**THE PAPUA NEW GUINEA UNIVERSITY OF TECHNOLOGY**

**DEPARTMENT OF ELECTRICAL AND COMMUNICATIONS ENGINEERING**

**SEMESTER ONE FINAL EXAMINATION (2022)**

**EE315 – ELECTRICAL POWER SYSTEMS I**

**THIRD YEAR ELECTRICAL ENGINEERING – POWER (BEEP/3)**

**TIME ALLOWED: 3 HOURS**

**INFORMATION FOR STUDENTS:**

1. You have **TEN (10) MINUTES** to read the paper.
   You must not begin writing during this time.

2. There are five (5) questions in this Examination.

3. **Answer all questions.** All answers must be written in the **ANSWER BOOK** supplied.

4. **COMPLETE THE DETAILS REQUIRED ON THE FRONT COVER OF YOUR ANSWER BOOK – DO THIS NOW, & SIGN ON THE SPACE PROVIDED.**

5. Only drawing instruments, calculators and pens are permitted on your desk.
   NO phones allowed.

6. If you are found cheating in the Examination, the penalties specified by the University shall apply.

7. **TURN OFF** all Mobile Phones and place them on the floor under your seat before the start of Examination.

## Question 1 (20 marks)

(a) Discuss and compare the features of DC and AC transmission.

(b) What are the typical transmission and distribution voltage levels in PNG power system?

(c) Sketch a single line diagram of the Ramu grid indicating the sources, generation, substations, transmission, and distribution voltage levels. Show the typical voltage levels in your diagram.

(d) What are the function of the following devices:

(i) Transformer,
(ii) Circuit breakers,
(iii) Relays.

## Question 2 (20 marks)

An industrial load consisting of a bank of induction motors consumes 40 kW at a power factor of 0.70 lagging from 415 V, 50 Hz, single phase source. By placing a bank of capacitors in parallel with the load, the resultant power factor is to be raised to 0.97 lagging. Find the net capacitance of the required capacitor bank in μF.

## Question 3 (20 marks)

Three zones of a single-phase circuit are identified in **Figure Q3**. The zones are connected by transformers $T_1$ and $T_2$, whose ratings are indicated in the diagram. Using base values of 30 kVA, and 240 volts in zone 1, redraw the per unit circuit and determine the per unit impedances and per unit voltages. Then calculate the load current in both per unit and in amperes. Neglect the transformer winding resistances and shunt admittance branches.

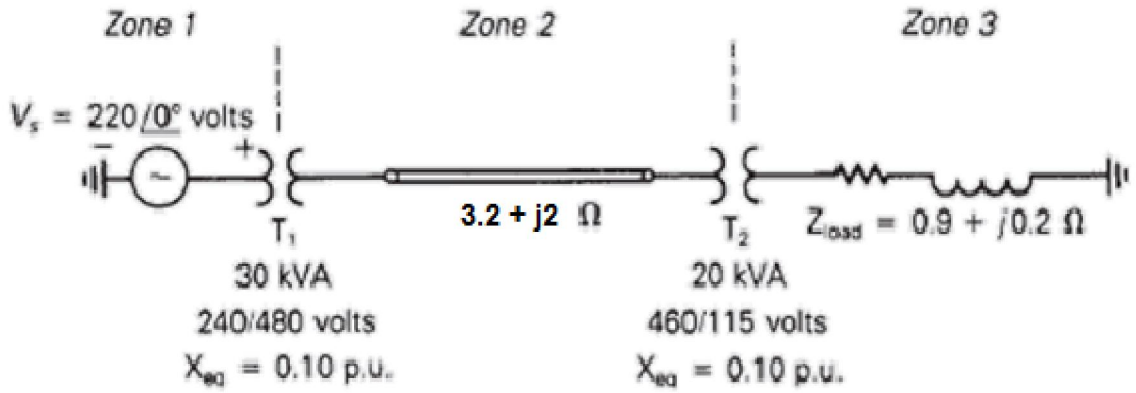


**Figure Q3**

## Question 4 (20 marks)

A 50-Hz system, 132-kV, 3-phase single conductor transposed transmission line is arranged in a horizontal plane with a total line length of 390 km. The conductor diameter is 20 mm. The distance between conductors are $D_{ab}$=$D_{bc}$ = 6 m.

(a) Derive the voltage equation /m/phase for a transposed transmission line. The transposed line arrangement is shown in **Figure Q4**.

(b) Calculate the total volt drop; assuming the transmission line carries a current of 600 A/phase.

(c) Calculate the total inductance and the total reactance for a phase conductor.

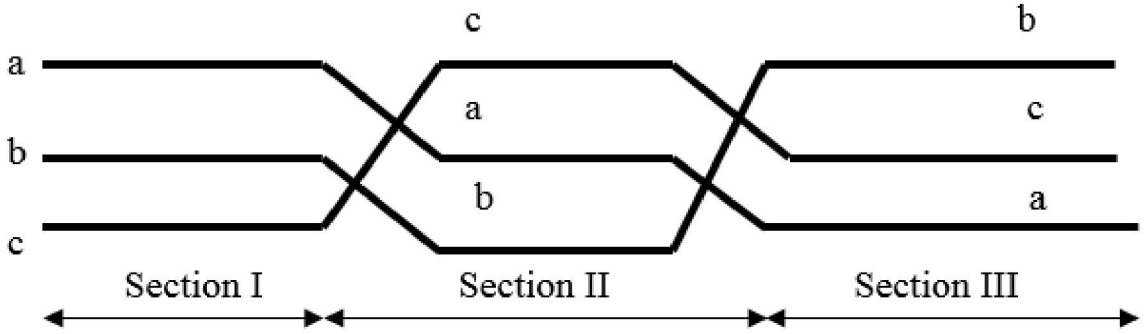


**Figure Q4**

**Question 5** **(20 marks)**

A 60-Hz three-phase, three-wire overhead line has solid cylindrical conductors arranged in the form of an equilateral triangle with 4 m conductor spacing. Conductor diameter is 15 mm.

(a) Calculate the capacitance-to-neutral in F/m.

(b) Rework Part (a) if the line spacing is increased by 20%.

(c) Rework Part (a) if the line spacing is decreased by 20%.

(d) Compare and comment on your answers in (a), (b), and (c)

***Hints***

$$\begin{bmatrix} \Delta V_a \\ \Delta V_b \\ \Delta V_c \end{bmatrix} = j\omega \frac{\mu_o}{2\pi} \begin{bmatrix} \frac{1}{4} + \ln \frac{2D}{R} & \ln 2 & 0 \\ 0 & \frac{1}{4} + \ln \frac{D}{R} & 0 \\ 0 & \ln 2 & \frac{1}{4} + \ln \frac{2D}{R} \end{bmatrix} \begin{bmatrix} I_a \\ I_b \\ I_c \end{bmatrix} \text{/m/phase}$$

## END OF EXAMINATION