Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	ELECTRIC POWER SYSTEM
COURSE CODE	:	BNR 21003
PROGRAMME CODE	:	BND
EXAMINATION DATE	:	DECEMBER 2019 / JANUARY 2020
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

Q1 (a) Electric power system transforms other types of energy into electrical energy and delivered this energy to the consumers. List **FOUR (4)** main components of electric power system.

(2 marks)

(b) One-line diagrams are widely used in three-phase power systems studies. Simplify the one-line diagram as shown in **Figure Q1(b)** into a reactance diagram.

(c marks)

(c) A 30 MVA 13.8 kV three-phase generator has a subtransient reactance of 15 %. The generator supplies two motors over two transmission line having transformers at both ends. The motors have rated inputs of *M1* = 20 MVA and *M2* = 10 MVA, both 12.5 kV with X = 20 %. The three-phase transformer *T1* is rated 35 MVA, 13.2 kV with leakage reactance of 10 %. Transformer *T2* is composed of three single-phase transformers each rated at 10 MVA, 12.5 kV with leakage reactance of 10 %. Series reactance of the transmission line is 80 Ω with line voltage of 120 kV for both transmission line. Select the generator rating as base in the generator circuit.

(i) Draw reactance diagram of the system.

(2 marks)

(ii) Find new per-unit impedance for each component of the system.

(5 marks)

(d) Construct the impedance diagram for the one-line diagram of the three-phase transmission system in **Figure Q1(d)** and express all the quantities in p.u. Use a common base of 100 MVA. The generator has a synchronous reactance of 0.18 p.u. The line is 65 km long with resistance and reactance of 0.1 Ω/km and 0.5 Ω/km respectively.

(9 marks)

Q2 (a) If the presence or remove of a generator in parallel with many other generators causes no difference to the voltage and frequency of the other, it is said to be connected to an infinite busbar. Draw the schematic diagram of a generator connected to an infinite busbar with corresponding phasor diagram. The resistance of generator for this system is neglected.

(2 marks)

(b) A 40 MVA, 25 kV, 1000 r/min, 3-phase generator has a synchronous reactance, X_s of 5 Ω per phase and is connected to an infinite busbar. If the exciting voltage is 14.3 kV (line-to-neutral), the system voltage is 24 kV (line-to-line) and using standard frequency in Malaysia, calculate:

(i) number of poles of the rotor.

(1 mark)

(ii) the torque angle, δ when the generator delivers 60 MW.

(2 marks)

(iii) the peak power that the generator can deliver before it falls out of step (loses synchronism).

(2 marks)

(c) A single-circuit three-phase line operated at 60 Hz is arranged as shown in **Figure Q2(c)**. The conductors are ACSR Drake. Given data from table, $d = 1.108$ inch.

(i) Find the capacitance and the capacitive reactance for 1 mile of the line.

(2 marks)

(ii) If the length of the line is 195 mile and the normal operating voltage is 220 kV, calculate capacitive reactance to neutral for the entire length of the line and the reactive power.

(2 marks)

(d) Determine the inductance of a single phase transmission line consisting of three conductors of 3.5 mm radius in the 'go' conductor and 4.5 mm radius in the 'return' conductor. The configuration of line is as shown in **Figure Q2(d)**.

(9 marks)

Q3 (a) State the name and function of the thermal generating station structure as shown in **Figure Q3(a)**.

(5 marks)

(b) Hydropower generating stations convert the energy of moving water into electrical energy via its hydraulic turbine which is coupled to a synchronous generator. A large hydropower station has a head 314 m and an average flow of 1250 m^3/s. The reservoir of water behind the dams and dikes is composed of a series of lakes covering an area of 5200 km^2. Calculate:

(i) the available hydraulic power the generation system

(1 mark)

(ii) the number of days this power could be sustained if the level of the water were allowed to drop by 1 m.

(3 marks)

(iii) the synchronous generator for this hydroelectric dam has 24 poles and rotating at standard frequency in Malaysia. Determine the rotor speed and the rotor type for this synchronous generator.

(2 marks)

(c) A 132 kV, three-phase transmission line is connected to a 50 MW load at 0.85 power factor lagging. The length of the transmission line is 88 km. The series impedance and the shunt admittance is $Z = 95\angle 78°\Omega$ and $Y = 0.001\angle 90°S$, respectively. By using the equivalent nominal-π circuit, calculate:

(i) the sending end voltage, V_s and sending end current, I_S

(7 marks)

(ii) the sending end power and line efficiency.

(2 marks)

Q4 (a) Shunt capacitor banks are widely used to improve the quality of the electrical supply and the efficient operation of the power system. Give **THREE (3)** benefits to the power system when the shunt capacitor banks are installed in the system.

(3 marks)

(b) A distribution system consists of all the facilities and equipment connecting a transmission system to the customer equipment.

(i) List down the classification of distribution systems.

(4 marks)

(ii) Describe the loop system used in secondary distribution lines with the aid of appropriate diagram.

(4 marks)

(c) A 220 kV, 150 MVA, 50 Hz three-phase transmission line is 260 km long. The characteristic parameter of the transmission line are:

$r = 0.12\ \Omega/\text{km}$

$x = 0.98\ \Omega/\text{km}$

$y = 5.1 \times 10^{-6}$ S/km

Voltage at the receiving end of the transmission line is 210 kV. Find the ABCD parameter of this transmission line.

(9 marks)

Q5 (a) Describe **TWO (2)** types of circuit breaker used in substation system.

(4 marks)

(b) Give **FOUR (4)** reasons of doing fault analysis in power system application.

(4 marks)

(c) When fault occurred in a system, it will produced large current to flow through the transmission line and will caused damage to the equipment located at the end of the network. As an engineering technologist, define the component that you will be used to protect the equipment from fault.

(2 marks)

(d) Based on **Figure Q5(d)**, find the fault current in ampere and the corresponding fault level in MVA. Take base of 200 MVA, 13.8 kV.

(10 marks)

- **END OF QUESTIONS** -

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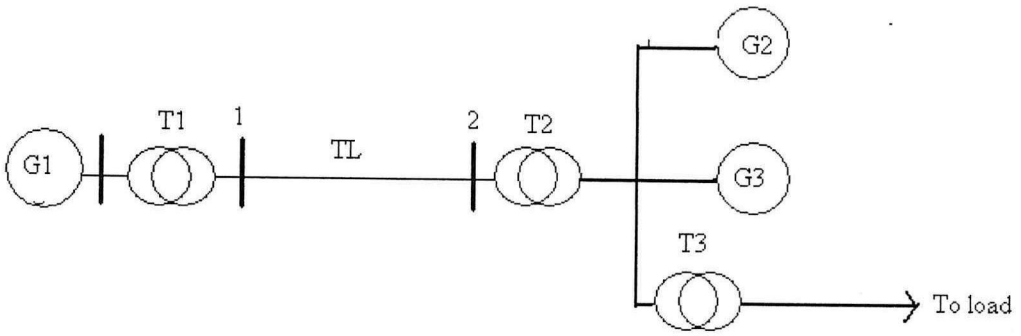

Figure Q1(b)

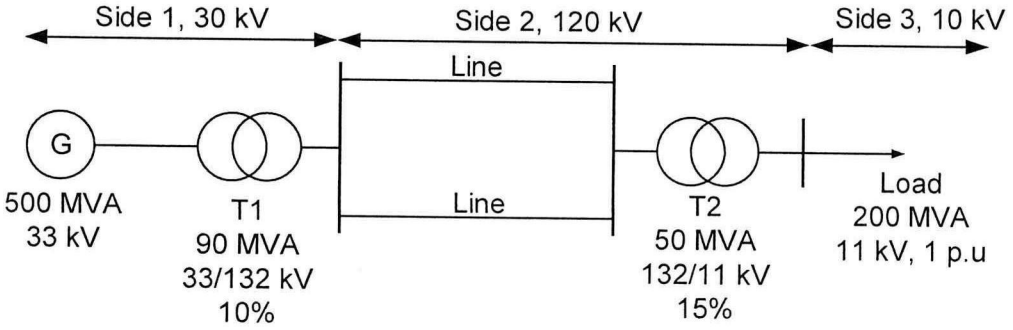

Figure Q1(d)

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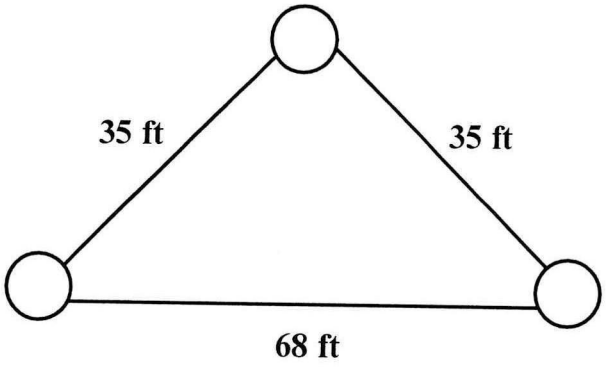

Figure Q2(c)

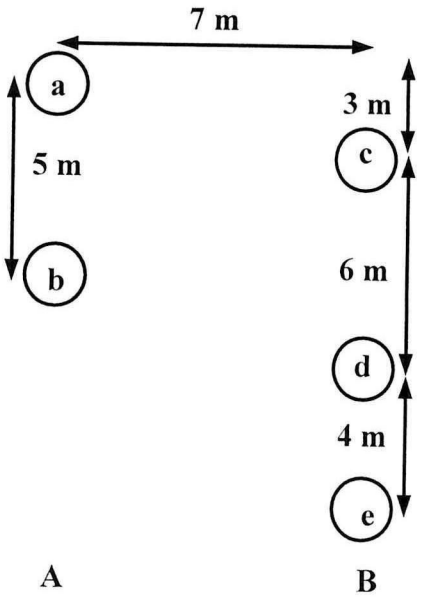

Figure Q2(d)

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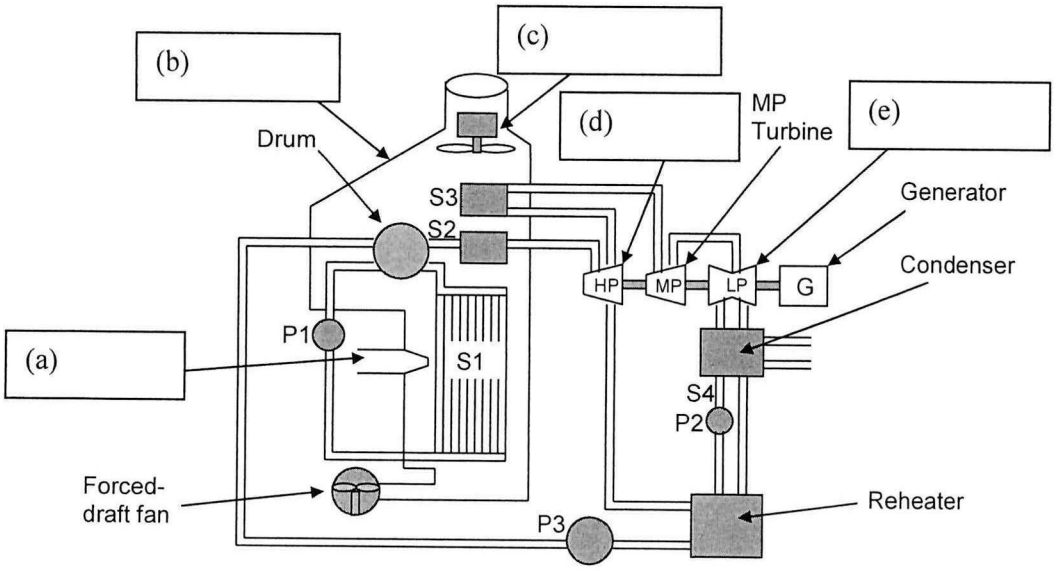

Figure Q3(a)

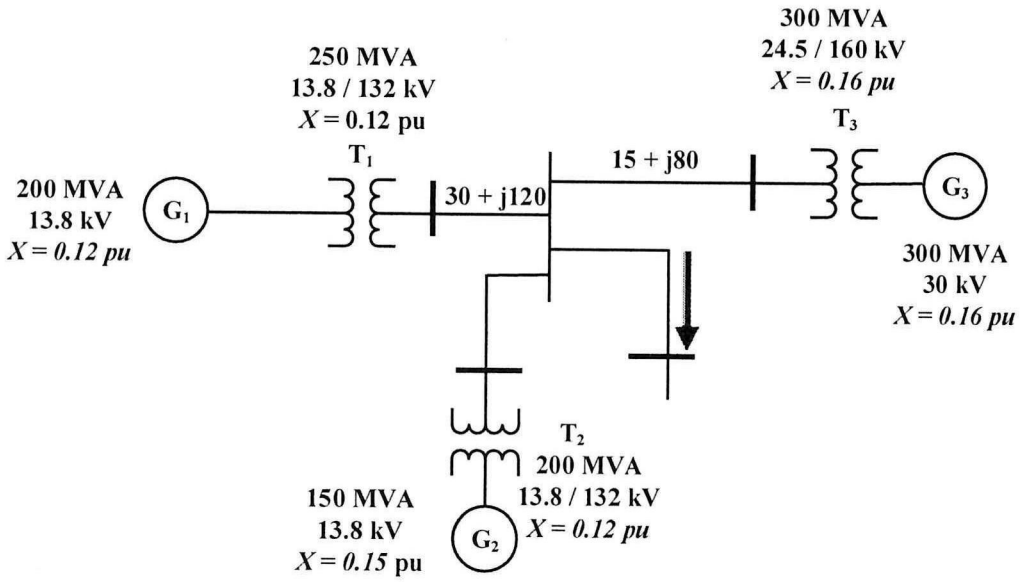

Figure Q5(d)