FIJI NATIONAL UNIVERSITY

COLLEGE OF ENGINEERING, SCIENCE AND TECHNOLOGY
SCHOOL OF ELECTRICAL AND ELECTRONICS ENGINEERING

BACHELOR OF ENGINEERING PROGRAMME, YEAR 3 (BENG 3)

EEE 782 ELECTRICAL MACHINES

FINAL EXAMINATION
(SEMESTER 1, 2016)

DATE/TIME/ROOM – Refer to Timetable

INSTRUCTIONS TO CANDIDATES

1. You are allowed 10 minutes extra time during which you are not to write.
2. Begin each answer on a fresh new page and use both sides of the sheets.
3. Write your identification number on the top of each attached sheet.
4. Insert all written foolscaps, graph paper, drawing paper etc. 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 you must attach to your answer script.
6. Write clearly the number(s) of the question(s) attempted on the top of each sheet.
7. *ANSWER ONLY TEN QUESTIONS.*

Total no. of pages - 3

1. (a) Develop the exact equivalent circuit of a single phase transformer. Explain the open circuit and short circuit test for determination of the equivalent circuit parameters of the transformer.
(b) A 400/100 V, 5 kVA, two winding transformer is to be used as an autotransformer to supply power at 400 V from 500 V source. Draw the connection diagram and determine the kVA output of the transformer. Also calculate the saving in conductor material in an auto transformer over a two winding transformer.

2. (a) Open circuit and short circuit test on a 50 kVA, 2400/120 V, 50 Hz, single phase transformer gave the following results:
O.C. Test - 120 V, 9.65 A, 396 W (l.v. side)
S.C. Test - 92 V, 20.8 A, 810 W (h.v. side)
Determine (a) the efficiency of the transformer at full load 0.9 power factor lagging (b) the approximate voltage regulation (c) the equivalent circuit parameters.
(b) A transformer has 1200 primary turns and 200 secondary turns. The primary and secondary resistances are 0.2 Ω and 0.02 Ω respectively and the corresponding leakage reactance are 1.2 Ω and 0.05 Ω respectively. Calculate the equivalent resistance, reactance and impedance referred to the primary winding.

3. (a) What are the distinguish features of Y-Y, Y-Δ, Δ-Δ and Δ-Y three phase connections? Compare their advantages and disadvantages.
(b) Two single phase transformers share having the same voltage ratio on no-load operate in parallel to supply a load of 1000 kVA at 0.8 power factor lagging. One transformer is rated at 400 kVA and has a per unit equivalent impedance of (0.01+ j 0.06), the other is rated at 600 kVA and has a per unit equivalent impedance of (0.01 + j 0.05). Determine the load on each transformer in kVA and the operating power factor.

4. (a) Explain the phenomenon of armature reaction when alternator is delivering a load current at (i) purely lagging pf (ii) unity pf (iii) purely leading pf.
(b) A three phase, 50 Hz, 8 pole alternator has a star connected winding with 120 slots and 8 conductor per slot. The flux per pole is 0.05 Wb, sinusoidally distributed. Determine the phase and line voltages.

5. (a) Define voltage regulation of an alternator. Sketch and explain the open circuit and short circuit characteristics of a synchronous machine. How voltage regulation can be calculated by the use of their results?
(b) A three phase, 16 pole synchronous generator has a resultant air gap flux of 0.06 Wb per pole. The flux is distributed sinusoidally over the pole. The stator has 2 slots per pole per phase and 4 conductors per slot are accommodated in two layers. The coil span is 150^0 electrical. Calculate the phase and line induced voltages when machine runs at 375 r.p.m.

6. (a) Explain hunting of a synchronous machine. What is the purpose of damper windings in a synchronous machine?
(b) 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.

7. (a) Explain the principle of operation of three phase induction motor. What is meant by slip in induction motor? Why cannot an induction motor run at synchronous speed?
(b) The power input to a three-phase induction motor is 60 kW. The stator losses total 1 kW. Find the mechanical power developed and the rotor copper loss per phase if the motor is running with a slip of 3%.

8. (a) Name the various methods of starting three-phase induction motor and describe the star-delta method of starting in details.
(b) A 500 V, 6 pole, 50 Hz, three-phase induction motor develops 20 kW inclusive of mechanical losses when running at 995 r.p.m., the pf being 0.87. Calculate (i) slip (ii) the rotor losses (iii) the total input if the stator loss is 1500 W (iv) line current (v) the rotor current frequency.

9. (a) Derive from first principle an expression for e.m.f. equation of a dc machine and for the electromagnetic torque developed in a dc motor.
(b) A DC generator has an armature e.m.f. of 100 V when the useful flux per pole is 20 *mWb* and the speed is 800 r.p.m. Calculate the generated e.m.f. (i) with the same flux and a speed of 1000 r.p.m., (b) with a flux per pole of 24 *mWb* and a speed of 900 r.p.m.

10. (a) Sketch the speed-torque, torque-armature current and speed- armature current characteristics for a D.C. (i) shunt motor (ii) series motor. Account for the shape of the above characteristics.
(b) A lap wound D.C. shunt generator having 80 slots with 10 conductors per slot at no load an e.m.f. of 400 V when running at 1000 r.p.m. At what speed should it be rotated to generate a voltage of 220 V on open circuit.

11. (a) Write short notes on any two of the following:
    (i) Capacitor motor.
    (ii) Shaded pole motor.
    (iii) Method of speed control of single phase induction motor.
(b) 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 pu, calculate (i) input current (ii) power factor (iii) developed power (iv) output power (v) efficiency.

[THE END]