MACHAKOS UNIVERSITY

University Examination 2018/2019

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

FOURTH YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (ELECTRICAL AND ELECTRONICS ENGINEERING)

EEE 412 POWER SYSTEMS III

DATE: 20/5/2019 **TIME: 8.30-10.30 AM**

INSTRUCTIONS

Answer Question ONE and any other TWO Questions.

QUESTION ONE (30 MARKS)

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)

QUESTION TWO (20 MARKS)

a) A hydro-electric power station has a reservoir of area 2·4 square kilometres and capacity 5×10^6 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)

b) 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)

QUESTION THREE (20 MARKS)

a) 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)

b) With the aid of a suitable diagram, describe the operation of a directional power relay. (10 marks)

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)

QUESTION FOUR (20 MARKS)

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%. (10 marks)

QUESTION FIVE (20 MARKS)

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)

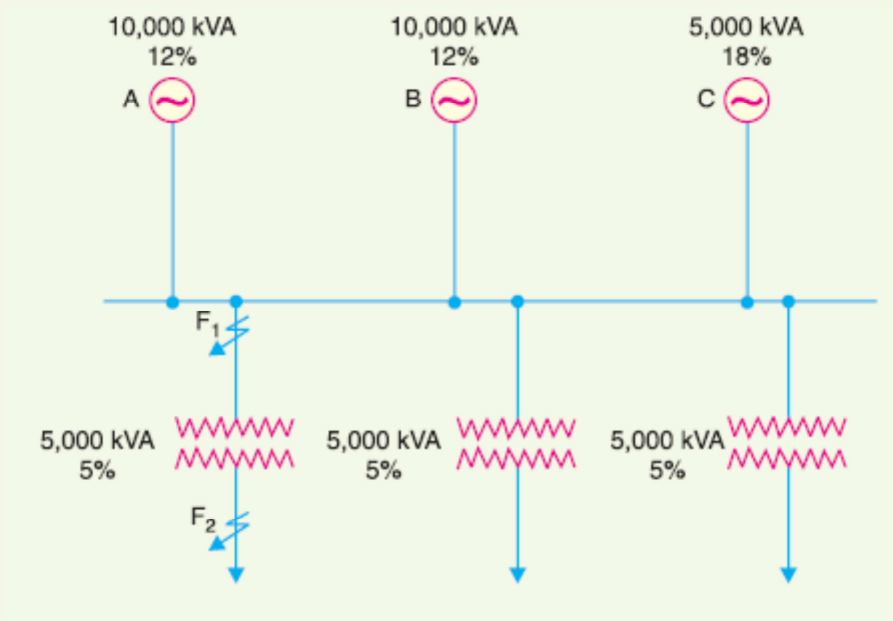

Figure Question 2(a)

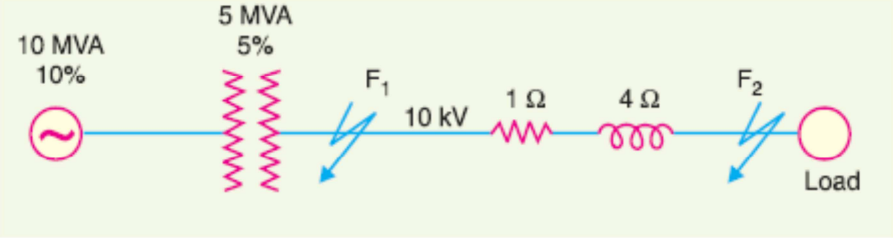

Figure Question 4(a)