University of KwaZulu-Natal
Electrical, Electronic & Computer Engineering Discipline
Main Examination: May/June 2026

DURATION: 2 HOUR **TOTAL MARKS: 60**

Examiners: Dr. R. Tiako (Internal)
Dr F. Khan (External)

Instructions: Answer all for Parts A & C plus B-1 and any 2 as indicated in Part B

Part A: *choose and write the most appropriate answer* **[5 Marks]**

1. Identify the characteristic to which the open-circuit characteristic (OCC) of a DC generator corresponds.
   [magnetic; internal; external; performance]

2. An industrial process requires smooth and specific variation of motor speed over a wide range. Based on this requirement, select the most suitable reason for using a DC motor
   [are inexpensive; have simple construction; provide precise speed control]

3. Determine the effect of adding a controller resistance in series with the armature of a DC motor on its speed.
   [only above the normal speed; only below the normal speed; both above and below the normal speed]

4. Identify which currents produce the rotating magnetic field that determines the synchronous speed in an induction motor.
   [rotor currents; stator currents; both rotor and stator currents]

5. Identify the factor that determines the copper saving when a two-winding transformer is converted into an autotransformer.
   [voltage transformation ratio; secondary load; magnetic properties of the core; size of the core]

6. Classify the type of power conversion performed by a DC chopper.
   [AC to DC; AC to AC; DC to DC; DC to AC]

(0.84) X 6 = [5]

Part B: answer **B-1** and any other 2 questions **[40 Marks]**

1. A 30 kVA, three-phase step-down transformer (400/120 volt, Y/Δ-connected) has the following per-phase parameters: primary resistance = 50 mΩ, primary reactance = 100 mΩ, secondary resistance = 12 mΩ, and secondary reactance = 30 mΩ. The core loss resistance is 400 Ω and the magnetizing reactance is 250 Ω. The transformer supplies its rated load at a power factor of 0.8 lagging with a rated secondary voltage of 120 V.

   (a) Draw an annotated per phase approximate model of the three-phase transformer. **[5]**

   (b) Using 12 kVA as the base power, 60 V as the base voltage on the secondary side, and using the approximate per-phase equivalent circuit of the transformer, draw the per unit circuit of the transformer and determine its per unit input voltage. **[10]**

2. A standard two-winding step-down transformer is reconfigured to operate as a step-up autotransformer. The autotransformer has a rated apparent power of 90 kVA, with a converted power of 72 kVA and a primary current of 750 A.

   Determine the nominal primary and secondary voltages of the original two-winding transformer. **[12.5]**

3. A 12 KW shunt generator having an armature circuit resistance of 0.85 Ω and a field resistance of 140 Ω, generates a terminal voltage of 360 V at full load.
   Determinate the developed power at half load condition, assuming the iron, friction and windage losses amount to 700 W. **[12.5]**

4. A DC series motor operates at a speed of 1200 rpm when supplied with a voltage of 500 V and drawing a current of 30 A. The armature resistance is 0.9 Ω, and the series field resistance is 0.5 Ω.
   Determine the value of an additional resistance that must be connected in series with the motor in order to reduce the speed to 750 rpm, assuming the current remains constant. **[12.5]**

Part C: **[15 Marks]**

A 480 V, 60 Hz, 47 hp, three-phase induction motor draws 60 A at a power factor of 0.85 (lagging). The stator copper losses are 3.5 kW, and the core losses are 2.8 kW. Stray losses may be neglected.

At full-load operation, the motor runs with a slip of 0.02

(a) Determine the friction and windage losses under these full-load conditions. **[12]**

(b) Find the resistance of the stator winding under the condition indicated in (a). **[3]**