TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Engineering & Technology

DEPARTMENT OF MECHANICAL AND AUTOMOTIVE ENGINEERING

UNIVERSITY EXAMINATIONS 2013/2014
FOR THE DEGREE OF BACHELOR OF SCIENCE IN ELECTRICAL ENGINEERING

EEE 2512: ENERGY SYSTEMS

Year IV Semester II SUPPLEMENTARY/SPECIAL EXAMINATIONS
SERIES: FEBRUARY 2013
TIME: 2 HOURS

INSTRUCTIONS:

- This paper consists of **FIVE** questions
  $1Hp = 746w,\ \ 1kcal = 418\,joules\, 1kWh = 36x10^6\ joules,\ g = 9.8m/s^2$
- Answer questions **ONE** and any other **TWO** questions.

This paper consists of Four printed pages.

QUESTION 1

a) Highlight **TWO** advantages and disadvantages of a diesel electric power station. **(4 marks)**

b) For an interconnected power station, explain the significance of classifying generating plans as base load and peak load plants. **(4 marks)**

c) While selecting the number of units and their rating from the load curve of a generating station. Explain why it is not advisable to select a single unit of large capacity. **(4 marks)**

d) A diesel engine power plant has one 1000kw and two 500kw generating units. The consumption is 0.28kg/kWh and the calorific value of fuel oil is 10200kcal/kg. if the plant has a plant capacity factor of 45%

i) Estimate the fuel oil consumed for a year

ii) Overall efficiency **(6 marks)**

e) State **THREE** factors that influence the demand of energy in a society. **(3 marks)**

f) Write an expression for the maximum efficiency of a heat engine and explain the factors that influence this efficiency. **(5 marks)**

g) Draw a power cycle of a steam generator and indicate the state of the working fluid. **(4 marks)**

QUESTION 2

a) i) Define **TWO** heat engine.

ii) With the aid of a diagram and relevant expressions. Explain how mechanical work is derived from a heat engine.

iii) A generating station using a heat engine has electrical efficiency of 67% and thermal efficiency of 55%, estimate the temperature of the hot reservoir for a power output of 1.5kw, if the output from the condenser is 35^0C. **(8 marks)**

b) A power station has three feeders whose daily load cycle is as in table 3.0.

Time Hours	**0 – 6**	**6 – 8**	**8 – 12**	**12 – 14**	**14 – 18**	**18 – 21**	**21- 24**
Feeder I kW	6,000	10,000	18,000	12,000	18,000	20,000	10,000
Feeder II kW	20,000	5,000	10,000	8,000	12,000	8,000	25,000
Feeder III kW	8,000	6,000	16,000	10,000	18,000	16,000	8,000

Table 2.0

i) Draw the load curve of the power station and calculate the load and diversity factor.

ii) Select suitable generating units put of the following available to provide for 20% reserve capacity and give an operational schedule for them.

$(5000\,kw, 10{,}000kW, 20{,}000kW, 30{,}000kW \ and \ 50{,}000kW)$. **(12 marks)**

QUESTION 3

a) Draw a schematic diagram of a nuclear power station and explain the function of the following:

i) Reactor

ii) Heat exchanger

iii) Condenser **(8 marks)**

b) i) Explain how the cost of generation is affected by the load factor, diversity factor and capacitor factor.

ii) Estimate the cost of generation per kWh in the following case

Installed capacity of the generating plant 50MW

Maximum demand on situation	40MW
Annual load factor	0.55
Capital cost of installed plant per kw	$250
Annual cost of fuel, oil, taxation, wages etc	$25 x 10^5
Annual interest and depreciation	10%

(12 marks)

QUESTION 4

a) i) With the aid of diagram, explain the working principle of a photovoltaic cell.
ii) Discuss the limitations of wind and solar over the conventional methods of generation such as hydro-electric and fuel/nuclear generation methods. **(8 marks)**

b) A power plant has two substations A and B. Substation A supplies power through feeders F_1 and F_2 while substation B supplies power through feeders F_3 and F_4. Distributors a, b, c supply power to industrial consumers and are connected to Feeder F_1. Distributors d, c, f, g supply power to residential lighting and are connected to feeder F_3. Distributor h, I, j, k supply power to general commercial lighting and are connected to feeder F_3 and distributors lm, n supply power to residence lighting and connected to feeder F_4. The connected loads on the distributor are as in table 4.0

Feeder F_1	**Feeder F_2**	**Feeder F_3**	**Feeder F_4**
a. 100H.P	d. 20kW	h. 20kW	l. 10kW
b. 50HP	e. 15kW	i. 30kW	m. 25kW
c. 75HP	f. 12kW	j. 15kW	n. 30kW
	g. 10kW	k. 10kW	

Table 4.0

The demand factor of power is as follows
Industrial consumers 0.55, residence lighting 0.5, commercial lighting 0.7
The diversity factors are between distributors a, b, c is 1.4 between d, e, f, g is 1.1, between k, i, j, k is 1.15 between substations A and B is 1.1. Assuming 15% power loss in the distribution system.

i) Draw a layout for the distribution system
ii) Find the maximum demand on substations A and B and the power plant
iii) Find the installed capacity of the plant providing for 25% reserve. **(12 marks)**

QUESTION 5

a) Explain the following terms as applied to power generation economics:
   i) Fixed and running cost
   ii) Maximum demand
   iii) Diversity factor

b) A power station has a load cycle as 60MW for 6hr. 200MW for 8hr, 160MW for 4hr and 100MW for 6h. If the power station is equipped with 4 sets of 75MW each.
   i) Draw a load duration curve of the station
   ii) Calculate the load factor and capacity factor
   iii) Calculate the daily duel requirement if the calorific value 7 the fuel oil is 10,000 kcal/kg and the average heat rate of the station is 2860kcal/kcal/kwh
   iv) The efficiency of the station. **(12 marks)**

c) Explain the purpose of the following in a high head hydro-electric power plant.
   i) Penstock
   ii) Sorge tank
   iii) Spill ways **(5 marks)**