



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

SCHOOL: SCHOOL OF ELECTRICAL & ELECTRONICS ENGINEERING

PROGRAMME: CERTIFICATE IV IN ELECTRICAL ENGINEERING-STAGE 4

UNIT CODE: EEE447

TITLE: ELECTRICAL MACHINES

## FINAL EXAMINATION – PENSTER 4, 2015

DAY/DATE: THURSDAY 08/10/2015      ROOM: AS PER TIMETABLE  
TIME: 9:00 – 11:10 AM

### 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.**

**QUESTION 1****DC MACHINES****(25 MARKS)**

- 1.1 With aid of circuit diagrams state three (3) differences in the construction components of self excited long shunt compound DC generator and short shunt compound DC motor?  
(5 marks)
- 1.2 With aid of Fleming left hand rule, explain briefly how the torque is produced in a DC motor?  
(4 marks)
- 1.3 With aid of Faradays and Lenzs Laws of induce voltage equations, explain briefly how back or counter EMF is produced at the starting period in a DC motor?  
(3 marks)
- 1.3 A Self excited shunt-connected generator operates with a terminal voltage of 240 V and rated load current of 10A. The armature has an effective resistance ( $R_a$ ) of 0.5  $\Omega$  and the shunt field ( $R_{sh}$ ) has a resistance of 480  $\Omega$ . The windage and friction losses are 175 watts. Calculate the:
- (a) shunt field current.
  - (b) armature current.
  - (c) voltage drop in armature circuit
  - (d) generated voltage
  - (e) copper loss in the armature
  - (f) copper loss in the shunt field
  - (g) total losses
  - (h) output power of the generator
  - (i) input power of the generator
  - (j) efficiency in percent
- (10 marks)
- 1.4 With the aid of the generated back emf equations identify at least two (2) main methods determines the speed control of DC motors?  
(3 marks)

**QUESTION 2****THREE PHASE INDUCTION MOTORS****(25 MARKS)**

- 2.1 State at least four (4) advantages that of three phase induction motors over single phase induction motor in terms of their construction and operation.  
(3 marks)

- 2.2 What are the three (3) basic construction components of an induction motor consists of?  
(3 marks)
- 2.3 With the aid of diagrams consisting of: a) one cycle of three phase magnetic flux Ac waveforms. And along the wave x axis starting from origin mark three (3) positions that are placed 60 electrical degrees apart. At each position indicate b) peripheral stator conductor currents direction flow and the direction resultant magnetic flux, explain briefly how the production rotating magnetic field in 3 phase induction motor.  
(8 marks).
- 2.4 Induction motors are available in many different enclosures, depending on the applications. List any three different types of enclosures used in the above motors.  
(3 marks)
- 2.5 A 2.2kW, four (4) pole induction motor has a friction and windage loss of 196W. The stator losses equal the rotor circuit loss. Calculate the:
- synchronous speed
  - slip speed when full load speed is 1420 rpm
  - rotor frequency
  - total mechanical power output
  - power absorbed by stator winding
  - stator loss
  - stator input power
  - efficiency percentage
- (8 marks)

**QUESTION 3      SINGLE PHASE INDUCTION MOTORS      (25 MARKS)**

- 3.1 Briefly explain the operation principle of split phase starting arrangement for a single phase motor.  
(3 marks)
- 3.2 Draw the circuit connections and label your diagram of the following single phase motors:
- capacitor motor
  - capacitor start, capacitor run motor
  - ac series motor
- (6 marks)
- 3.3 List down the two (2) functions of the :
- run capacitor in a capacitor start- capacitor run motor.
  - centrifugal switch
- (4 marks)

- 3.4 With aid of circuit diagrams of shaded pole motor explain one of the methods of:  
a) producing starting torque  
b) reversing the rotation  
(6 marks)
- 3.5 State three (3) main differences between run and start windings of single phase motors  
(3 marks)
- 3.6 AC series motor is connected to single 234V supply and draws full load current of 1.72A at 0.8 power factor with full load torque of 0.92Nm. If the rated full speed is 1610 rpm  
Calculate the:  
a) power input  
b) power output  
c) efficiency percentage  
(3 marks)

**QUESTION 4      MOTOR STARTERS & SOFT STARTER      (25MARKS)**

- 4.1 Outline the characteristic performance factors to be considered when selecting motor starters.  
(4 marks)
- 4.2 List four (4) applications for star – delta starters.  
(3 marks)
- 4.3 What are three (3) the major characteristics autotransformer starters?  
(3 marks)
- 4.4 Draw schematic diagrams of a Forward and Reverse starter for three phase induction motor and briefly explain its operation.  
(8 marks)
- 4.5 Name three (3) typical soft start applications in single phase motors.  
(3 marks)
- 4.6 State four (4) characteristic performance of single phase motor without soft starter.  
(4 marks)

**THE END**