University of KwaZulu-Natal
Electrical, Electronic & Computer Engineering Discipline
Main Examination: November 2025

DURATION: 2 HOURS **TOTAL MARKS: 100**

Examiners: Dr. R. Tiako (Internal)
Dr. R. Sarma (Moderator)

Instructions: **(1) Answer all questions from Parts A & C, and any three questions from Part B**
(2) All numerical application should have at least 2 decimal points

Part A: **[10 Marks]**

1. Two alternators are connected in parallel. Their kVA and kW load share can be changed by changing their……..
[driving torque and excitation], [excitation and driving torque], [excitation only], [driving torque only]

2. An alternator is said to be overexcited when it is operating at……...
[unity power factor], [leading power factor], [lagging power factor], [either lagging or leading power factor]

3. An over-excited synchronous motor takes …….
[leading current], [lagging current], [both leading and lagging currents], [none of the indicated]

4. In a split phase motor, ……
[the running winding is connected through a centrifugal switch],[the starting winding is connected [through the centrifugal switch] , [both starting and running winding are connected through a centrifugal switch], [centrifugal switch is used to control supply voltage]

(2.5) X4 = [10]

Part B: **[60 Marks]**

B-1: A 16-pole, 3-phase, 60Hz, star-connected alternator runs at 450 rpm. The stator has 1440 conductors in total, with the conductors of each phase connected in series. The armature resistance is 1.5 Ω and the synchronous reactance is 5 Ω. The induced emf leads the terminal voltage by 26°. The alternator supplies 140 A at 0.87 power factor lagging. If the flux per pole is 60 mWb (sinusoidally distributed) and the winding factor is 0.76, calculate the developed torque. **[20]**

B-2: A 90-MVA, Y-connected, three-phase synchronous generator has negligible armature resistance and a synchronous reactance of 3.25 ohm. The machine is connected in parallel with an infinite bus rated at 15 kV, 60 Hz. The infinite bus can supply or absorb any amount of real or reactive power without a change in its voltage magnitude or frequency. The generator is initially operating at rated load and unity power factor.

(a) If the internal generated voltage is reduced by 25%, sketch the phasor diagrams showing the initial condition and the new condition. **[4]**

(b) Determine the new reactive power output of the generator. Clearly state whether the machine is generating or absorbing reactive power. **[16]**

B-3: A 380-V, 150-kW, 0.75-PF-lagging, four-pole, three-phase, 60-Hz synchronous generator's prime mover has a no-load speed of 1830 rpm and a full-load speed of 1810 rpm. It is operating in parallel with a 380-V, 140-kW, 0.70-PF-lagging, six-pole 60-Hz synchronous generator whose prime mover has a no-load speed of 1230 rpm and a full-load speed of 1210 rpm. The loads supplied by the two generators consist of 750 kVA at 0.8 PF lagging.

How much power is supplied by each of the two generators? Sketch an annotated house diagram of the system. **[20]**

B-4: A 200-kVA, 480-V, 50-Hz, 4-pole, Y-connected synchronous generator (field current = 5 A) gives: Voc = 600 V, Isc = 100 A, DC test: 30 V→12 A. The stator has 24 slots, full-pitch single-layer winding.

(a) With phase **a** coil starting in Slot 1, list only the slot numbers for phase **b** coils (abc sequence). **[10]**

(b) Find the armature resistance and synchronous reactance at rated conditions. **[10]**

Part C **[30 Marks]**

C-1: A 120 V, 50 Hz, 6-pole single phase induction motor has a stator impedance of 2.5 + j1.25 Ω and a rotor impedance referred to the stator of 3.75 + j1.25 Ω. The magnetization reactance is 65 Ω. If the rotational loss is 35 W at a slip of 5%. If the calculated backward impedance is 0.925 + j0.64 Ω, determine the forward air-gap power. **[15]**

C-2: A 480-V, 50-kVA, Y-connected, 60-Hz synchronous motor possesses a synchronous reactance of 3.8 Ω and a negligible armature resistance. The friction and windage losses are specified as 2.9 kW, while the core losses amount to 1.7 kW.

Under initial operating conditions, the motor delivers a shaft load of 24 hp at a certain leading power factor. When the mechanical load on the shaft is increased, using the exact value of the initial power factor, the calculated excitation voltage is 630.4 V.

(a) Sketch and comment the behaviour observed in the phasor diagram as the shaft load increases. **[4]**

(b) Determine the initial magnitude of the armature current corresponding to the original operating condition. **[11]**