Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2016/2017

COURSE NAME	:	INDUSTRIAL POWER SYSTEMS
COURSE CODE	:	BNE 41003
PROGRAMME	:	BNE
EXAMINATION DATE	:	DECEMBER 2016 / JANUARY 2017
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY

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

Q1 (a) Explain briefly **THREE (3)** consideration that should be taken to ensure the reliability of distribution system in the system planning and design stage.

(6 marks)

(b) i) Explain the important of primary selective in distribution from **Figure Q1(b)**.

(3 marks)

ii) Design a simple secondary selective arrangement of distribution system with two feeders available.

(4 marks)

(c) **Figure Q1(c)** shows the *redundant* UPS block diagram. Design the *non-redundant* UPS system.

(4 marks)

(d) Sketch and discuss the following distribution system commonly used in industrial plant:

i) Simple radial system.

(4 marks)

ii) Expanded radial system.

(4 marks)

Q2 (a) Discuss why the usage of *High Efficiency Motors* is now a trend in industries.

(4 marks)

(b) Referring to **Figure Q2(b)** identify any **TWO (2)** components that may improve the efficiency of an AC induction motor.

(2 marks)

(c) A DC compound motor having a rating of 10 kW, 1150 rev/min, 230 V, 50 A, has the following losses at *full-load:*

bearing friction loss	=	40W
brush friction loss	=	50W
windage loss	=	200W
iron losses	=	420W
copper loss in the shunt field	=	120W

copper losses at full-load:

a. in the armature	=	500W
b. in the series field	=	25W
c. in the commutating winding	=	70W

Calculate the losses and efficiency at no-load and at 25, 50, 75, 100, and 150 percent of the nominal rating of the machine. Plot a graph showing efficiency as a function of mechanical load (neglect the losses due to brush contact drop).

(14 marks)

(d) A DC machine turning at 1100 rev/min carries an armature winding whose total weight is 45 kg. The current density is 2.2 A/mm^2 and the operating temperature is 85°C. The total iron losses in the armature amount to 1.2 kW.

Calculate :

i) The copper losses

(3 marks)

ii) The mechanical drag [N-m] due to the iron losses

(2 marks)

Q3 (a) Explain why low power factor causes higher electricity bill.

(3 marks)

(b) An electric motor utilize AC power is shown in **Figure Q3(b)**. Analyse the system and solve the following :-

i) Determine the power factor

(2 marks)

ii) Design the capacitor rating to bring the overall power factor to 80%

(3marks)

iii) Design the capacitor rating to bring the overall power factor to 90%

(3 marks)

iv) Compare all the answers above and make conclusion.

(3 marks)

(c) Discuss **FOUR (4)** design criterion of protective relaying

(6 marks)

(d) Modern digital protection relay is now a very popular tool in protection system compared to the traditional electromechanical relay. Justify this statement.

(5 marks)

Q4 (a) Briefly explain **TWO (2)** advantages of load characteristic in power systems.

(4 marks)

(b) With the aid of diagram, state the differences between load curve and load duration curve.

(4 marks)

(c) A residential consumer has connected 6 lamps each of 100 W and 4 fans of 60 W at his premises. His demand is as follows:

From midnight to 5 am : 120 W
From 5 am to 6 pm : No load
From 6 pm to 7 pm : 380 W
From 7 pm to 9 pm : 680 W
From 9 pm to midnight : 420 W

i) Find the energy consumption in 24 hours.

(4 marks)

ii) Calculate the demand factor, the average load, the maximum load and the load factor.
(4 marks)

(d) A generating gas station has a maximum demand of 80 MW, a load factor of 65 %, a plant capacity factor of 40 % and a plant use factor of 85 %. Find the maximum energy that can be produced daily if the plant is running all the time.
(5 marks)

(e) Describe **FOUR (4)** components required to protect the LV switchboard system.
(4 marks)

Q5 (a) Name **TWO (2)** industrial equipment that should be protected by overload protection scheme. Give **TWO (2)** protective device for each of the mentioned equipment and explain its function.
(6 marks)

(b) Explain the differences between infrequent fault and frequent fault of the transformer with the aid of diagram.
(3 marks)

(c) **Table Q5(c)** shows the load data for typical 11 kV line in a substation. Based on the table:

i) draw load curve and load duration curve.
(8 marks)

ii) find the maximum demand, average demand and the load factor of the feeder.
(3 marks)

iii) calculate the contribution factors for each of the loads.
(3 marks)

iv) find the diversity factor and coincidence factor for the loads.
(2 marks)

- **END OF QUESTION –**

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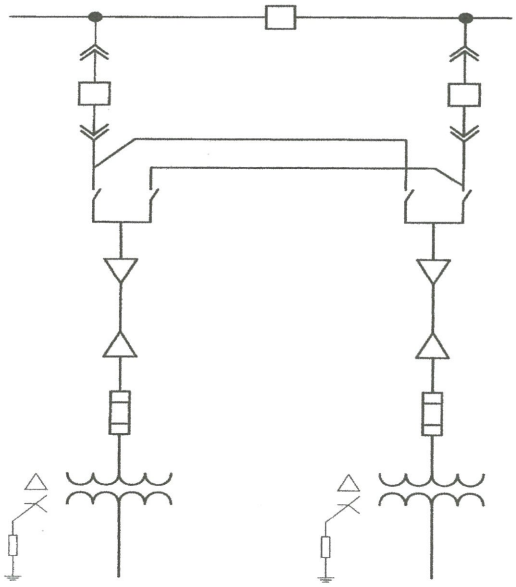

FIGURE Q1(b)

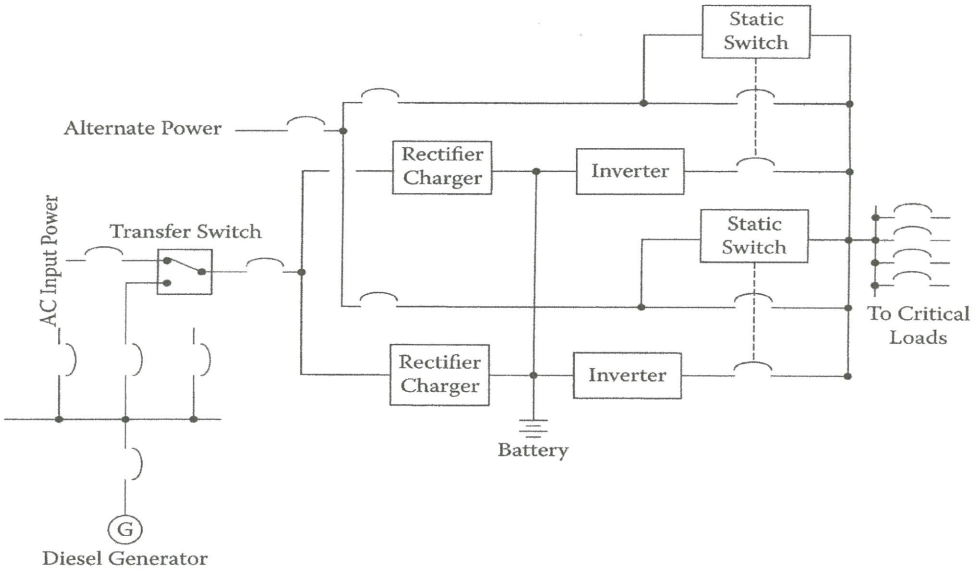

FIGURE Q1(c)

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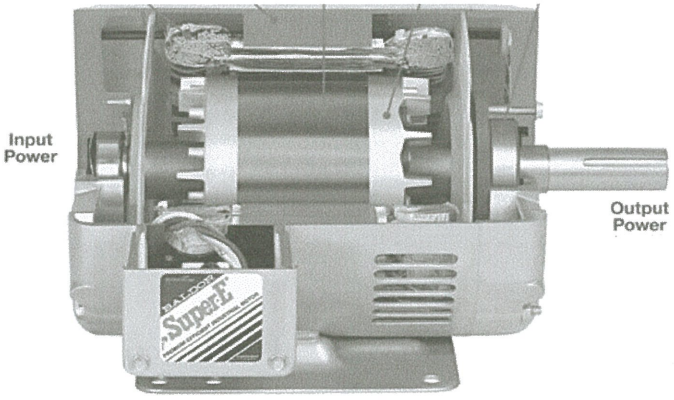

FIGURE Q2(b)

TABLE Q2(d)

Material	Chemical symbol or composition	Electrical properties			Mechanical properties			Thermal properties		
		resistivity ρ		temp coeff	density	yield strength	ultimate strength	specific heat	thermal conduc-tivity	melting point
		0°C nΩ·m	20°C nΩ·m	at 0°C ($\times 10^{-3}$)	kg/m^3 or g/dm^3	MPa	MPa	J/kg·°C	W/m·°C	°C
aluminum	Al	26.0	28.3	4.39	2703	21	62	960	218	660
brass	≈ 70% Cu, Zn	60.2	62.0	1.55	≈ 8300	124	370	370	143	960
carbon/ graphite	C	8000 to 30 000	-	≈ −0.3	≈ 2500	-	-	710	5.0	3600
constantan	54% Cu, 45% Ni, 1% Mn	500	500	−0.03	8900	-	-	410	22.6	1190
copper	Cu	15.88	17.24	4.27	8890	35	220	380	394	1083
gold	Au	22.7	24.4	3.65	19 300	-	69	130	296	1063
iron	Fe	88.1	101	7.34	7900	131	290	420	79.4	1535
lead	Pb	203	220	4.19	11 300	-	15	130	35	327
manganin	84% Cu, 4% Ni, 12% Mn	482	482	±0.015	8410	-	-	-	20	1020

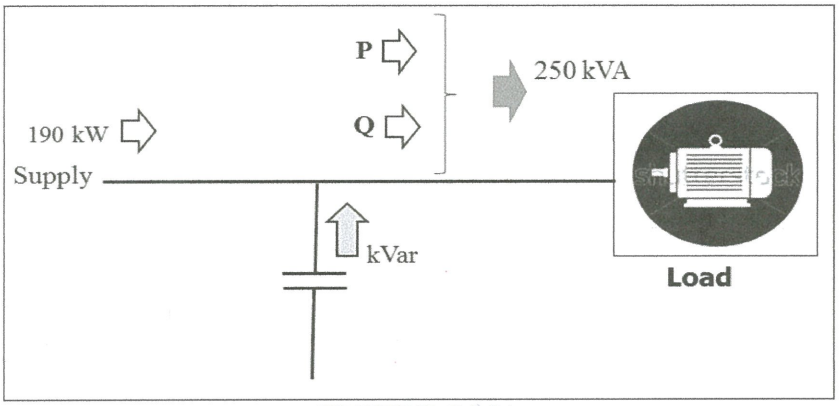

FIGURE Q3(b)

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TABLE Q5(C)

Time Hour/ Load kW	Street Light	Residential	Commercial	Industrial	Agricultural
0.00 – 6.00 AM	80	200	320	100	600
6.00 – 8.00 AM	-	700	400	100	400
8.00 – 9.00 AM	-	800	400	300	-
9.00 – 10.00 AM	-	600	400	400	-
10.00 – 5.00 PM	-	500	700	400	-
5.00 – 6.00 PM	-	600	900	400	-
6.00 – 7.00 PM	80	800	1200	320	-
7.00 – 8.00 PM	80	1000	1200	320	-
8.00 – 9.00 PM	80	1000	1200	220	-
9.00 – 10.00 PM	80	800	1050	170	-
10.00 – 12.00 PM	80	500	320	100	400

Resistivity $\rho - \rho_0(1 + \alpha t)$

Losses $P_c = 1000 f^2 \rho / \delta$