Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2018/2019

COURSE NAME	:	POWER SYSTEM FUNDAMENTAL / ELECTRIC POWER SYSTEM
COURSE CODE	:	BNE 22203 / BNR 21003
PROGRAMME CODE	:	BNE / BND
EXAMINATION DATE	:	JUNE / JULY 2019
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

Q1 (a) Descibe **TWO (2)** causes and disadvantages of poor power factor.

(4 marks)

(b) Two balanced three-phase motors in parallel, an induction motor drawing 400 kW at 0.8 power factor lagging and a synchronous motor drawing 150 kVA at 0.9 power factor leading, are supplied by a balanced, three-phase 4160 V. Cable impedances between the source and load are neglected.

(i) Draw the power triangle for each motor and for the combined-motor load.

(5 marks)

(ii) Determine the magnitude of the line current delivered by the source.

(1 marks)

(iii) A delta-connected capacitor bank is now installed in parallel with the combined-motor load. Find the value of capacitive reactance required in each leg of the capacitor bank to make the source of power factor unity.

(2 marks)

(c) Power-system quantities such as voltage, current, power, and impedance are often expressed in per-unit or percent of specified base values. State **TWO (2)** advantages of per unit system in power system.

(2 marks)

(d) 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. Find new per-unit impedance for each component of the system. Select the generator rating as base in the generator circuit.

(6 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 24000 kVA, 17.32 kV, Y-connected synchronous generator has a synchronous reactance of 5 Ω/phase and negligible armature resistance.

(i) At a certain excitation, the generator delivers rated load, 0.8 power factor lagging to an infinite bus bar at a line-to-line voltage of 17.32 kV. Determine the excitation voltage per phase.

(3 marks)

(ii) The excitation voltage is maintained at 13.4 kV/phase and the terminal voltage at 10 kV/phase. Find the maximum three-phase real power that the generator can develop before pulling out of synchronism.

(2 marks)

(iii) Determine the armature current for the condition of **Question 2b(ii)**.

(1 marks)

(c) The sag plays an important role in the design of overhead line. With the aid of diagram, show the meaning of sag in overhead lines. Describe **TWO (2)** disadvantages of providing too small or too large sag on a line.

(4 marks)

(d) Overhead system can be operated at 400 kV or above but underground system offers problems at such voltages. Discuss this situation in details.

(2 marks)

(e) One circuit of a single-phase transmission line is composed of three solid 0.5 cm radius wires. The return circuit is composed of two solid 2.5 cm radius wires. The arrangement of conductors is as shown in **Figure Q2(e)**. Applying the concept of the GMD and GMR, find the inductance of the complete line in mH/km.

(6 marks)

Q3 (a) The present trend is towards AC for generation and distribution and DC for transmission. Discuss the reasons for it.

(4 marks)

(b) Nuclear power plant has become much more attractive compare to the other conventional power plant. Explain **THREE (3)** reasons regarding to this issue.

(3 marks)

(c) Draw the basic layout and explain the working principles of a thermal power plant.

(7 marks)

(d) 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 marks)

(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)

Q4 (a) State **TWO (2)** differences between nominal-T and nominal-π methods of transmission line.

(2 marks)

(b) A 220 kV three-phase transmission line with load of 200 MVA at 0.8 lagging power factor has a per phase series impedance of $z = 0.05 + j0.45\ \Omega$ per km and a per phase shunt admittance of $y = j3.4 \times 10^{-6}$ siemens per km. The line is 80 km long. Using the nominal-π model:

(i) Determine the transmission line ABCD constants.

(3 marks)

(ii) Find the sending end voltage and current, voltage regulation, the sending end power and the transmission efficiency when the line delivers.

(8 marks)

(c) Discuss briefly the design considerations in distribution system.

(3 marks)

(d) With appropriate diagram and explanation, propose **TWO (2)** alternatives which the primary distribution lines can be laid.

(4 marks)

Q5 (a) In each distribution station there will be a system that control the power flows from the transmission lines to the consumer. List **FIVE (5)** equipments generally located inside the substation.

(5 marks)

(b) Circuit breakers are used to interrupt short circuit currents. Following are the types of circuit breakers:

(i) Air blast circuit breakers.
(ii) Oil circuit breakers.
(iii) Vacuum circuit breakers
(vi) SF_6 circuit breakers

Give detail explanations of each of the above circuit breaker.

(4 marks)

(c) List **FOUR (4)** types of fault that could occurred at the transmission line and its percentages.

(3 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.

(8 marks)

- END OF QUESTIONS -

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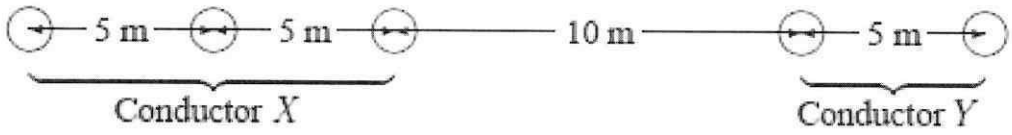

Figure Q2(e)

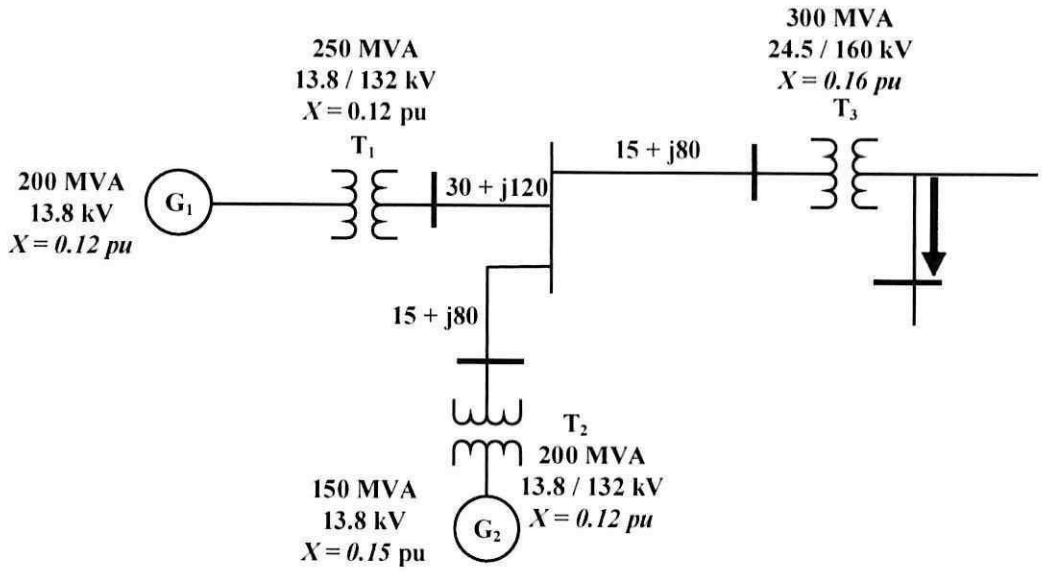

Figure Q5(d)