

DTEMS PAST PAPER
TECHNICAL

Sir Arthur Lewis Community College
Division of Technical Education and Management Studies
Department of Engineering

Final Examination May 2015 Exam

PROGRAMME TITLE(S) : Mechanical Engineering
PROGRAMME CODE(S) : 3ME-MEC-AD
COURSE TITLE : **Applied Electricity**
COURSE CODE : **ELT 213**
DURATION : 3 HOURS
TIME AND DATE : 1:00 Wednesday May 6th 2015
ROOM : TRA-R3
COURSE TUTOR : Mr. Narpaul Heeralall
INVIGILATOR(S) : K Numa and F. Nicholas

#E75

Students ID Number

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INSTRUCTIONS

1. This paper has **TWO SECTIONS A and B**
2. All questions in each section carry the same marks
3. You are to answer **SEVEN QUESTIONS**
 - **FOUR from SECTION A - Question ONE is compulsory**
 - **THREE from SECTION B.**
4. Ensure your answers and pages are numbered correctly
5. You will be rewarded for neat clear explanations and presentation.
6. Do all work in blue or black ink pen.
7. Submit this question paper and your answer booklet **with your student registration number clearly marked on each page.**



**DO NOT TURN THIS COVER SHEET UNTIL
YOU ARE TOLD TO DO SO**

You may begin

Section A

Question 1 This is a compulsory question

(20 marks)

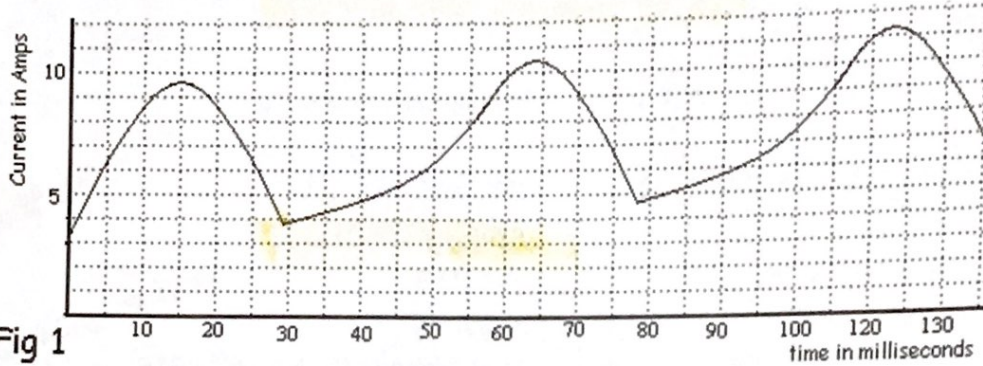


Fig 1

- 1a. Determine the RMS and average value if the waveform over ONE cycle.
- b. A 4 pole machine has coils of 200 turns and dimensions 12cm by 15cm rotates at 1200 RPM in a uniform field of flux density 0.75 Tesla. Determine the following:
- The amplitude of the EMF generated.
 - The frequency and period of the EMF
 - The equation of the instantaneous value of the EMF
 - The average value of the EMF
 - The RMS value of the EMF
- c. The EMF is applied across an impedance of 12Ω that produces a current with a phase lag of 75°
- Draw the phasor diagram showing the two quantities (voltages & current)
 - The equation of the instantaneous value of the current
 - Make a sketch of the current waveform showing at least THREE instance where the current is zero
 - The current when $t = 12.5$ milliseconds.
 - The time when the current is 13 Amps

Question 2 (15 marks)

The figure 2 shows a RLC series circuit supply by a 200V single phase 50Hz supply.

- a. Determine the following:
- The total impedance of the circuit
 - The current and power factor
 - Draw the phasor showing the voltage across each component
 - Calculate the apparent power, active power and reactive power.

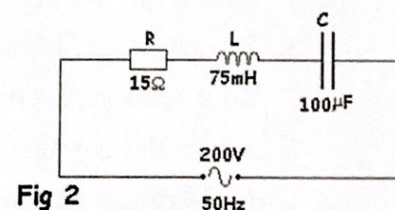


Fig 2

- b. If instead the current through the circuit was 7.5A, determine
- the voltage across each component
 - The supply voltage and the power factor of the circuit.

Question 3 (15 marks)

The figure 3 shows a RLC parallel supplied by a 200V 50Hz single phase supply.

- a) Determine
- The current and power factor through each branch.
 - Draw the phasor showing each current
 - The total current and power factor
 - The apparent power, active power and reactive power
- b) If instead the current through the current through the RL branch was 8 amps, what would be the supply voltage?
- c) Calculate the apparent power and reactive power of a load rated at 5 KW single phase 240V 50Hz 0.75 lagging. What is the resistance and inductance of the windings?

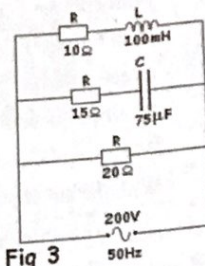


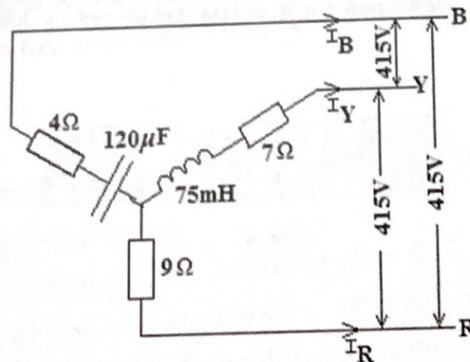
Fig 3

Question 4 (15 marks)

- a. Calculate the capacitor that should be placed in series with a 5 KW single phase 240V 50Hz 0.75 motor to improve the power factor to 0.95.
- b. State and explain the advantages of power factor improvement.
- c. A small industrial establishment supplied with 240V single phase 50Hz has the following load installed
- A compressor rated at 15hp 0.6pf lagging
 - A arc welder rated at 15KVA 0.3pf lagging
 - A lathe rated at 35Amps 0.75pf lagging
 - A kiln rated at 4KW
 - Miscellaneous loads totaling 65 amps at 0.8pf lagging
- Calculate the total load in the establishment and pf.
- d. Determine the amount of switch gear capacity that would be released by improving the power factor to 0.95lagging

Question 5 (15 marks)

The circuit below shows a three phase star connected load supplied by 415V 50Hz supply.



Calculate the following:

- The impedance in each phase
- The current and power factor in each phase
- The apparent power, reactive power and active power in each phase
- Draw the phasor diagram showing the currents and phase voltage
- Calculate the neutral current.

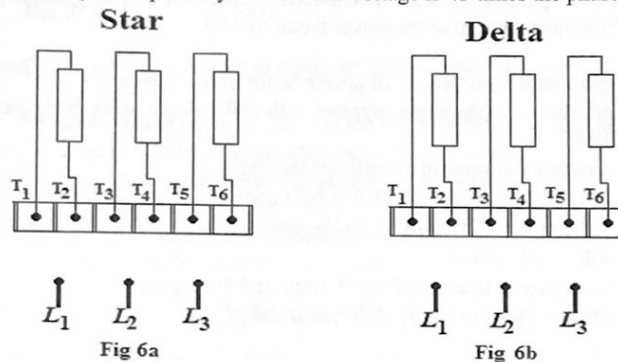
SECTION B

Question 6 (12 marks)

- a) List four types of direct current motors
- b) With relevant diagrams briefly explain the construction of direct current motor
- c) With reference to relevant diagrams, explain how the direct current motor develops its torque.
- d) Briefly explain the process of commutation in the direct current motor
- e) Briefly explain what is armature reaction in the direct current motor
- f) With the aid of suitable diagrams explain the following
 - i. The series wound motor
 - ii. The shunt wound motor
 - iii. The compound wound motor

Question 7 (12 marks)

- a) List the advantages of three phase power over single phase supply
- b) Show that in any three phase system the line voltage is $\sqrt{3}$ times the phase voltage



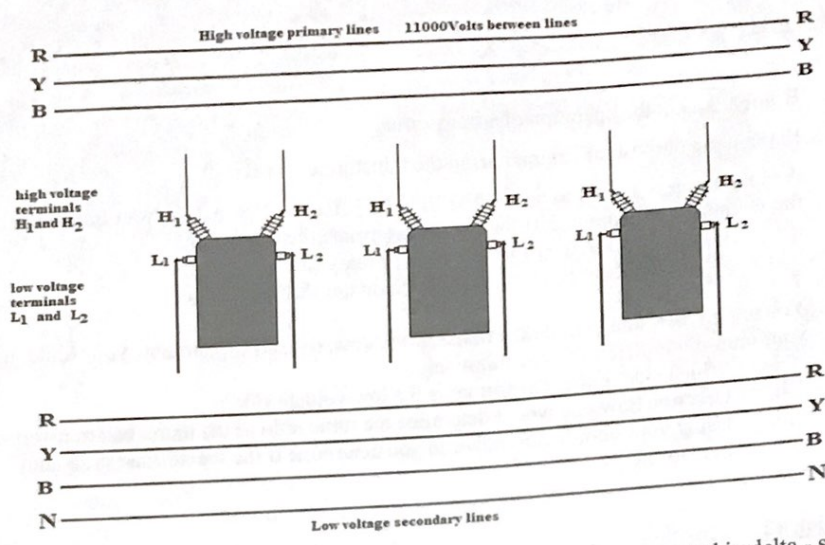
- c) Figure 6a and 6b each show three identical loads connected to terminals T₁ – T₆. Draw in the connection so that the loads in fig 6a are connected in star and 6b in delta.
- d) List the advantages/disadvantages of star versus the delta connections in three phase systems.
- e) Fig 6c shows a very long unmarked three phase underground cable with just the ends exposed. Describe clearly how you would use a multi-meter to identify the corresponding ends of the cable



Fig 6c

Question 8 (12 marks)

- a) List four types of transformers and give a brief explanation on the purpose of each.
- b) The diagram below shows three identical single phase transformers each rated at 750KVA 11000/240 volts 50 Hz arrange to form a three phase bank. However the connections to the high voltage and low voltage lines are omitted.



Complete the diagram to show how the transformers are to be connected in delta - star configuration

- c) With the transformer connected in the delta star configuration determine the following:
- What is the voltage between the high voltage terminals on the transformer?
 - What is the voltage between the low voltage terminals on the transformer?
 - What is the voltage between the low voltage lines?
 - What is the total KVA rating of the entire bank?
 - What is the current delivered by each transformer on full load?

Question 9 (12 marks)

- Explain clearly how you would distinguish between a squirrel cage motor and a wound rotor motor
- What is meant by synchronous speed and slip in relation to induction motors?
- Apart from the name plate ratings, (Phase, KWH, Voltage, Frequency, power factor) list and explain FOUR other specifications that should be considered when selecting a motor.
- List the advantages of 3 phase motor over the single phase motors.
- Briefly describe Three maintenance operation that should be done on induction motors

Question 10 (12 marks)

- Explain clearly how you would distinguish between a single phase induction motor and a three phase induction motor.
- Briefly why the single phase motor is not self starting
- List the five types of single phase motor starting methods
- Describe the circuit connection and operation of any one of the five starting methods
- You re given a single phase induction motor that has **four** pairs of leads emerging out of the terminal box. Using your multi tester explain how you would determine what each pair of lead is connected to in the motor.

Question 11 (12 marks)

- a. Briefly explain the operation of a transformer
- b. Explain the purpose of laminations in the transformer core.
- c. A transformer is known to be a 240V/30 volts 50Hz step down 3000 watt transformer. If the secondary winding is 250 Turns then determine the following:
 - i. What is the number of turns on the primary side?
 - ii. What would be the current delivered on the secondary side?
- d. You are given a small unmarked transformer, describe and explain how you would, using your ohm-meter determine the following:
 - i. Which side of the transformer is the low voltage side?
 - ii. Describe how you would determine the turns ratio of the unmarked transformer
 - iii. Using your ohm-meter, how can you determine if the transformer is an auto transformer?

Question 12 (12marks)

- a. Describe the operation of an SCR. Explain clearly how the device is biased and how the gate controls the current flow between the anode and cathode.
- b. Explain how the SCR can be used for phase control
- c. Describe the operation of one practical circuit that utilizes one or more SCR's
- d. Explain how, using an Ohm-meter a SCR can be tested.

END of EXAM