Nagal

2022EEB1192

Quiz 1

Electromechanics, EE 205

Session 2023-2024

Valid assumptions for any missing data can be made. Symbols and abbreviation has usual meaning unless specified.

Use of calculator is allowed

Maximum time 90 mins

Maximum marks (20), weightage 10% of total marks of the course

1. Objective type question (2 marks)

i. In a two winding transformer the resistance between its primary winding and secondary winding is ..... (zero, infinite, 1 ohms, 1000 ohms) **(0.5 marks)**

ii. A 200/100V, 50 Hz transformer is to be excited at 40 Hz from the 100 V side. For exciting current to remain same, the applied voltage should be ..... **(0.5 marks)**

iii. A 2:1 ratio, two -winding transformer is connected as an auto transformer. Its kVA rating as an auto transformer compared to the two winding transformer is ..... (same, 1.5 times, 2 times, 3 times) **(1 marks)**

2. A 10-kVA 480/120-V conventional transformer is to be used to supply power from a 600-V source to a 480-V load. Consider the transformer to be ideal, and assume that all insulation can handle 600 V. *(a)* Sketch the transformer connection that will do the required job. *(b)* Find the kilo-voltampere rating of the transformer in the configuration. *(c)* Find the maximum primary and secondary currents under these conditions. **(4 marks)**

3. Three 20-kVA 24,000/277-V distribution transformers are connected in Y-Y. The open-circuit test was performed on the low-voltage side of this transformer bank, and the following data were recorded:

$V_{line,OC} = 480$ V	$I_{line,OC} = 10.4$ A	$P_{3,OC\,\phi} = 945$ W

The short-circuit test was performed on the high-voltage side of this transformer bank, and the following data were recorded:

$V_{SCline,} = 1400$ V	$I_{SCline,} = 80.1$ A	$P_{3,SC\,\phi} = 912$ W

(a) Find the per-unit equivalent circuit of this transformer bank. **(3 marks)** *(b)* Find the voltage regulation of this transformer bank at the rated load and 0.90 PF lagging. (use per unit equivalent only) **(2 marks)** (c) What is the transformer bank's efficiency under these conditions? **(2 marks)**

4. Two single-phase transformers rated 1000 kVA and 500 kVA have per unit leakage impedance of $(0.02 + j\,.06)$ and $(0.025 + j\,0.08)$ respectively. What is the largest kVA load that delivered by the parallel combination of these two transformers without overloading any one? Also find the load shared by individual transformer. **(6 marks)**

Nq/Cuf

2022 EE 01172

Quiz 2

Electromechanics, EE 205

Session 2023-2024

Valid assumptions for any missing data can be made. Symbols and abbreviation has usual meaning unless specified.

The use of a calculator is allowed

Don't write anything on question paper

Maximum time 55 mins

Maximum marks (15), weightage 10% of total marks of the course

1. Objective questions
   i) For four pole dc machine, the coil pitch for full pitch armature winding is ..... degree electrical and ..... degree mechanical. (1.0 Marks)
   ii) If the magnetic circuit of a dc machine is in the linear region of the BH characteristics, the armature reaction ..... (increases/decreases/does not affect) the flux per pole of the machine. (0.5 Marks)
   iii) Armature voltage control technique based dc drive is .....drive and flux control technique based drive is ..... drive. (constant torque/constant power (0.5)
2. A 2 pole, lap wound dc shunt generator charges a 100V battery of negligible internal resistance. The armature of the machine is made up of 1000 conductors, each of 2 milli-ohms. The charging current are found to be 10A and 20 A for generator speeds of 1055 and 1105 rpm, respectively. Find the field circuit resistance and flux per pole of the generator. Neglect armature reaction effects. (5 marks)
3. A 250V dc shunt motor has R_f =150 Ω and Ra=0.6 Ω. The motor operates on no load with a full field flux at its base speed of 1000 rpm with Ia =5A. If the machine drives a load requiring a torque of 100 Nm, Calculate the armature current and speed of the motor. If the motor is required to develop 10 kW at 1200 rpm, what is the required value of the external series resistance in the field circuit? Neglect the saturation and armature reaction. (2+3)
4. When rotated using external prime mover, a shunt generator did not generate terminal voltage. What could be the possible reasons for it? Give the remedial solutions for it. (2 marks)
5. A 220 V d.c shunt motor has armature and field resistances of 0.15 Ω and 220 Ω, respectively. Find the amount of starting resistance required to limit the maximum starting current to 15 A. (1 mark)

Quiz 3

Electromechanics, EE 205

Session 2023-2024

Valid assumptions for any missing data can be made. Symbols and abbreviation has usual meaning unless specified.

The use of a calculator is allowed

Maximum time 60 mins

Maximum marks (15), weightage 10% of total marks of the course

1. A three phase star connected 400 V (line voltage), 50 Hz, 4-pole induction motor has the following per phase constants in ohms referred to stator, r1=0.15, x1= 0.45, r2=0.12, x2=0.45, Xm=28.5. friction, windage and core losses are equal to 400 W. Find the output shaft torque of the motor at rated voltage and frequency at a slip of 4 percent. (5 marks)
   Also find the starting torque, breakdown torque and slip corresponding to breakdown torque of the motor under the following conditions (hint: maximum induced torque is achieved when r2/s absorbs the maximum power, parameters given above are for the rated conditions)
   (a) 400V (line voltage), 50Hz (5 marks)
   (b) 200V (line voltage), 25Hz (5 marks)

Some important expressions with usual symbols (if you wish, you can refer these expressions)

Thevenin's equivalent from rotor side

$$Z_{TH} = R_{TH} + jX_{TH} = \frac{jX_M(R_1 + jX_1)}{R_1 + j(X_1 + X_M)}$$

$$R_{TH} \approx R_1\left(\frac{X_M}{X_1 + X_M}\right)^2$$

$$X_{TH} \approx X_1$$

$$\tau_{ind} = \frac{3V_{TH}^2 R_2/s}{\omega_{sync}[(R_{TH} + R_2/s)^2 + (X_{TH} + X_2)^2]}$$

$$\tau_{max} = \frac{3V_{TH}^2}{2\omega_{sync}[R_{TH} + \sqrt{R_{TH}^2 + (X_{TH} + X_2)^2}]}$$

The students are required to write name and entry no.

Name .....Na/cuf..... **Entry No:**..2192.....

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EE205

INDIAN INSTITUTE OF TECHNOLOGY ROPAR

Electromechanics EE 205

First Semester of Academic Year 2023- 224

Mid semester Examination

Duration:2 Hours	Max. Marks: 30	Date:18-09-2023

Instructions

- Use of scientific calculator is allowed.
- Answer to each question must start on a new page.
- Answer to all the sub-part of a question should appear together.
- All questions are compulsory
- Any missing data can be suitably assumed.
- Symbols and abbreviations have their usual meanings unless specified.
- You can't write on question paper except your name and entry number.

1. Objective type question
   i) If impedance angle of a load is negative, the current flowing in the load .... the voltage applied across it. (leads/lags). (0.5 marks)
   ii) Load Power factor angle when observed from the primary side of a practical transformer is ..... the power factor angle of the actual load. (same as/greater than/ less than) (0.5 marks)
   iii) Nature of current within the winding of a dc motor is ..... (AC/DC) (0.5 marks)
   iv) Total number of parallel path for current in a 6 pole dc machine with duplex LAP winding is ..... (0.5 marks)
   v) Thin laminations of the core material of electric machines are used to reduce ..... losses. (eddy current/hysteresis) (0.5marks)
   vi) At the time of starting of linear dc motor, the back emf generated in the armature winding is ..... (0.5 marks)
2. Give two methods to reduce the leakage flux in the transformer. (be brief) 1 marks

3. Two single phase transformers T1 and T2 are needed to be connected in parallel to supply the power to the load. The primary side connection of both the transformers are connected as shown in the Figure 1. The dots are also marked. Do the proper connection at the secondary side of the transformers along with the load. Use the same labels as given in the figure. **(2 marks)** (give proper reason)

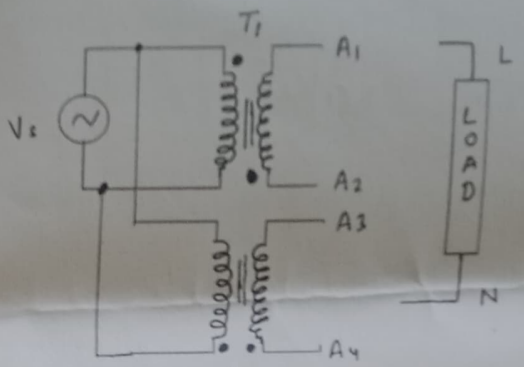

Figure 1

4. A 120 V/480 V, 10kVA transformer is to be used as an autotransformer to supply a 600 V load from a 480 V source. For the two winding transformer shunt branch parameters are Rc=380 Ω, Xm= 76.5 Ω and series impedance Zeq= 0.222+j 0.917 Ω.
   i) Firstly find the per unit equivalent circuit of two winding transformer, its efficiency and voltage regulation at full load and unity power factor load (use per unit parameters only for efficiency and voltage regulation calculation) **(1+1+1 marks)**
   ii) Draw appropriate connections which is needed to be made on the two winding transformer to operate it as an autotransformer. (Connections with proper dots and direction of current) **(1marks)**
   iii) Determine the KVA rating of the autotransformer connection (don't use direct expression) **(2 Marks)**
   iv) Find the efficiency and voltage regulation when the transformer is used as an autotransformer at full load, with unity power factor (Excitation branch remains same in case of auto transformer connections. Neglect the shunt branch parameters for voltage regulation calculation) **(4 marks)**
5. A Δ-Y connected bank of three identical 100-kVA, 2400 V/120 V 60Hz transformers is supplied with power through a transmission line whose impedance is 0.65+j0.87 Ω per phase. The voltage at the sending end of the transmission line is held constant at 2400 V line to line. The results of a single phase short circuit test on one of the transformers with its low-voltage terminals short circuited are Vsc=53.4 V, f=60Hz, Isc= 41.7A and Psc=832 W.
   i) Determine the line to line voltage on the low voltage side of the transformer when the bank delivers the rated current to a balanced three-phase load at 0.8pf lagging. **(5 marks)**
6. A Scott-T connection is a way to derive the two phases which are 90° apart from a three-phase supply. Design a Scott- T connected transformer which convert 11 kV three-phase supply voltage to two phase supply with 230 V for each phase. Give proper phasor diagram and transformer connections. Also find the appropriate turn ratio to meet the demand **(6 marks)**
7. Open and short circuit tests performed on a 500 kVA, 6600/2300 V, 50 Hz transformer yielded the following data:
   No-load loss=3 kW, Full load short circuit loss = 4 kW.

   The transformer supplies the following load cycle. 12 hrs, full load, 0.85 pf and 12 hrs, half load, 0.9 pf. Calculate the all day efficiency of the transformer. **(3 marks)**

*****End*****

The students are required to write name and entry no.

Name ..Nagpal..... Entry No:.....1192.....

EE205

INDIAN INSTITUTE OF TECHNOLOGY ROPAR

Electromechanics EE 205

First Semester of Academic Year 2023- 224

End semester Examination

Duration:3 Hours | **Max. Marks: 40** | **Date:24-11-2023**

Instructions

- Use of scientific calculator is allowed.
- Answer to each question must start on a new page.
- Answer to all the sub-part of a question should appear together.
- All questions are compulsory
- Any missing data can be suitably assumed.
- Symbols and abbreviations have their usual meanings unless specified.
- You can't write on question paper except your name and entry number.

1. Objective Type Questions

a) Universal motors are dc ..... (series/shunt/separately excited) motors (0.5 M)

b) Single phase Induction Motors are inherently self-starting motor (true/false) (0.5 Marks)

2. Give two methods of starting for high power induction motor. Be brief. (2 marks)

3. Describe (draw the torque speed characteristics) the effect on the torque speed characteristic of an induction motor produced by (a) halving the magnitude of applied input voltage and keeping its frequency constant and (b) when both the magnitude and frequency of the applied voltage is reduced to half. (2 marks)

4. A 200 V dc series motor, when operating from rated voltage while driving a certain load draws 10 A current and runs at 1000 rpm. The total series resistance is 1 Ω. The magnetic circuit is assumed to be linear. At the same supply voltage the load torque is increased by 44%. Find the speed of the motor in rpm for the new load condition. (4 marks)

5. A dc shunt motor with an armature resistance of 0.2 Ω drives a load at 1245 rpm, drawing an armature current of 125 A from a 440 V supply. If the excitation is reduced to 75% of the

initial value and the total torque developed by the armature remains unaltered. Calculate new speed of the motor in rpm. (4 marks)

6. A 22kV, 3-phase star-connected turbo alternator with a synchronous impedance of j12 Ω/phase is delivering 230 MW at unity pf to 22kV grid. With the turbine power remaining constant, the alternator excitation is increased by 30%. (a) Determine the stator current and power factor of the alternator. (b) At the new excitation, the turbine power is now increased till the machine delivers 275 MW. Calculate the new current and power factor. (3+3 marks)

7. A 1000kVA, 50Hz, 2300 V, Y-connected, 3-phase synchronous generator gave the following test data:

Field Current (A)	40	80	100	120	140	170	240
(Open Circuit Test) Voc in Volts (Line voltage)	1000	1900	2200	2450	2600	2750	3000
SC Test :Isc (A)	1000						

(a) Plot open circuit and short circuit characteristics on a graph paper (ask the invigilator for one graph paper) and find saturated and unsaturated synchronous reactance of the machine from it. (neglect the winding resistance) (4 marks)

(b) Find the field current required to deliver rated kVA at 0.8 pf at rated terminal voltage (chose the saturated synchronous reactance) (3 Marks)

8. A three-phase Y-connected, 400 V, 6-pole, 50 Hz induction motor develops mechanical power of 20kW at 985 rpm when powered by a Y-connected three-phase alternator of 400V with per phase armature resistance and synchronous reactance of 0.6 Ω and 4.8 Ω respectively. The stator losses in the induction motor is 1800 W (mechanical loss is neglected).

(a) Find the total input power and the input line current of the three-phase induction motor if the input power factor of the motor at the given load is 0.85. (4 marks)

(b) Also find the induced emf and the torque angle of the alternator for the above given load condition. (4 marks)

9. A test on the main winding of a 1 kW, 4 pole, 215 V, 50Hz Single phase induction motor gave the following results:

No load Test: Voc=215 V, Ioc = 3.9 A, Woc = 185 W, R1 = 1.6Ω

Blocked Rotor Test: Vsc = 85 V, Isc = 9.8A, Psc = 390 W

The stator winding resistance is 1.6Ω and $X_1=X_2'$

(a) Draw the equivalent circuit diagram of the single phase IM based on double field revolving theory. (Assuming auxiliary winding is not there) with their values. (4 marks)

10. Two induction motors A and B have the torque speed characteristics as shown in Figure 1. Both the motors have same starting and breakdown torque for same voltage rating. The application demands good speed regulation with respect to change in load torque from no load to full load. Out of these two, which motor should be chosen and why? (2 Marks)

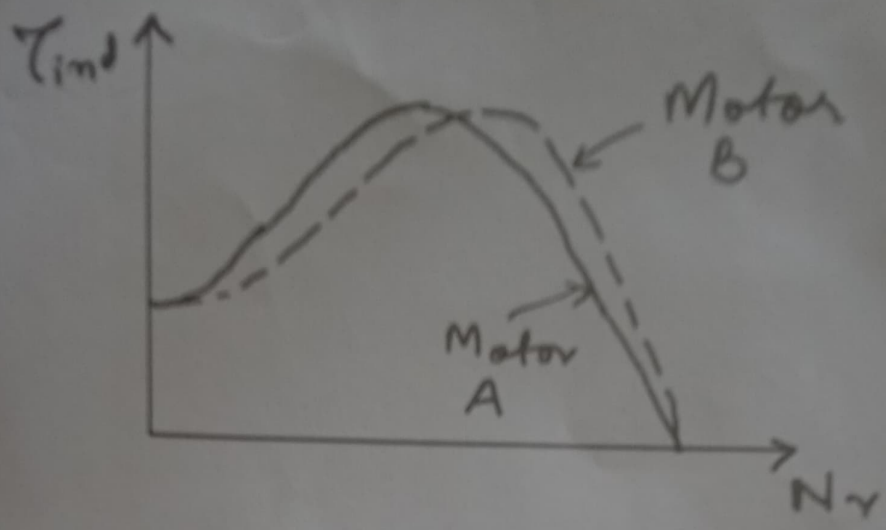

Figure 1

XXXXXXXXXXXXXXXXX End of Paper XXXXXXXXXXXXXXXXXXXXXXXXXXXXX

Some important expressions with usual symbols (if you wish, you can refer these expressions)

Thevenin's equivalent from rotor side for three phase induction Motor

$$Z_{TH} = R_{TH} + jX_{TH} = \frac{jX_M(R_1 + jX_1)}{R_1 + j(X_1 + X_M)}$$

$$\tau_{ind} = \frac{3V_{TH}^2 R_2/s}{\omega_{sync}[(R_{TH} + R_2/s)^2 + (X_{TH} + X_2)^2]}$$

$$\tau_{max} = \frac{3V_{TH}^2}{2\omega_{sync}[R_{TH} + \sqrt{R_{TH}^2 + (X_{TH} + X_2)^2}]}$$

Synchronous Machines

$$Z_S = \sqrt{R_1^2 + X_S^2} = \frac{E_A}{I_A} = \frac{V_{t(OC)}}{I_A}$$

$$P_{conv} = \frac{3 V_t E_a}{X_S} \sin\delta$$