



# MACHAKOS UNIVERSITY

University Examination 2018/2019

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

FIFTH YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (ELECTRICAL AND ELECTRONICS ENGINEERING)

EEE 534: POWER SYSTEM ECONOMICS AND PLANNING

DATE: 16/5/2019

TIME: 8.30-10.30 AM

## INSTRUCTIONS

Answer Question ONE and any other TWO Questions.

### QUESTION ONE (30 MARKS)

- a) Why is there a need for a managed electricity spot market? (10 marks)
- b) Explain THREE differences between a Megawatt-hour and a Barrel of Oil. (10 marks)
- c) A power station having a maximum demand of 100 MW has a load factor of 30% and is to be supplied by one of the following schemes :
  - i. a steam station in conjunction with a hydro-electric station, the latter supplying  $100 \times 10^6$  kWh per annum with a maximum output of 40 MW.
  - ii. a steam station capable of supplying the whole load.
  - iii. a hydro-station capable of supplying the whole load.

Compare the overall cost per kWh generated, assuming the following data :

|                                                     | Steam      | Hydro     |            |
|-----------------------------------------------------|------------|-----------|------------|
| (a) Capital cost/kW installed                       | Sh 1250    | Sh 2500   |            |
| (b) Interest and depreciation on capital investment | 12%        | 10%       |            |
| (c) Operating cost/kWh                              | 5 cents    | 1.5 cents |            |
| (d) Transmission cost/kWh                           | negligible | 0.2 paise | (10 marks) |

## QUESTION TWO (20 MARKS)

- a) i Explain the following forms of bilateral trading in open electrical energy markets:
- I. Customized long-term contacts.
  - II. Trading “over the counter”.
  - III. Electronic trading.
- ii Regarding the price of each transaction, what is the essential characteristic of the above three forms of bilateral trading? (10 marks)
- b) Compare the annual cost of supplying a factory load having a maximum demand of 1 MW and a load factor of 50% by energy obtained from (i) a private oil engine generating plant and (ii) public supply.
- i. Private oil engine generating unit :
- Capital cost = Sh  $12 \times 10^5$  ; Cost of repair and maintenance = Sh 0.005 per kWh generated
- Cost of fuel = Sh 1600 per 1000 kg ; Interest and depreciation = 10% per annum
- Fuel consumption = 0.3 kg/kWh generated ; Wages = Sh 50,000 per annum
- ii. Public supply company :
- Sh 150 per kW of maximum demand plus 15 cents per kWh (10 marks)

## QUESTION THREE (20 MARKS)

- a) How do electricity pools operate? (10 marks)
- b) The equipment in a power station costs sh 1,560,000 and has a salvage value of sh 60,000 at the end of 25 years. Calculate the depreciated value of the equipment at the end of 20 years on the following methods:
- i. Straight line method
  - ii. Diminishing value method
  - iii. Sinking fund method at 5% compound interest annually. (10 marks)

#### QUESTION FOUR (20 MARKS)

- a) A load having a maximum value of 150 MW can be supplied either by a hydroelectric station or steam power plant. The costs are as follows :

| Plant       | Capital cost per kW installed | Operating cost per kWh | Interest |
|-------------|-------------------------------|------------------------|----------|
| Steam Plant | Sh 1600                       | Sh 0.06                | 7%       |
| Hydro Plant | Sh 3000                       | Sh 0.03                | 7%       |

Calculate the minimum load factor above which the hydro-electric plant will be more economical. (10 marks)

- b) The capital cost of a hydro-power station of 50MW capacity is sh 1,000 per kW. The annual depreciation charges are 10% of the capital cost. A royalty of sh 1 per kW per year and sh 0.01 per kWh generated is to be paid for using the river water for generation of power. The maximum demand on the power station is 40 MW and annual load factor is 60%. Annual cost of salaries, maintenance charges etc is sh 700,000. If 20% of this expense is also chargeable as fixed charges, calculate the generation cost in two part form. (10 marks)

#### QUESTION FIVE (20 MARKS)

- a) The annual working cost of a power station is represented by the formula Sh (a+ b x kW + c x kWh) where the various terms have their usual meaning. Calculate the values of a, b and c for a 60 MW station operating at annual load factor of 50% from the following data:

- Capital cost of building and equipment is Sh  $5 \times 10^6$
- The annual cost of fuel, oil, taxation and wages of operating staff is Sh 9,00,000
- The interest and depreciation on building and equipment are 10% per annum
- Annual cost of organization and interest on cost of site etc. is Sh 5,00,000.

(10 marks)

- b) A distribution transformer costs sh 200,000 and has a useful life of 20 years. If the salvage value is sh 10,000 and rate of annual compound interest is 8%, calculate the amount to be saved annually for replacement of the transformer after the end of 20 years by sinking fund method. (10 marks)