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# MANIPAL INSTITUTE OF TECHNOLOGY
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## III SEMESTER B.TECH (ELECTRICAL & ELECTRONICS ENGINEERING)
## END SEMESTER EXAMINATIONS, NOVEMBER 2019

### ELECTRICAL MACHINES-I [ELE 2154]

REVISED CREDIT SYSTEM

**Time: 3 Hours** **Date: 23, November 2019** **Max. Marks: 50**

**Instructions to Candidates:**
- Answer **ALL** the questions.
- Missing data may be suitably assumed.

**1A.** In a 5 kVA 200/400V, 50Hz single phase transformer, the maximum value of core flux is 0.025 Wb. Calculate:
(i) Induced EMF/turn (ii) number of turns in primary and secondary windings. ***(02)***

**1B.** A 100 kVA, 11000 / 240 V, 50 Hz, single phase transformer has the following test data :
Open Circuit Test : 240 V, 20.7A, 950 W with HV open circuited
Short Circuit Test : 128.3 V, 9.09A, 1050 W with LV short circuited
Draw approximate equivalent circuit of the transformer referred to HV side. ***(03)***

**1C.** The efficiency of 6600/400V, 200 kVA transformer at unity power factor is 98 % both at full load and half-full load. Calculate:
(i) Iron loss and full load copper loss
(ii) kVA load corresponding to maximum efficiency and
(iii) Value of maximum efficiency for a load power factor of 0.8 lagging. ***(05)***

**2A.** With neat sketches, show that open-delta connection has a kVA rating of 58 % of the rating of the normal delta-delta connection. ***(02)***

**2B.** Two transformers A and B are connected in parallel to a load of (8+j6) Ω. The equivalent impedances of the two transformers are $Z_A$ = (0.3+j3) Ω and $Z_B$ = (0.2+j1) Ω in terms of their secondary. Their no-load terminal voltages are $E_A$=6600 V and $E_B$=6500 V. Determine:
(i) Common terminal voltage
(ii) Current delivered by each transformer along with their power factors. ***(05)***

**2C.** With a neat sketch explain the working of an OFF load tap changing transformer. What are its disadvantages? ***(03)***

**3A.** Derive an expression for gross torque developed in a 3 phase induction motor running at a slip 's' in terms of machine parameters. Sketch and explain the torque-slip characteristic of a 3-phase slip-ring induction motor (i) with slip rings short circuited (ii) slip rings are connected to an external star connected rheostat. ***(04)***

**3B.** A cage induction motor when started by means of a star-delta starter takes a line current 180% of full load line current and develops 35% of full load torque at starting. Calculate:

(i) full load slip

(ii) starting torque and supply line current in terms of full load values, if an auto-transformer with 75% tapping were employed ***(03)***

**3C.** A 4 pole, 50 Hz, 3-phase slip ring induction motor has rotor resistance of 0.4 Ω per phase and inductive reactance of 4 Ω per phase at standstill conditions. Calculate:

(i) speed at maximum torque

(ii) ratio of maximum torque to starting torque

(iii) value of external resistance per phase required in rotor circuit to get 50% of maximum torque at starting ***(03)***

**4A.** A 440 V, 50 Hz, 6-pole, 3 phase induction motor has a rotor input power of 80 kW. The rotor emf is observed to make 100 complete cycles per minute. Calculate:

(i) speed at which rotor is running

(ii) rotor copper loss per phase

(iii) gross mechanical power developed

(iv) rotor resistance per phase if the rotor current is 65 A per phase ***(03)***

**4B.** With a suitable connection diagram, explain the procedure of no-load and blocked rotor test on 3-phase induction motor. How are the parameters of equivalent circuit determined from the test results? ***(04)***

**4C.** Explain double-revolving-field theory for single phase induction motors. Draw and explain the forward and backward torques developed and torque-slip curve of a single phase induction motor based on the above theory and hence show that single phase induction motor is not self-starting. ***(03)***

**5A.** Explain with relevant characteristic, the voltage build-up in a DC shunt generator when driven at rated speed. ***(04)***

**5B.** Draw and explain the external characteristic of DC (i) shunt (ii) Long shunt differential generator. ***(03)***

**5C.** A long shunt DC compound generator has armature, series field and shunt field resistances of 0.05 Ω, 0.03 Ω and 250 Ω respectively. It delivers a load of 25 kW at a terminal voltage of 500 V. The armature consists of 400 lap wound conductors. The net field flux per pole is 30 mWb. Allowing 1 V per brush for contact drop, calculate:

(i) Generated emf (ii) Speed at which the generator is running. ***(03)***