FIJI NATIONAL UNIVERSITY

COLLEGE OF ENGINEERING, SCIENCE AND TECHNOLOGY

SCHOOL OF ELECTRICAL AND ELECTRONICS ENGINEERING

B.E. (HONORS) (ELECTRICAL ENGINEERING) PROGRAMME, (BENG 3)

EEB 712 ELECTRICAL MACHINES

FINAL EXAMINATION
(SEMESTER 2, 2019)

DATE/TIME/ROOM – Refer to Timetable

Total Marks – 100 Time Duration – 3 hours & 10 Minutes

INSTRUCTIONS TO CANDIDATES

1. You are allowed 10 minutes extra time during which you are not allow writing.
2. Begin each answer on a new page and use both sides of the sheets.
3. Write your identification number on the top of each attached sheet.
4. Attach all written foolscaps, graph paper, drawing paper in their correct sequence and secure with string provided.
5. For all sheets of paper in which rough work has been done, cross it through and attach to your answer script.
6. Write clearly the number(s) of the question(s) attempted on the top of each sheet.
7. *ANSWER ALL QUESTIONS.*

1. (a) Explain the open circuit and short circuit test for determination of the equivalent circuit parameters of the transformer. Develop the exact equivalent circuit of a single-phase transformer. [6 Marks]

   (b) A 30 kVA, 2400/120 V, 50 Hz transformer has a high voltage winding resistance of 0.1 Ω and a leakage reactance of 0.22 Ω. The low voltage winding resistance is 0.035Ω and leakage reactance of 0.012 Ω. Find the equivalent winding resistance, reactance and impedance referred to the (i) high voltage side (ii) low voltage side. [6 Marks]

2. (a) Two single-phase transformers A and B rated at 250kVA each are operated in parallel on both sides. Percentage impedances for A and B are (1+j 6) and (1.2 +j 4.8) respectively. Compute the percentage load shared by each when the load is 500 kVA at 0.8 p.f. lagging. [4 marks]

   (b) A 500 kVA, 2300/230 V, 50 Hz, distribution transformer has core loss of 1600 W at rated voltage and copper loss of 7.5 kW at full load. It has the following load cycle

% load	0%	20%	50%	80%	100%	125%
Power factor	-	0.7 lag	0.8 lag	0.9 lag	1	0.85 lag
Hours	2	4	4	5	7	2

   Determine the all-day efficiency of the transformer. [6 Marks]

3. (a) Derive emf equation for an alternator. Explain the effect of distribution of winding and use of short pitch coil on the magnitude of the generated voltage of an alternator. [4 Marks]

   (b) A three-phase, 16 pole alternator has star connected winding with 144 slots and 10 conductors per slot. The flux per pole is 0.03 Wb, sinusoidally distributed and the speed is 375 r.p.m. Calculate the phase and line e.m.f. Assume full pitch coil. [6 Marks]

4. (a) What are the V curves and inverted V curves of a synchronous motor? What are the main characteristics of V curves, explain with suitable circuit diagram. [5 Marks]

   (b) A 100 kVA, 3000V, 50 Hz, three-phase star connected alternator has effective armature resistance of 0.2 Ω. The field current of 40A produces short-circuit current of 200A and an open circuit emf of 1040 V (line values). Calculate the full load voltage regulation at 0.8 p.f. lagging and 0.8 p.f. leading. [6 Marks]

5. (a) Explain with the help of analytical method, how rotating magnetic field is produced in three phase induction motor. [5 Marks]

   (b) A 150 kW, 3000V, 50 Hz , 6 pole star connected induction motor has a star connected slip ring rotor with a transformation ratio of 3.6 (stator/rotor). The rotor resistance is 0.1Ω/phase and its leakage reactance per phase is 3.61mH. The stator impedance may be neglected. Find the starting current and starting torque on rated voltage with short-circuited slip rings. [6 Marks]

6. (a) Show and explain through power flow diagram, how electrical input is converted into mechanical power output in an induction motor, and hence show that [5 Marks]

P_g : rotor cu loss: $P_m = 1 : s : (1-s)$; where s is slip.

(b) The star connected rotor of an induction motor has a standstill impedance of (0.4 +j 4) ohm per phase and the rheostat impedance per phase is (6 +j 2) ohm. The motor has an induced emf of 80V between slip rings at standstill when connected to its normal supply voltage. Calculate (i) rotor current at standstill with the rheostat is in the circuit (ii) when slip rings are short-circuited and motor is running with a slip of 3%. [6 Marks]

7. (a) Derive the expressions for the induced emf and torque of a dc machine using standard symbol. [4 Marks]

(b) A long shunt compound generator delivers a load current of 50A at 500V and has armature series field and shunt field resistances of 0.05Ω, 0.03 Ω and 250 Ω respectively. Calculate the generated voltage and the armature current. Allow 1v per brush for contact drop. [6 Marks]

8. (a) An 8-pole D.C. shunt generator with 778 wave-connected armature conductors and running at 500 r.p.m. supplies a load of 12.5 Ω resistance at terminal voltage of 250 V. the armature resistance is 0.24 Ω and the field resistance is 250 Ω. Find the armature current, the induced emf and the flux per pole. [5 Marks]

(b) A 4 pole, 220V shunt motor has 540 lap wound conductor. It takes 32A from the supply mains and develops output power of 5.595 kW. The field winding takes 1A. the armature resistance is 0.09 Ω and the flux per pole is 30mWb. Calculate (i) the speed (ii) the torque developed in newton-meter. [5 Marks]

9. A 230 V, 50 Hz, 4 pole single-phase induction motor has the following circuit impedances:
$R_{1m} = 2.2\ \Omega$, $R_2' = 4.5\ \Omega$, $X_{1m} = 3.1\ \Omega$, $X_2' = 2.6\ \Omega$, $X_M = 80\ \Omega$
Friction, windage and core loss = 40 W.
For a slip of 0.03 p.u., Calculate (a) input current (b) power factor (c) developed power (d) output power (e) efficiency. [10 Marks]

10. Write short notes on any ONE of the following: [5 Marks]
(a) Capacitor start motor.
(b) Shaded pole motor.

[THE END]