MACHAKOS UNIVERSITY

University Examinations for 2016/2017

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

THIRD YEAR SECOND SEMESTER EXAMINATION FOR BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONICS ENGINEERING

EEE 303: POWER SYSTEMS 1

DATE: 16/6/2017 **TIME: 8.30-10.30 AM**

Instructions

- *This paper consists of Five Questions*
- *Attempt Question 1(**COMPUSORY**) and any other Two Questions*

QUESTION ONE

a) The Figure in Q. 1 shows a Micro Grid

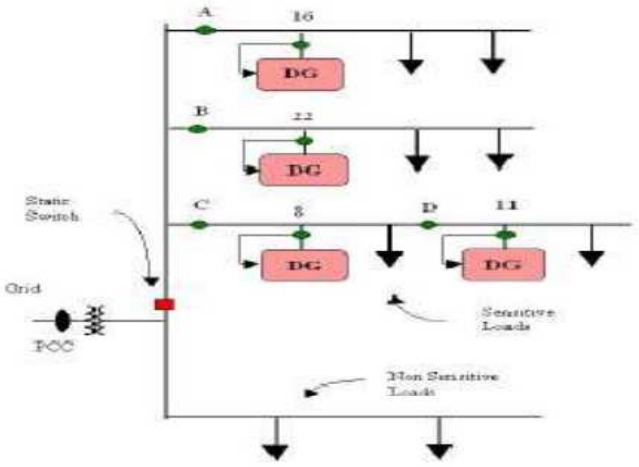

Fig Q.1

i. Define a Micro grid (2 marks)

ii. Explain Four attributes of a micro grid (2 marks)

iii. Explain four importance of micro grids (2 marks)

iv. Write short notes on Distributed Generation (2 marks)

b) The term hybrid power system is used to describe any power system combine two or more energy conversion devices, or two or more fuels for the same device, that when integrated, overcome limitations inherent in either. The design and structure of a hybrid energy system obviously take into account the types of renewable energy sources available locally, and the consumption the system supports.

i. Discuss four merits of hybrid power systems (2 marks)

ii. Explain three configurations of hybrid systems (3 marks)

c) A PV array of 500W has been installed to pump water from a bore-well of 2 meters deep using a submergible motor and pump system to an over-head tank. The length of pipe required to pump the water is 30 meters. Following are the costs involved for the sub-systems and their life spans:

Particulars	Life span (Years)
PV Array: $8/peak watt	15
Motor and pump: $2/watt	7.5
Pipe cost: $8/meter	5
Cost of digging the bore-well: $20/meter	
Maintenance cost: $80/year	
Miscellaneous cost: $3.5/watt	

If the interest rate is 10%, determine the Life Cycle Cost of the water for a period of 15 Years and also water cost per year (ALCC) (5 marks)

d) Using diagrams explain the following with respect to the AC distribution

i. 3-phase 4-wire distribution

ii. Interconnected network system

iii. Radial feeder system (3 marks)

e) A single phase 2-wire feeder 1500m long supplies a load of 60A at 0.8 pf ,40A at 0.85pf and 50A at 0.88pf lagging at distances 600m,1200m and 1500m respectively from the feeding point. The resistance and reactance of the feeder per Km length are 0.06Ω and 0.1Ω respectively. The voltage at the far end is to be maintained at 220V.Determine the voltage at the sending end and its phase angle with respect to the receiving end (5 marks)

f) A ring main distributor PQR has impedances in sections PQ,QR,and RP being (1.5+j 1.5)Ω ,(2+j3)Ω and (2+j2.5)Ω.Power is fed at point P while at Q and R,loads of 50A at 0.85pf and 100A at 0.8pf are drawn ,the power factors being with respect to the voltage at P. Determine the currents in each section. (5 marks)

QUESTION TWO

a) With the help of a Schematic diagram, explain the adaptations of a Nuclear Power Plant to its function (5 marks)

b) From the first principles, show that the half-life of a radioactive fuel is defined by the equation

$$t_{1/2} = \frac{0.693}{\lambda}$$

Where the symbols carry their usual meanings (4 marks)

c) State the Four types of radioactive emissions that can be produced by a Nuclear Power Plant, and give the Chemical symbol of each (2 marks)

d) Distinguish between Isotopes and Isobars (1 mark)

e) Explain the importance of Shielding in Nuclear Power Plant (1 mark)

f) With the help of diagrams, explain Nuclear Fission and Chain Reaction (2 marks)

g) With the aid of well labelled diagrams, explain the Five Types of Nuclear Reactors (5 marks)

QUESTION THREE

a) State the eight advantages of underground power transmission systems as compared to the overhead transmission systems (4 marks)

b) Show that the working voltage for a transmission line is inversely proportional to the square of the volume of the material required per phase to manufacture the conductors (4 marks)

c) Explain the eight factors limiting the practical application of *Kelvin's Law* in the determination of the economic size of line conductors for a transmission system (4 marks)

d) The cost per Km for each of the copper conductors of a section a cm^2 for a transmission line is Ksh (2800a+1300).The load factor of the load current is 80% and the load factor for the losses is 65%.The rate of interest and depreciation is 10% and the cost of energy is 50cts/Kwh.Given that the Specific resistance of copper is $1.78 * 10^{-8}$ Ω-m,determine the most economical current density for the transmission line using Kelvin's law. (5 marks)

e) A 3-wire dc transmission system is converted to 4-wire 3-phase ac transmission system by the addition of another wire equal in section to one of the outers. For the same effective voltage between the outers and neutral at the consumers terminals, the same percentage loss and assuming a balanced load and a power factor of 0.9 in the ac system, show that an extra load of 22% can be supplied by the 3-phase 4-wire system. (3 marks)

QUESTION FOUR

a) Using a well labelled diagram, explain the 2-wire DC distribution system (3 marks)

b) A two- wire DC distributor 500m long has a uniformly distributed load of 1A/m .There are concentrated loads of 200A,150A,50A and 100A at 100m,200m,300m and 400m respectively from end A. The distributor resistance is 0.1Ω/Km(go and return and is fed at both ends at a voltage of 250V.Determine the position and value of the minimum potential on the distributor (7 marks)

c) Three loads A, B and C are connected to 240V supply through separate cables having resistances of 0.06Ω, 0.15Ω and 0.12Ω respectively. A is joined with B through a 0.08Ω connector and B is joined with C through a connector with resistance 0.05Ω.The loads are 40A,60A and 25A at load points A,B and C respectively. Determine the voltages at points A,B and C (5 marks)

d) A DC 3-wire system with 500V across outers supplies 1000A on positive side and 800a on negative side and 1000A across the outers.The rotary balancer has each an armature resistance of 0.1Ω and takes 10A on no load. Determine the Load on the main generator and the Current loading of each balancer unit (5 marks)

QUESTION FIVE

a) Discuss the three types of power factor tariffs (3 marks)

b) Explain the Application of Synchronous Machines in Power Factor Correction (4 marks)

c) The load on a certain installation may be considered constant at 1,200KVA, 0.75 power factor lagging for 3000hrs per annum. The tariff in force is Ksh 1,300 per KVA maximum demand plus Ksh 0.8 per KWh.

i. Determine the annual charge on electricity

ii. Power factor improving apparatus is installed to improve the power factor to 0.95 lagging. The power factor improving apparatus costs Ksh 1,200 per KVAR with annual interest and depreciation charges at 10% of the capital cost. Determine the KVAR required and the new annual charge (7 marks)

d) A 35 kW induction motor has power factor 0.9 and efficiency 0.9 at full-load, power factor 0.6 and efficiency 0.7 at half full-load. At no load the current is 25% of full-load current and power factor is 0.1. Capacitors are supplied to make the line power factor 0.8 at half full-load. With these capacitors in circuit, calculate the line power factor at :

(i) Full load

(ii) No load (6 marks)