Department of Electrical Engineering IIT Delhi

EEL 203 Electromechanics

Time 120mts **Major Test** Max Marks 40

Attempt ALL questions

Q1. (a) Draw a suitably labeled exact equivalent circuit of a 2-winding transformer as viewed from primary winding. Also define the labels. [2]

(b) A 20 KVA, 2000/200V, 50Hz, 1-phase step-down transformer has the following parameters: $r_p = 4\Omega$, $r_s = 0.04\Omega$, $x_{lp} = 12\Omega$, $x_{ls} = 0.12\Omega$, $x_{mp} = 15\,k\Omega$ and $r_{cp} = 20\,k\Omega$.

The transformer operates at 80% of rated load having 0.8 lagging power factor. Obtain the following (i) the primary and the secondary winding currents, (ii) the primary winding core loss and magnetising current, (iii) the voltage regulation and (iv) the efficiency; at the rated load voltage. [6]

Q2. (a) Why a dc shunt motor is operated with a starter? Draw the layout of a 3-point starter for a dc shunt motor and explain its operation. [3]

(b) A 10 KW, 100V, 1000rpm dc shunt motor has armature resistance $r_a = 0.1\Omega$ and is connected to a 100Vdc supply. (i) obtain the ratio of starting to rated current in the motor when operated with no starter. (ii) when the motor is operated with a starter determine the values of starter resistances required such that the armature current is constrained within 100 to 200% of the rated value. [5]

Q3. A 3-phase, 400V, 50Hz, Y-connected salient pole synchronous motor is operated at 40A, 0.8 pf lagging. The d and q-axis reactances x_d and x_q are 3Ω/ph and 2Ω/ph respectively. The armature resistance r_a is 0.5Ω/ph and the

rotational losses are 5% of the power developed by the motor. Obtain (i) The excitation voltage E_f, (ii) the torque angle δ, (iii) the power developed due to the field excitation, (iv) the power developed due to the saliency of the motor and (v) the efficiency of the motor. [6]

Draw the corresponding phasor diagram for the motor [2]

Q4 (a) Give description of the tests to be conducted on a 1-phase, capacitor start induction motor to determine the stator and rotor resistances and leakage reactances and the magnetising reactance parameters of the main winding of the motor. How the rotational losses are obtained? [4]

(b) A 230V, 50Hz 1-phase capacitor start induction motor is ~~tested to yield the following data~~:

Voltage (V)	current (A)	Power (W)
230	5	137.5
40	6.15	227.0

Calculate the model parameters [4]

Given main winding resistance is 2.5Ω.

Q5. (a) Draw the layout of one phase armature winding of a 3-phase, 2-pole, Y-connected synchronous generator having 36 armature slots in the stator. The armature winding is ~~having distributed~~ double layer Lap wound structure. Derive the expression for the winding distribution factor K_d, from the basics.

(b) A 36-slot, 2-pole, 50-Hz, 3-phase, Y-connected synchronous generator has 6 turns per coil. The flux per pole 20 mWb. Determine (i) the number of coil per phase group (ii) the slot span (iii) the winding distribution factor and (iv) the generated voltage per phase. Assume series connection. [4+4]

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