FACULTY OF SCIENCE & TECHNOLOGY

#### MIDLANDS STATE UNIVERSITY

**Mining and Mineral Processing Engineering Department**

**PRINCIPLES OF ELECTRICAL ENGINEERING**

**CODE: HMIE 221**

### SESSIONAL EXAMINATIONS

**DECEMBER 2016**

**DURATION: 3 HOURS**

**EXAMINER: MR E CHIPFUPI**

## INSTRUCTIONS

1. *Answer* ***All*** *Questions*
2. *All questions carry equal marks*
3. *Total marks:100*

**QUESTION 1**

1. Define the following terms
2. Root mean square current
3. Root mean square voltage
4. Impedance
5. Reactance
6. Resonant frequency **[5]**
7. For the RLC circuit shown in Figure 1, show that
$Q\_{0}=\frac{V\_{0}}{ω\sqrt{R^{2}+(X\_{L}-X\_{C})^{2}}}$ **[10]** **Figure 1**
	* + 1. An *instrumentation amplifier* shown in Figure 2 is an amplifier of low-
			level signals used in process control or measurement applications and
			commercially available in single-package units. Show that
			$v\_{0}=\frac{R\_{2}}{R\_{1}}\left(1+\frac{2R\_{3}}{R\_{4}}\right)\left(v\_{2}-v\_{1}\right)$ **[10]**
			

**Figure 2**

**QUESTION 2**

1. Calculate the average power absorbed by each of the five elements in the circuit of Figure 3. **[10]**
 **Figure 3**
2. Obtain the line currents in the three-phase circuit of the circuit shown in Figure 4. **[10]**
**Figure 4**
3. Assume $I\_{0}=1A$ and use linearity to find the actual value of $I\_{0}$in the
circuit of Figure 5. **[5]**

**Figure 5**

**QUESTION 3**

1. A 50 hp, 250 V, 1200 rpm DC shunt motor with compensating windings has
an armature resistance (including the brushes, compensating windings, and
interpoles) of 0.06 Ω. Its field circuit has a total resistance Radj + RF of 50 Ω, which produces a no-load speed of 1200 rpm. The shunt field winding has 1200 turns per pole.

(i) Find the motor speed when its input current is 100 A. **[5]**
(ii) Find the motor speed when its input current is 200 A. **[5]**
(iii) Find the motor speed when its input current is 300 A. **[5]**
(iv) Plot the motor torque-speed characteristic. **[5]**
2. What are the Advantages of three-phase systems over single-phase supplies?

**[5]**

**QUESTION 4**

1. A 5 kVA single-phase transformer has a turns ratio of 10:1 and is fed from a 2.5 kV supply. Neglecting losses, determine
2. the full-load secondary current,
3. the minimum load resistance which can be connected across the secondary winding to give full load kVA,
4. the primary current at full load kVA.

**[10]**

1. A 50-kVA 13800/208V **∆-Y** distribution transformer has a resistance of 1% and a reactance of 7% per unit.
	1. What is the transformer’s phase impedance referred to the high voltage side? **[4]**
	ii. Calculate this transformer’s voltage regulation at full load and 0.8pf lagging, using the calculated high side impedance. **[5]**
	iii. Calculate this transformer’s voltage regulation under the same conditions, using the per-unit system **[6]**

**END OF PAPER**