

Electro Mechanical Systems (EE2010)

Date: May 25th, 2024

Course Instructor(s)

Mr. Muhammad Abdul Majid

Mr. Syed Muhammad Ismaeel

Final Exam

Total Time: 3 Hours

Total Marks: 100

Total Questions: 4

Semester: SP-2024

Campus: Lahore

Dept: Electrical

Engineering

Student Name

Roll No

Section

Student Signature

Vetted by

Vetter Signature

CLO #3: Analyze Synchronous Generator performance along with special emphasis towards environmental cost of generation

Q1:

[marks 25]

A 2.8 KV, 1.5 MVA, 0.85-PF-lagging, 50-Hz, 16 pole, Y-connected synchronous generator, has a synchronous reactance of 1.2Ω and an armature resistance of 0.2Ω . At 50 Hz, its friction, windage and core losses are 50 KW. The field circuit has a dc voltage of 200 V. The resistance of the field circuit is adjustable over the range from 10Ω to 210Ω .

The generator is providing 300A, at 0.8 PF lagging to a load. The line voltage at load terminals is 2500 V. Answer the following questions.

- Draw a properly labelled equivalent circuit diagram with proper current directions and voltage polarities
- Find Voltage regulation
- Field circuit resistance
- Output torque of prime mover

I_F (A)	2	4	6	8	10
$V_{T,NL}$ (V)	1200	2200	2700	2950	3050

OCC for above generator

Page 1 of 3

2500

$$I_F : V_T$$

$$2 : 250$$

$$x : 100$$

$$x = \frac{250}{250}$$

$$0.8$$

$$I_F = 6.8A$$

CLO #2: Investigate working of a DC Machine

Q2:

[marks = 25]

A 25HP, 240V compensated DC shunt motor has armature resistance of 0.4Ω . Its field resistance is 80Ω and adjustable resistance connected in series with field coil can vary from 50Ω to 200Ω . Its no load characteristic curve at a speed of 1800 rpm is tabulated as under.

I_f (A)	0.3	0.6	0.9	1.2	1.4	1.6
E_A (V)	130	230	274	288	292	295

Find out following quantities assuming rated terminal voltage in all cases.

- No load speed of motor if adjustable resistance connected in series with field coil has been set to a value of 100 ohm.
- The speed at a line current of 65A, with same field current as in part (a)
- Fully labeled Circuit diagram for part (b)
- Output torque in part (b) if mechanical and core losses are 700 watts
- Maximum possible no load speed of the motor

CLO #5: Analyze an Induction motor circuit

Q3:

[marks = 25]

A 120 HP, 440-V, 50-Hz four-pole Y-connected induction motor is working under steady conditions. The equivalent circuit parameters are

$$R_1 = 0.075 \Omega \quad R_2 = 0.065 \Omega \quad X_M = 7.2 \Omega$$

$$X_1 = 0.17 \Omega \quad X_2 = 0.17 \Omega$$

$$P_{F\&W} = 1.0 \text{ kW} \quad P_{\text{misc}} = 150 \text{ W} \quad P_{\text{CORE}} = 1.1 \text{ kW}$$

For a slip of 5% and at rated voltage and frequency, find out

- Motor speed
- The stator copper losses
- The air gap power
- Shaft torque

CLO #4: Appraise the existence of a rotating magnetic field and its application to a Synchronous Motor

Q4:

[marks = 25]

A 415-V, Y-connected, 30 pole, synchronous motor is delivering a power of 30 HP at 0.75 lagging power factor and rated voltage. The field current flowing under these conditions is 4.5 A. Its synchronous reactance is 1.2Ω . Total losses of the motor under these conditions are 2300watts. Assume a linear open-circuit characteristic.

Find the torque angle and internally generated voltage

$$45.8 \text{ A}$$

Page 2 of 3

How much field current is required to run the motor at a PF of 0.8 leading, keeping everything else constant?
What is the load torque?