours: 30 kW at pf 0.6
8 hours: 75 kW at pf 0.8
4 hours: 90 kW at pf 0.9

(i) Calculate the iron loss and full load copper losses.
(ii) Find the total energy loss in the day and 'all day' efficiency of the transformer.
(iii) Voltage regulation at full load and unity power factor **[15]**

Q.2 A transformer is to be designed for a power transmission application in such a way that its secondary line voltage must be ($\frac{\pi}{6}$) radian ahead of primary line voltage. Suggest a most optimal design of transformer with properly marked winding and connection diagram with polarities. Also draw a neat phasor diagram with all phase and line voltages of primary and secondary sides to justify the above-mentioned phase difference. **[10]**

Q.3 A two winding transformer of 15 kVA, 250/750 V is available with a manufacturing unit. The engineer is given a task to feed a load of 7 kW at 0.8 lagging power factor at 500 volts from the available supply of 250 volts. Using the two-winding transformer, how can the engineer device a solution to cater the load at the specified voltage?

a) Show the connection diagram of the solution with properly marked polarities.
b) Determine the primary side and secondary side currents of the solution chosen on the given load.
c) What is rated primary side current for the solution? **[15]**

Q.4 Determine the line voltage across secondary of a transformer (delta/star connected) having turns ratio (N_2/N_1) of 3 when this transformer is fed from a star connected 50 Hz, 10 pole synchronous generator. Synchronous generator has 72 slots and 20 conductors per slot. The maximum flux per pole is 60 mili-weber. Total turns per phase are assumed to be series connected. Also determine the synchronous speed. **[10]**

Q.5 Four single phase transformers (*A, B, C and D*) each of 200 kVA, 50 Hz are having equal transformation ratio and are connected in parallel. Transformers *A* and *C* have equivalent impedance of (0.01 + j 0.16) pu each and transformers *B* and *D* have equivalent impedance of (0.015 + j 0.08) pu each. Their rated voltages are equal. (i) Draw the transformer connection diagram with dot polarities (ii) What will be the share of each of the four transformers if the total load of 400 kW at unity power factor is to be shared? **[15]**

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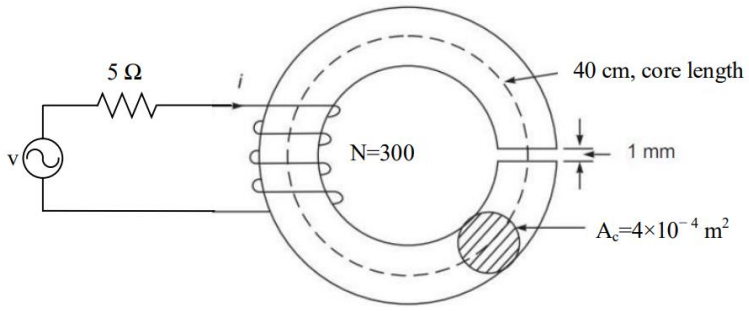
Q.6 Following AC circuit comprises of a resistance in series with a magnetic circuit, and is supplied by an AC source $v = 100sin314t$ V. The core's geometry is as shown in the figure below, and its relative permeability of the core is 4000. There is an air-gap of 1 mm. Find: (a) the inductance of the circuit, (b) total impedance of the AC circuit, (c) power factor at source, (d) the real power supplied by the source. Ignore fringing. **[10]**



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