THE MOMBASA POLYTECHNIC UNIVERSITY COLLEGE

Faculty of Engineering and Technology

DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

DIPLOMA IN TECHNOLOGY
Electrical Power Engineering

EEC 2205

MACHINES UTILIZATION I

SEMESTER EXAMINATION

SERIES: FEBRUARY 2011 SERIES

TIME: 2 HOURS

Instructions to Candidates:

1.   You are required to have the following for this examination;
   - Answer booklet
   - A non-programmable calculator

2.   Answer Question **ONE (COMPULSORY)** and any other **TWO** Questions.

(COMPULSORY)

Question ONE

a) i)   Explain any THREE significance of back emf in d.c motors.   (3 marks)

    ii)   A 440V shunt motor has an armature resistance of 0.8Ω and a field resistance of
          200Ω. Determine the back emf when the motor is giving an output of 7.46 kw at
          85% efficiency.   (4 marks)

    iii) State any THREE applications of d.c. shunt motors.   (3 marks)

b) i)   State any TWO application of the following single phase machine.
          I)   Hysteresis motors
          II)   Universal motor   (4 marks)

    ii)   With the aid of a circuit diagram, explain the operation of a capacitor start –
          capacitor run single phase induction motor.   (6 marks)

c) i)   State any TWO types of rotors used in induction motor.   (2 marks)

    ii)   A 3-phase induction motor is wound for a pole and is supplied from 50Hz system.
          Calculate:
          I)   The syndronous speed
          II)   The rotor speed when the slip is 4%
          III) Rotor frequency when the rotor is at 600vpm.   (3 marks)

    iii) Using a well labelled diagram explain the autotransformer method of starting
          induction motors.   (5 marks)

(ANSWER ANY OTHER TWO QUESTIONS)

Question TWO

a) i)   State any THREE tests carried in d.c. machines.   (3 marks)

    ii)   Show that the armature torgue developed in a series d.c motor is given by:
          $T_a \propto T_a^2$ (7 marks)

b) i)   State any TWO applications of the following d.c. motor
          I)   Compound motors
          II)   Series Motors   (4 marks)

    ii)   A 25kw 250v d.c. slunt generator has an armature field resistance of 0.06Ω and
          100Ω respectively. Determine the total armature power developed when working as:
          I)   Generator delivering 25kw
          II)   Motor taking 25kw   (6 marks)

Question THREE

a) i)   Define the term slip as used in induction.   (2 marks)

    ii) Give TWO significance of having skewed slots on squirrel-cage rotor.   (2 marks)

    iii) The input to a 3 phase 4-pole – 50Hz induction motor is 150kw, stator losses are
         5kw mechanical losses are 3kw and full load slip 0.05. Find
         I)   Frequency of the rotor emf at standstill
         II)   Frequency of the rotor emf at full load
         III) Rotor copper loss
         IV)   Efficiency of the motor   (6 marks)

b) A 415V three-phase 50Hz four pole star connected induction motor operates at 1425rev/min
    on full load. The rotor resistance and reactance per phase are 0.4Ω and 4Ω respectively and
    the effective rotor-stator terms ratio is 0.8:1. Calculate:
    i)   The full load torque
    ii)   The power output if the mechanical losses amount to 480W.
    iii) The maximum torgue
    iv)   The speed at which maxim torque occurs
    v)   The torque at start.   (10marks)

Question FOUR

a) i)   State any TWO types of repulsian-type single phase motors.   (6 marks)

    ii) With the aid of circuit diagrams differentiate between a resistor-start and an
         inductor-start single phase motors.   (6 marks)

b) i)   With the aid of a well labelled diagram, explain the Hopkinson's test for d.c. motors.
                                                                              (4 marks)

    ii) A 250V d.c. shunt machine has an armature resistance including inter-pole of 0.5
         and shunt field resistance of 125Ω both values at working temperatures. When it is
         running light as a motor, the current taken from the supply is 5A. Calculate the
         efficiency of the machine.
         I)   When taking a current of 52A from the supply as a motor
         II)   When delivering a current of 35A as a generator.   (8 marks)

Question FIVE

a)   Draw a well labelled exact equivalent circuit diagram of a 3 phase induction motor.(2marks)

b)   For a 3-phase induction motor; show that the maximum torque is reached when

$$S = \frac{R_2}{X_2}$$ (8 marks)

c)   A 440V, 3ϕ ,50Hz 8 pole star connected induction motor has the following equivalent circuit parameters per phase. $R_1 = R^1_2 = 0.1\Omega$, $X_{1=X}{}^1_2 = 0.7\Omega$ Rm $= 100\Omega$ Xm $= 25\Omega$. Calculate the rotor current referred to the stator current. The input power factor, the torque and the efficiency of the motor at 40% slip and the starting torque.   (10marks)