ELECTRICAL POWER GENERATION, TRANSMISSION & PROTECTION I
OCTOBER, 2012

1. (a) State any **two** advantages of a diesel power station. (2 marks)

(b) With aid of a schematic diagram of a hydro-electric power plant, explain the functions of any **three** components parts.
(10 marks)

(c) A Hydro-electric plant has a reservoir of area 4.4 km^2 and capacity 6×10^6 m^3. The effective head of water is 200 m. The penstock, turbine and generator efficiencies are 98%, 92%, 88% respectively,
determine the:

(i) total energy in kwh which can be generated from the power station.

(ii) fall in reservoir level if a load of 18 000 kw has been supplied for 2 hours.
(8 marks)

2. (a) Define the following terms as used in power generation

(i) Demand factor

(ii) Base load (2 marks)

(b) Table 1 shows a generating station's daily load cycle.

HOURS	LOAD
0 - 4	Increasing from 0 - 8 MW
4 - 8	Decreasing from 8 MW - 0
8 - 16	No load
16 - 20	Increasing from 0 - 8 MW
20 - 24	Decreasing from 8 MW to 0

Table 1

Plot the load curve and determine the load factor. (9 marks)

(c) (i) Explain the need of an excitation system.

(ii) With aid of labelled diagram, explain the brushless excitation system.
(9 marks)

3. (a) State

(i) Kelvin's law
(ii) any **two** limitations of a(i). (4 marks)

(b) A two-core cable 1 km long is required to supply a constant current of 200 A through out the year. The cost of the cable including installation is Kshs (20A + 20) per metre where A is Cross -sectional Area of conductor in cm^2. The cost of energy is sh.0.05 per kwh and interest plus depreciation equals 10%. Determine the most economical conductor size.
Assume resistivity of conductor material to be 1.73 $\mu\Omega$ cm. (10 marks)

(c) (i) State an **two** advantages of static capacitors when used for power factor correction.

(ii) A substation transformer is supplying 360 kw at 0.6 power factor lagging. Determine using a phasor diagram, the rating of the loss- free static capacitors to be installed in order to improve the power factor to 0.95 lagging. (6 marks)

4. (a) State any **two** properties of insulators as used in overhead transmission lines. (2 marks)

(b) (i) Explain any **two** methods of improving the string efficiency of insulators.

(ii) Describe the following insulator tests.

I Porosity Test
II. Puncture Test (10 marks)

(c) With aid of a labelled diagram, show that voltage distribution along a 3 unit string of suspension insulators whose capacitance to ground is C and mutual capacitance between the units is KC, is given by

$$V_3 = V_1(1 + 3k + k^2)$$ (8 marks)

5. (a) Derive an expression for inductance per phase for a single phase overhead transmission line. (10 marks)

(b) Three conductors of a three phase transmission line are arranged at the corners of a triangle of sides 2m, 2.5m, 4.5 m. If the diameter of each line conductor is 1.24 cm, determine the inductance per km of the line when conductors are regularly transposed. (4 marks)

(c) (i) State any **three** groups of underground service cables and for each indicate the applied voltage.

(ii) A single core underground cable has a conductor diameter of 1 cm and insulation thickness of 0.4 cm. If the specific resistance of insulation is $5 \times 10^{14} \Omega$ - cm. Determine the insulation resistance for a 2 km length of cable. (6 marks)

6. (a) (i) State any:

(I) **three** possible faults on overhead lines.
(II) **two** advantages of reactors when used for control of short circuit currents.

(ii) With the aid of sketches, show how reactors are connected to generators and feeders. (7 marks)

(b) Explain **two** effects of short circuits in a power system. (4 marks)

(c) Figure 1 shows the single-line diagram of a three phase system.
If the percentage reactance of each alternator is based on its own capacity,

(i) Draw a reactance diagram indicating the point of fault.

(ii) Determine the short circuit current that will flow at the point of fault F

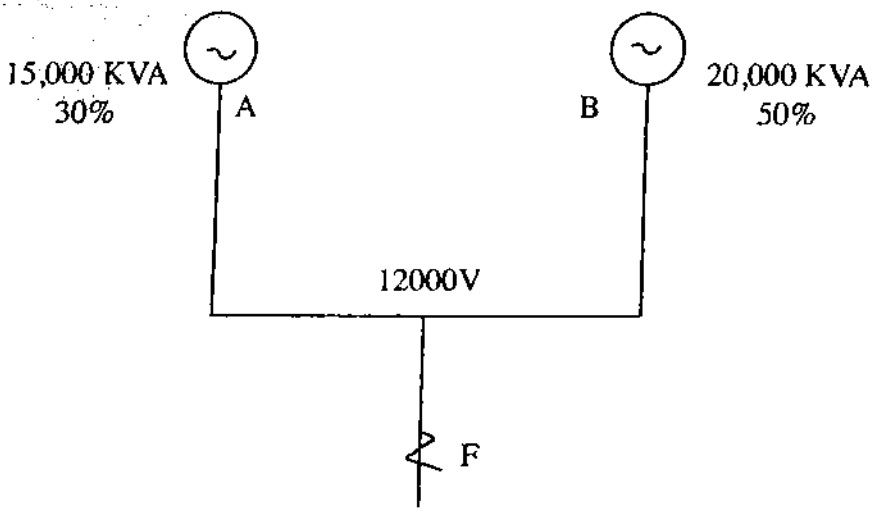

Figure 1 (9 marks)

7. (a) State any **two**:

(i) advantages of overhead to underground distribution systems.

(ii) faults likely to occur in underground cables. (4 marks)

(b) Explain with aid of a circuit diagram, the murray loop method of locating earth fault in underground cables. (10 marks)

(c) Explain with aid of a labelled diagram, the constructional features of a three-core belted cable. (6 marks)

8. (a) Define the following terms with reference to circuit breakers:

(i) Restriking voltage

(ii) Recovery voltage (4 marks)

(b) With aid of a labelled diagram, explain the construction of a High Rupturing Capacity fuse. (8 marks)

(c) (i) State any **two** functions of a circuit breaker.

(ii) Explain with aid of a labelled diagram, the construction and operation of an oil break circuit -Breaker. (8 marks)