ELECTRICAL POWER TRANSMISSION AND DISTRIBUTION

SECTION A [40 MARKS]

Attempt **ALL** the Questions in this Section.

SECTION A I

Write the correct alternative in the answer booklet provided (1 mark @)

1. Transmission line connects
   A. Generating station to a switching station/step-down transformer station.
   B. Step-down transformer station to service transformer banks.
   C. Distribution transformer to consumer premises.
   D. Service points to consumer premises.

2. Which of the following methods of voltage control in an a.c. power system is reserved for only transmission lines?
   A. Excitation control B. Tap changing transformer
   C. Synchronous condenser D. Induction regulators

3. Which of the following is NOT a constituent for making porcelain insulators?
   A. Quartz B. Kaolin C. Felspar D. Silica

4. The material used for the manufacture of ground wire is
   A. Aluminium B. Galvanised steel C. Cast iron D. Stainless steel

5. The function of steel wire in an ACSR conductor is to
   A. Compensate for skin effect. B. Take care of surges.
   C. Provide additional mechanical strength. D. Reduce inductance.

6. For a long transmission line,
   A. the line constants are uniformly distributed over the entire length of the line.
   B. The resistance and inductive reactance are the shunt elements.
   C. The leakage susceptance and leakage conductance are the series elements.
   D. The leakage current through the shunt admittance is minimum at the sending end.

7. Which of the following materials is NOT used for the transmission and distribution of electrical power?
   A. Copper B. Aluminium C. Tungsten D. Steel

8. Which of the following is the voltage at primary distribution in Uganda?
   A. 415 V B. 33 Kv C. 66 kV D. 132 Kv

9. Which of the following statements is correct?
   A. Ice on conductors increases skin effect.
   B. Wind pressure reduces corona effect.
   C. Wind pressure is taken to act at perpendicular to that for ice.

D. Ice on conductors reduces sag.

10. Which type of insulator is used on 132 kV transmission lines ?
A. Pin type B. Disc type C. Shackle type D. Pin and Shackle type

11. Stranded conductors usually have a central wire around which there are successive layers of 6,12,18,24 wires. For n-layers, the total number of individual wires is
A. 3 n (n+1) B. 2 n (n+1) C. 3 n (n+1) + 1 D. 2 n (n+1) + 1

12. The power transmitted will be maximum when
A. Corona losses are minimum B. Receiving end voltage is high.
C. Reactance is high. D. Sending end voltage is high.

13. A 3-phase 4 wire system is commonly used for
A. Primary transmission. B. Secondary transmission.
C. Primary distribution. D. Secondary distribution.

14. The main reason for using high voltage for long distance power transmission is
A. Reduction in transmission losses. B. Reduction in time of transmission.
C. Increase in system reliability D. None of the above

15. Which of the following voltage regulations is considered best?
A. 10% B. 20% C. 100% D. 4%

16. A conductor, due to sag between two supports, takes the form of
A. Catenary B. semi-circle C. triangle D. ellipse

17. The main drawback of underground system over overhead system is
A. Exposure to lightning
B. Heavy initial cost
C. Exposure to atmospheric hazards such as smoke, ice, wind etc.
D. Inductive interference between power and communication circuits.

18. A circuit is disconnected by isolators when
A. Line is on full load. B. circuit breaker is not open.
C. There is no current in the line. D. line is energized.

19. By increasing the Transmission voltage double of its original value, the same power can be dispatched keeping the line loss
A. Equal to its original value B. Half of original value
C. Double the original value D. One-fourth of original value

20. Which of the following equipment, for regulating the voltage in the distribution feeder, will be most economical?
A. Static Condenser B. Tap Changing Transformer
C. Synchronous Condenser D. Shunt Capacitor

SECTION AII

a) Why should power systems be interconnected? **(1 mark)**

b) List **three** advantages of interconnected power systems. **(3 marks)**

c) List **four** factors affecting the length of a span for an overhead power line. **(4 marks)**

d) What do you understand by the term voltage fluctuation? **(1 mark)**

e) State **three** likely causes of power failure in a given area. **(3 marks)**

f) What are the **four** elements that can be used in making static VAR compensator (VAR) in a typical power system? **(4 marks)**

g) With reference to Uganda, state the different voltage levels found in a typical electrical power system. **(4 marks)**

SECTION B [60 MARKS]

Attempt **ONLY THREE** Questions in this Section.

Question 1

(a) Explain the mode of operation of any **four** basic power system components. **(8 marks)**

(b) Using a single line diagram explain the flow of energy from the generating station to the consumer. **(5 marks)**

(c) Give **four** advantages of Alternating Current (AC) over Direct Current (DC) **(4 marks)**

(d) Distinguish between primary and secondary distribution in power systems. **(3 marks)**

Question 2

(a) Explain in details the components of a distributional system. **(5 marks)**

(b) Explain the classification of a distribution system. **(5 marks)**

(c) Give **five** factors which must be considered when selecting the right size of a cable for use **(5 marks)**

(d) Give **two** reasons a user who prefers a ring rather a radial in electrical power systems. **(2 marks)**

(e) Assume you have been chosen to plan a distribution line for a rural area, outline three factors to be put into consideration. **(3 marks)**

Question 3

(a) What are the **two** main impacts of skin effect on conductors in power systems? **(2 marks)**

(b) What do you understand by Geometric Mean Radius (GMR) of an electric wire? **(3 marks)**

(c) (i) What do you understand by the word corona in the study of power systems? **(1 mark)**

(ii) Give any **two** advantages and three disadvantages of corona in power systems. **(5 marks)**

(d) A 20 km single phase line has two parallel conductors separated by 1·5 metres. The diameter of each conductor is 0·823 cm. If the conductor has a resistance of 0·311 Ω/km, find the loop impedance of this line at 50 Hz. **(4 marks)**

(e) The three conductors of a 3-phase line are arranged at the corners of a triangle of sides 4, 5 and 6 metres. Calculate inductance per km of the each conductor when conductors are regularly transposed. The diameter of each line conductor is 2 cm. **(5 marks)**

Question 4

(a) (i) State any four properties of conductor materials used for transmission and distribution of electric power. **(4 marks)**

(ii) Compare and contrast copper and aluminum as conductor materials used in power transmission and distribution. **(4 marks)**

(b) Suspension type insulators are normally used for high voltages above 33kV. Give any **four** advantages of suspension type over pin type insulators. **(4 marks)**

(c) Explain how cables can be classified in terms of voltage ratings. **(3 marks)**

(d) A transmission line has a span of 150 m between the level supports. The conductor has a cross-sectional area of 2 cm^2. The ultimate strength is 5000 kg/cm^2. The specific gravity of the material is 8·9 gm/cm^3. If the wind pressure is 1·5 kg/m length of conductor, calculate the sag at the centre of the conductor if factor of safety is 5. **(5 marks)**

Question 5

(a) Give the expression for voltage regulation for a short transmission line and draw the necessary conclusions. **(4 marks)**

(b) What is the Ferranti Effect in power systems? **(2 marks)**

(c) A single phase overhead transmission line delivers 1,100 kW at 33 kV at 0.8 power factor lagging. The total resistance and inductive reactance of the line are 10 Ω and 15 Ω respectively. Determine

i) sending end voltage **(5 marks)**

ii) sending end power factor. **(2 marks)**

iii) transmission efficiency **(3 marks)**

(d) A short 3-phase transmission line connected to a 33kV, 50 Hz generating station at the sending end is required to supply a load of 10 MW at 0·8 lagging power factor at 30 kV at the receiving end. If the minimum transmission efficiency is to be limited to 96%, estimate the per phase value of resistance and inductance of the line. **(4 marks)**