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The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Electrical & Computer Engineering

Study Programme	: Bachelor of Technology Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	**: EEX4552 Power Systems I** (ECX4252)
Academic Year	: 2017/18
Date	: 28th January 2019
Time	: 0930-1230hrs
Duration	: **3 hours**

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Six (6)** questions in **Five (5)** pages.
3. Answer any **Five (5)** questions only. All questions carry equal marks.
4. Answer for each question should commence from a new page.
5. Relevant charts/ codes are provided.
6. This is a Closed Book Test (CBT).
7. Answers should be in clear hand writing.
8. Do not use Red colour pen.

Q1.

I.

a. A schematic diagram of conventional thermal power plant is shown in figure Q1. Identify the elements 1,2,3, 4, 5, 6 and A,B,C and D. Write briefly functions of 2,4 and 5

[8 Marks]

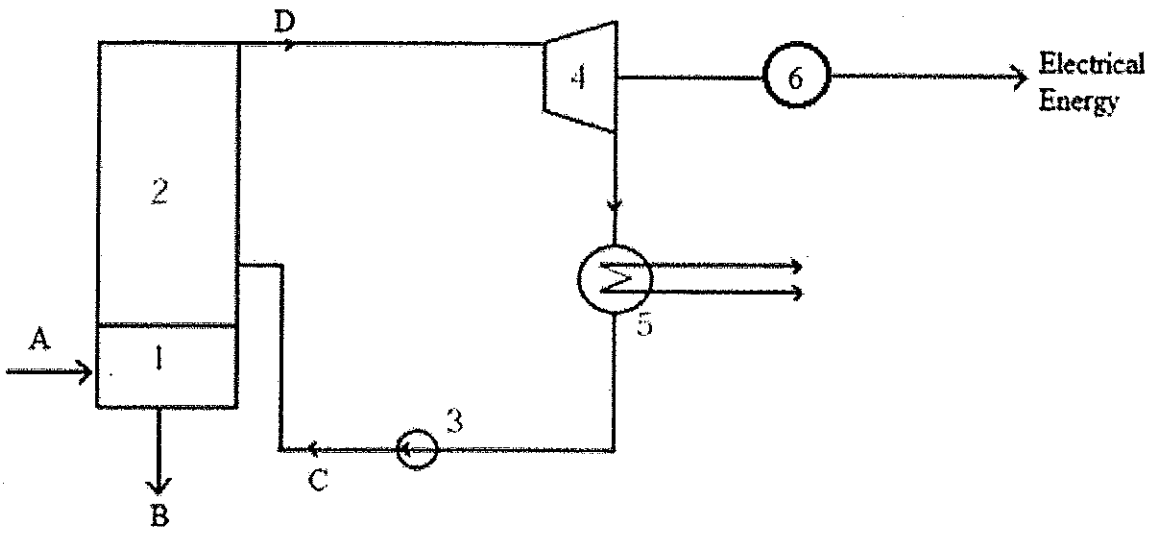

Figure Q1

b. Write three reasons for rapid increase of use of renewable energy sources for generating electricity **[3 Marks]**

c. Compare single bus bar arrangement and double bus-bar arrangement in terms of reliability, operation, cost and available area **[4 Marks]**

II. The system load power demand of a certain power system for a given day can be approximated by the expression below.

$$P(t) = 280\text{-}38\cos(0.5417t\text{-}10) \quad \text{MW}$$

Where t is the time of the day in **hours**

Calculate,

a. time of the day when peak demand occurs **[3 Marks]**

b. peak demand in MW **[2 Marks]**

Q2.

I.

a. Define load factor and briefly explain how it influences the cost of electrical power generation **[4 Marks]**

b. A power station supplies power to three localities having peak load of 40 MW, 25 MW and 30 MW. The annual load factor and diversity factor at the station are 0.80 and 1.80 respectively.

Calculate,

i) maximum demand of the power station **[2 Marks]**

ii) energy supplied in a year **[3 Marks]**

II.

a. Briefly explain the importance of power factor improvement for both utility and industrial consumers **[3 Marks]**

b. The kWh meter readings of a typical day of a manufacturing factory is shown in table Q2-I. During each 30 min interval power consumed remains constant. Average power factor of the factory throughout the day is recorded as 0.76.

Table Q2-I

Time	Meter reading (kWh)	Time	Meter reading (kWh)
0:00	0	12:00	380
0:30	0	12:30	420
1:00	0	13:00	460
1:30	0	13:30	500
2:00	0	14:00	540
2:30	0	14:30	600
3:00	0	15:00	660
3:30	0	15:30	740
4:00	0	16:00	820
4:30	0	16:30	870
5:00	0	17:00	920
5:30	0	17:30	940
6:00	0	18:00	960
6:30	0	18:30	970
7:00	0	19:00	980
7:30	5	19:30	990
8:00	10	20:00	100
8:30	15	20:30	100
9:00	20	21:00	100
9:30	60	21:30	50
10:00	100	22:00	50
10:30	160	22:30	20
11:00	220	23:00	10
11:30	300	24	5

According to the data given table Q2-I,

i) What is the maximum kVA demand in 30mins of the factory? **[3 Marks]**

ii) The tariff structure for the industry is given in table Q2-II. Calculate the monthly electricity bill. **[5 Marks]**

Table Q2-II

Time Interval	Energy Charge (LKR/kWh)	Fixed Charge(LKR/Month)	Maximum demand charge per month (LKR/kVA)
Peak (18.00-22.00)	20.50	3000	1100
Day(06.00-18.00)	11.00		
Off Peak (22.00-06.00)	6.50		

Q3

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I. Briefly explain the following power distribution systems by giving advantages and disadvantages

a. Radial Systems **[2 Marks]**
b. Loop (Ring) Systems **[2 Marks]**
c. Interconnected Systems **[2 Marks]**

II. A 220 kV, 150 km, three phase transmission line has a per phase series impedance of $z = 0.5\angle 85^{\circ}\ \Omega$/km and per phase shunt admittance of $y = 4\times10^{-5}\angle 90^{\circ}$ S/km. The line delivers power to a load of 250 MVA at 0.85 lagging power factor. Voltage at the receiving end is 90% of the rated voltage.

Using the π **model** of the transmission line, Calculate;

a. ABCD constants of the line **[4 Marks]**
b. The sending end voltage and current **[4 Marks]**
c. The sending end power factor **[2 Marks]**
d. Percentage regulation of the line **[2 Marks]**
e. The percentage transmission efficiency **[2 Marks]**

Q4.

I.

a. What is meant by grading of cables? Briefly explain two methods used in grading **[4 Marks]**
b. A 33 kV, single core cable has core diameter of 1 cm and sheath diameter of 4 cm. Calculate maximum and minimum stress in insulation **[6 Marks]**

II. A single line diagram of a distribution section of a simple power system is shown in figure Q4 and sectional impedances of the system are shown in table Q4. The voltage at the point C is maintained at 11 kV.
Calculate,

a. voltages at points A and B **[7 Marks]**
b. total apparent power delivered to the distribution system at point A and its power factor **[3 Marks]**

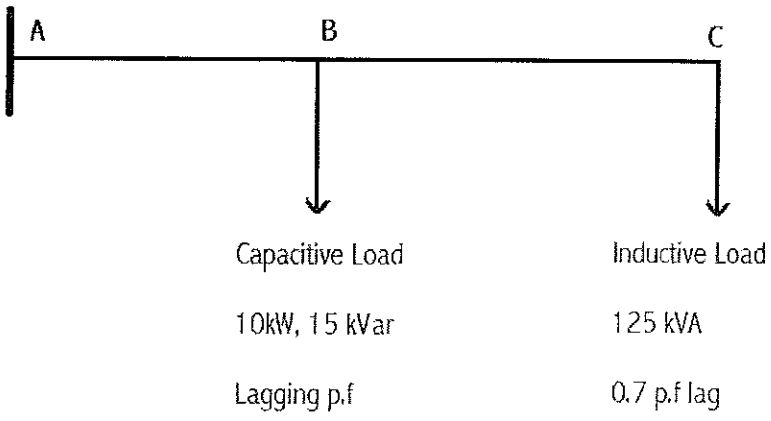

Figure Q4

Table Q4

Section	Line Impedance (Ω)
AB	2+3j
BC	1 + 4j

Q5.

I. A power plant having four (4) generators is connected to the grid via 4 MVA, 12.5 kV/132 kV step up transformer as shown in figure Q5.

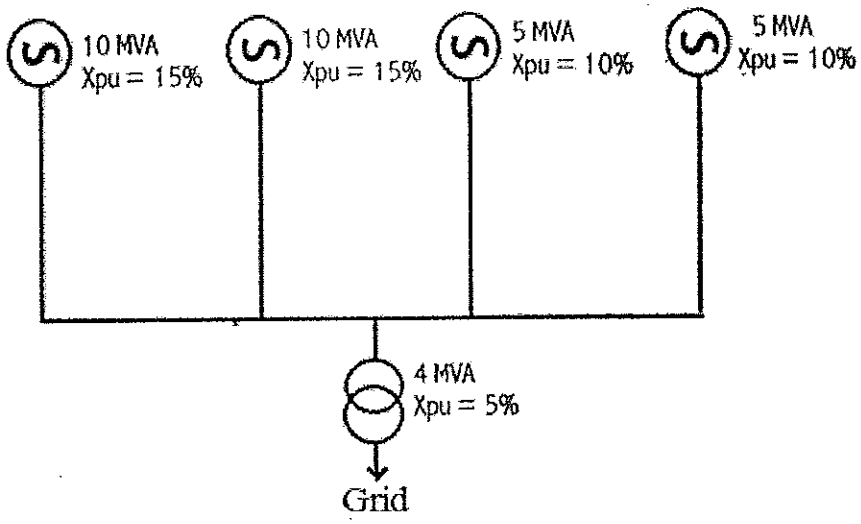

Figure Q5

Assuming S_{base}= 10 MVA for the system and Calculate,

a. Fault level at low voltage side of the transformer **[4 Marks]**
b. Fault level at high voltage side of the transformer **[4 Marks]**
c. State two assumptions which you made for above calculations **[2 Marks]**

II. Phase voltages and impedance components for a three phase unbalanced power system is shown in table Q5.

Table Q5

Phase	Voltage (V)	Impedance (Ω)
A	$230 \angle 10^{\circ}$	$10 \angle 20^{\circ}$
B	$215 \angle -100^{\circ}$	$12 \angle 15^{\circ}$
C	$260 \angle 110^{\circ}$	$15 \angle 10^{\circ}$

a. Calculate sequence components of phase currents in the system **[5 Marks]**
b. Calculate total active power associated with the system **[5 Marks]**

Q6.

Q.6

I. Briefly discuss the purpose of fault level analysis **[3 Marks]** 00055

II. The single line diagram of a section of a power system is shown in figure Q6. The ratings of the components of the element s of system are given in table Q6. Per unit values given in the table are on equipment base.

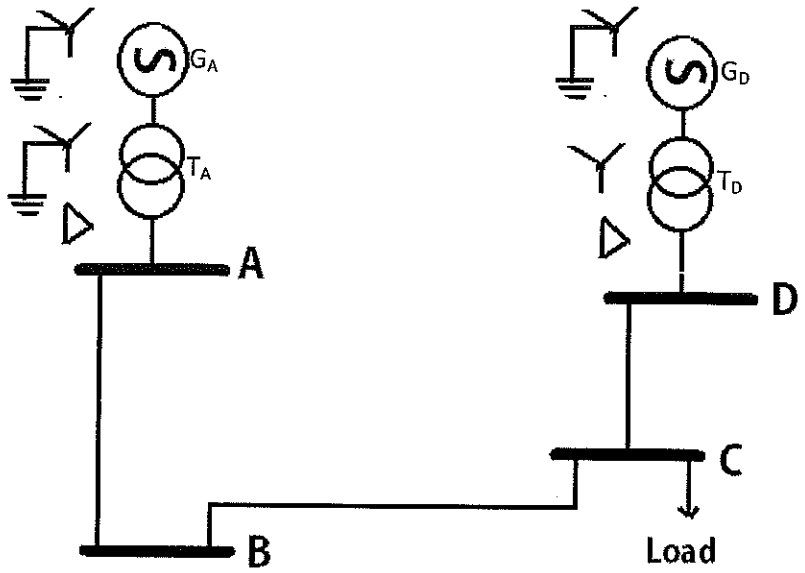

Figure Q6

Table Q6

	Rated MVA	Rated kV	X_1	X_2	X_3
Generator A	125	12.5	0.1 pu	0.08 pu	0.08 pu
Transformer A	150	12/132	0.1 pu	0.1 pu	0.1 pu
Generator D	100	12	0.12 pu	0.1 pu	0.08 pu
Transformer D	125	11/132	0.1 pu	0.1 pu	0.1 pu
Line AB		132	12 Ω	12 Ω	20 Ω
Line BC		132	15 Ω	15 Ω	25 Ω
Line CD		132	10 Ω	10 Ω	20 Ω

a. Convert all the impedances of the system given in table Q6 to a common base with MVA_{base}=100MVA and kV_{base} = 132 kV at transmission lines **[7 Marks]**

b. A load of 100 MW at unity p.f. is connected to C. Using suitable calculations show how you would treat it in a fault study **[2 Marks]**

c. Sketch sequence diagrams for the system shown, with significant values indicated on the diagrams **[4 Marks]**

d. A line to line fault occurs at bus B with negligible fault impedance. Calculate fault current at the point **[4 Marks]**