University of Saskatchewan

Department of Electrical Engineering
EE 341.3 Electric Machines I (Term 2)
Final Examination (Total Duration: 3 hrs)

Dated: April 24, 2006 **Time: 9:00am – 12:00 pm**
Instructor: Dr. Ramakrishna (Rama) Gokaraju **Total Marks: 50**

Instructions:

1) This examination paper consists of 7 problems and 2 pages in total.
2) This is a closed-book examination. Two-page formula sheet is allowed. Solved examples are not allowed in the formula sheet.
3) Your solutions should be methodical. Write the steps of your numerical computations clearly. You would be severely penalized if your solutions are illegible.
4) Mark allotted for each problem is shown on the right margin.
5) You are advised not to spend more than 25 minutes on any given problem.

Problem 1

A 1732 V, 300 kVA, Y-connected, synchronous generator has a synchronous impedance of 0.5+j4 Ω/phase. Determine the power factor of the load that yields zero voltage regulation.

7 Marks

Problem 2

A 10.8 kVA, 208 V, Y-connected, three-phase, synchronous generator supplies the rated load at 0.8 pf lagging. The synchronous impedance is 0.5 + j5 Ω/phase. The field winding resistance is 20 Ω. Its per-phase OCC at the rated speed is given as

$$E_A = \frac{2400 I_F}{7.5 + 6.5 I_F}$$

Where, E_A is the internal generated voltage and I_F is the field current. If the rotational loss is 1.2 kW, determine the voltage regulation and efficiency of the generator. If the field voltage is 120 V (dc), what must be the external resistance in the field-winding circuit?

7 Marks

Problem 3

A 4,000 V, 5000 hp, 60 Hz, 12-pole synchronous generator with a synchronous reactance of 4 ohms per phase is excited to produce unity power factor at rated load. Neglect all losses.

a) Find the rated and maximum torques.
b) What is the armature current corresponding to the maximum torque?

7 Marks

Problem 4

A 460 V, Y-connected, three-phase, synchronous motor takes 30 kW at full load when the power factor is unity. The synchronous reactance is 4 ohms per phase and the winding resistance is negligible. For a constant power output at 0.8 pf leading, what must be the change in excitation voltage? What are the new power angle, armature current and power factor?

7 Marks

Problem 5

The following test data apply to a 208 V, 4-pole, Y-connected, three-phase induction motor: Running without load at its rated voltage, the line current and the power input are 2 A and 360 W. With blocked rotor, the current is 20 A and power input is 600 W when the applied voltage is 30 V. The friction and windage loss is 36 W. The resistance between any two lines is 0.2 Ω. Obtain the equivalent circuit parameters of the motor. Use $f_{test} = 45Hz$.

$f_{RATED} = 60Hz$

7 Marks

Problem 6

A three-phase induction motor, operating at rated voltage and frequency, has a starting torque of 135 % and a maximum torque of 220%, both with respect to its rated-load torque. Neglecting the effects of stator resistance and rotational losses and assuming constant rotor resistance, determine (a) the slip at maximum torque, (b) the slip at rated load, (c) the rotor current at starting (as a percentage of rotor current at rated load).

8 Marks

Problem 7

A 240 V, 1800 rpm dc shunt motor has an armature circuit resistance of 2.5 Ω and a field resistance of 160 Ω. When it operates at full load and its rated speed, it takes 21.5A from the source (supply). What resistance must be placed in series with the armature in order to reduce the speed to 450 rpm while the torque developed by the motor remains the same?

7 Marks

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