MACHAKOS UNIVERSITY COLLEGE

SECOND SEMESTER EXAMINATION 2018/2019

FOURTH YEAR SUPPLEMENTARY EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONICS ENGINEERING

EEE 412 POWER SYSTEMS III

DATE: 27TH MAY, 2019 **TIME: 8.00 A.M - 10.00 A.M**

INSTRUCTIONS

This paper consists of **FIVE** questions.

Answer **QUESTION 1** and ANY **OTHER TWO** questions.

Question 1 carries 30 marks and is COMPULSORY.

1. (a) With the aid of a suitable diagram, describe the operation of a non-directional over-current induction type relay.

(10 marks)

(b) Draw the layout of a thermal(coal) power station.

(10 marks)

(c) A hydro-electric power station has a reservoir of area 2·4 square kilometres and capacity 5 x 10^6 m^3. The effective head of water is 100 metres. The penstock, turbine and generation efficiencies are respectively 95%, 90% and 85%.

(i) Calculate the total electrical energy that can be generated from the

power station.

(ii) If a load of 15,000 kW has been supplied for 3 hours, find the fall in reservoir level.

(10 marks)

2. (a) The plant capacity of a 3-phase generating station consists of two 10,000 kVA generators of reactance 12% each and one 5000 kVA generator of reactance 18%. The generators are connected to the station bus-bars from which load is taken through three 5000 kVA step-up transformers each having a reactance of 5%. Calculate the maximum fault MVA which the circuit breakers on :

(i) low voltage side and

(ii) (ii) high voltage side may have to deal with.

See Figure Question 4(a)

(10 marks)

(b) What is the power ouput of a $_{92}U^{235}$ reactor if it takes 30 days to use up 2 kg of fuel? Given that energy released per fission is 200 MeV and Avogadro's number = $6{\cdot}023 \times 10^{26}$ per kilomole.

. (10 marks)

3. (a) With the aid of a suitable diagram, describe the operation of a directional power relay.

(10 marks)

(b) A diesel power station has the following data :

Fuel consumption/day = 1000 kg
Units generated/day = 4000 kWh
Calorific value of fuel = 10,000 kcal/kg
Alternator efficiency = 96%
Engine mech. Efficiency = 95%

Calculate :

(i) specific fuel consumption,

(ii) overall efficiency, and

(iii) thermal efficiency of engine.

(10 marks)

4. (a) A 3-phase transmission line operating at 10 kV and having a resistance of 1Ω and reactance of 4 Ω is connected to the generating station bus-bars through 5 MVA step-up transformer having a reactance of 5%. The bus-bars are supplied by a 10 MVA alternator having 10% reactance. Calculate the short-circuit kVA fed to symmetrical fault between phases if it occurs :

(i) at the load end of transmission line
(ii) at the high voltage terminals of the transformer
See Figure Question 4(a)

(10 marks)

(b) A hydro-electric generating station is supplied from a reservoir of capacity 5 x10^6 cubic metres at a head of 200 metres. Calculate the total energy available in kWh if the overall efficiency is 75%.
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(10 marks)

5. (a) A 3-phase, 20 MVA, 10 kV alternator has internal reactance of 5% and negligible resistance. Calculate the external reactance per phase to be connected in series with the alternatorso that steady current on short-circuit does not exceed 8 times the full load current.

(10 marks)

(b) A 100 MW steam station uses coal of calorific value 6400 kcal/kg. Thermal efficiency of the station is 30% and electrical efficiency is 92%. Calculate the coal consumption per hour when the station is delivering its full rated output.

(10 marks)

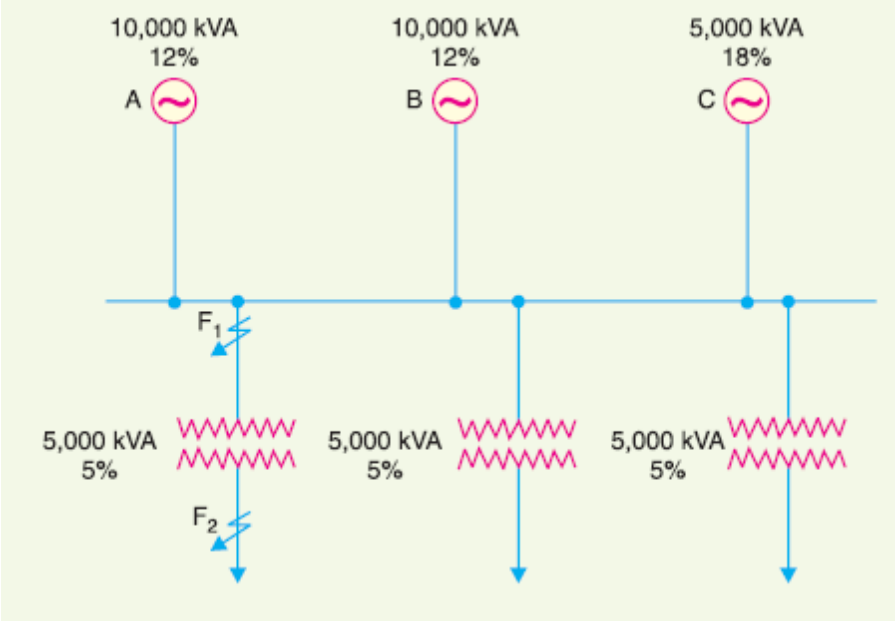

Figure Question 2(a)

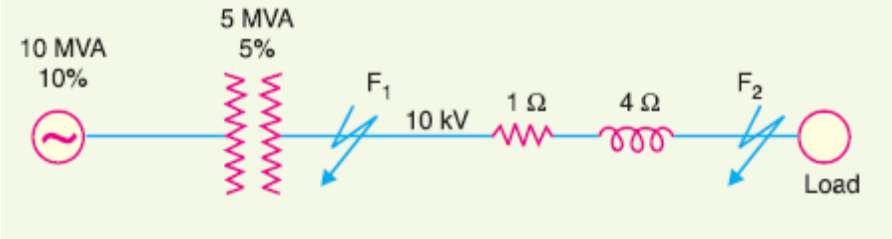

Figure Question 4(a)