FIJI NATIONAL UNIVERSITY

COLLEGE: COLLEGE OF ENGINEERING, SCIENCE & TECHNOLOGY (CEST)

SCHOOL: SCHOOL OF ELECTRICAL & ELECTRONICS ENGINEERING

PROGRAMME: TRADE DIPLOMA IN ELECTRICAL ENGINEERING - STAGE 4

UNIT CODE: EEE545

TITLE: ELECTRICAL MACHINES

FINAL EXAMINATION – TRIMESTER 1, 2018

TIME: 3 HOURS & 10 MINUTES
ROOM: AS PER TIMETABLE

INSTRUCTIONS TO STUDENTS

1. You are allowed 10 minutes extra reading time during which you are NOT to write.
2. Begin each SECTION on a fresh page and use both sides of the sheet.
3. Write your candidate number at the top of each attached sheet.
4. Insert all written foolscaps, graph paper, drawing paper, etc. in their correct sequence and secure with a string.
5. For all sheets of paper on which rough/draft work has been done, cross it through and ATTACH these to your answer scripts.
6. Write clearly the number(s) of the question(s) attempted on the top of each sheet.
7. Use of programmable calculator(s) is prohibited.
8. ANSWER ALL QUESTIONS
9. Show all working where necessary.
10. ALWAYS CHECK YOUR WORK BEFORE YOU LEAVE THE EXAM ROOM.

SECTION A **SHORT ANSWERS** **60 MARKS**

1. Generators are used in different ways and one factor that governs performance is the method of field excitation employed. Briefly describe the following types of direct current generators.
   a) shunt excited generators (2 marks)
   b) series excited generators (2 marks)

2. Describe how the rotating magnetic field is produced in a three phase motor. (3 marks)

3. List the three essential parts of a split phase induction motor. (3 marks)

4. An autotransformer has a single winding with two end terminals and one or more terminals at intermediate tap points. State two advantages of autotransformers. (3 marks)

5. Explain the starting methods of synchronous motors. (3 marks)

6. State two characteristics of synchronous motors. (4 marks)

7. Name two types of stepper motors. (2 marks)

8. Describe the principles of operation of the three phase induction motor. (2 marks)

9. Two transformers are connected in parallel means that the two primary windings are connected to supply bus and the two secondary windings are connected to load bus-bars. State the three requirements for connecting a transformer in parallel and explain the effects of each. (6 marks)

10. An alternator is an electrical machine which converts mechanical energy into alternating electric energy. They are also known as synchronous generators. Name and describe the two types of rotor's used in an AC generator/alternator. (4 marks)

11. Different starting methods are employed for starting induction motors because induction motor draws more starting current during starting. To prevent damage to the windings due to the high starting current flow, we employ different types of starters. State two advantages and two disadvantages of direct on line starter. (4 marks)

12. Direct current machine can be used as either a motor or a generator. The construction of each is virtually identical other than for specialized exceptions for specific purposes. Explain the function for each of the DC generator components listed below:
    a) field pole (1.5 marks)
    b) field coil (1.5 marks)
    c) commutator (1.5 marks)
    d) brush gear (1.5 marks)

13. List three applications of single phase induction motors. (3 marks)

14. A direct current machine is one that either produces or consumes direct current. In either case it acts as an energy convertor. Draw the basic motor circuit for:
    a) shunt excited motor (2 marks)
    b) series excited motor (2 marks)

15. State two advantages and two applications of stepper motors? (4 marks)

16. Explain the working principles of single phase double wound transformer. (2 marks)

17. State three advantages of parallel operation of alternators. (3 marks)

SECTION B CALCULATIONS 40 MARKS

1. A shunt connected motor draws 25A on a 200V d.c. supply. If the motor field has a current of 1A flowing through it and the armature resistance is 0.25 ohms, find the value of the back e.m.f. (3 marks)

2. A 10 kW shunt-connected generator operates with a terminal voltage of 240 V. The armature has an effective resistance (Ra) of 0.20 Ω and the shunt field (R_{sh}) has a resistance of 110 Ω. Calculate:
   (a) The full load current. (2 marks)
   (b) The field current. (2 marks)
   (c) The total armature current (2 marks)
   (d) The induced armature volt (3 marks)

3. A d.c. shunt connected motor runs at 1050r/min on no load and slows to 990r/min on full load. Find the speed regulation. (3 marks)

4. A three phase 415 volts induction motor draws a current of 170 amperes when connected to a DOL starter. If a primary resistance starter is connected to the motor so that the voltage to the motor is reduced to 250 V for starting, determine the:

   (a) Percent of rated voltage applied to the motor during starting. (2 marks)
   (b) Starting current taken by the motor. (2 marks)

5. A 4-pole armature contains 420 effective conductors. Given the magnetic flux as 0.02 webers per pole and the speed rotation 1000 rpm, find the value of generated voltage, for lap and wave wound. (5 marks)

6. A three-phase two-pole induction motor is connected to a 50 Hz supply. Determine the synchronous speed of the motor in rev/min. (4 marks)

7. Determine the total copper loss of a transformer on full-load having secondary and primary currents of 200A and 40A respectively. (Winding resistance: secondary = 0.03 ohms; primary = 0.06 ohms) (6 marks)

8. The maximum flux of a 50Hz transformer is 0.002 Wb. If the primary is wound with 1000 turns, find the applied primary voltage and then calculate the number of turns required for a 20V secondary. (6 marks)

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