UNIVERSITI TUN HUSSEIN ONN
MALAYSIA

FINAL EXAMINATION
SEMESTER 1
SESSION 2009/2010

SUBJECT NAME	:	ELECTRICAL ENERGY UTILISATION
SUBJECT CODE	:	BEE 4213
COURSE	:	4BEE
EXAMINATION DATE	:	NOVEMBER 2009
DURATION	:	3 JAM
INSTRUCTION	:	ANSWER ANY **FOUR (4)** QUESTIONS FROM THE GIVEN SIX (6) QUESTIONS.

THIS PAPER CONTAINS OF 7 PAGES

Q1 (a) Tenaga National Berhad (TNB) plans to upgrade the national grid system to 500 kV in various phases in recent years. List any two advantages of upgrading to 500 kV as compared to the existing 275 kV system.

(5 marks)

(b) There are differences between the North American electrical distribution system and the European system. Name any two such differences.

(5 marks)

(c) Describe what do you understand by the term 'load curve' and list the information that is conveyed by a daily load curve.

(5 marks)

(d) It has been desired to install a diesel power station to supply power in a suburban area having the following particulars:

(i) 1000 houses with average connected load of 1.5 kW in each house. The demand factor and diversity factor being 0.4 and 2.5 respectively.
(ii) 10 factories having overall maximum demand of 90 kW.
(iii) 7 tube wells of 7 kW each and operating together in the morning.

The diversity factor among the above three types of consumers is 1.2. Determine the maximum capacity of the power station.

(5 marks)

(e) A generating station has the following daily load cycle:

Time (Hours)	0-6	6-10	10-12	12-16	16-20	20-24
Load (MW)	40	50	60	50	70	40

Draw the load curve and find:

(i) Maximum demand
(ii) Units generated per day
(iii) Average load
(iv) Load factor

(5 marks)

Q2 (a) An air conditioning unit has two motors, a 5.0 hp compressor and a 1.0 hp condensing fan. Both motors are rated at 230 V, single-phase. Design a circuit for this unit using a Moulded Case Circuit Breaker(MCCB) as the Over-Current (OC) device. The motor Full Load Ampere (FLA) data is given in Table Q2(a).

(4 marks)

(b) A 75 kVA step-down transformer with a 3.3 kV three-phase primary and 415Y/240 V secondary is selected to serve a lighting panel. Select the correct OC device for this transformer.

(6 marks)

(c) Draw and label a neat single line domestic wiring diagram showing the supply from TNB, the energy meter, the overload protection devices, the ground fault protection as well as fuse or miniature Circuit Breaker (MCB) for lighting and power loads. Use standard symbols

(7 marks)

(d) A 415Y/240 V panelboard serves the following loads. Compute the total connected load, the demand load and the rating of the circuit breaker protecting this panel board.

No.	Load	Rating	Demand factor
1.	Lighting	16.0 kVA @ PF=0.95	1.25
2.	Receptacles	8.0 kVA @ PF=0.90	1.00
3.	Air Conditioning	13.0 kVA @ PF=0.85	1.00
4.	Motors	6.0 kVA @ PF=0.80	0.65
5.	Water Heating	5.5 kW	0.90
6.	Spare Capacity	12.0 kVA @ PF=0.90	1.00

(8 marks)

Q3 (a) (i) List 3 disadvantages of low power factor.

(3 marks)

(ii) Determine 2 causes of low power factor.

(2 marks)

(b) A single phase motor connected to 400 V, 50 Hz supply takes 31.7 A at a power factor of 0.7 lagging. Calculate the capacitance require in parallel with the motor to raise the power factor to 0.9 lagging.

(6 marks)

(c) A 3- phase, 50 Hz, 400 V motor develops 100 hp (74.6 kW), the power factor being 0.75 lagging and efficiency 93%. A bank of capacitors is connected in delta across the supply terminals and power factor raised to 0.95 lagging. Each of the capacitance units is built of 4 similar 100 V capacitor. Determine the capacitance of each capacitor.

(14 marks)

Q4 (a) A 415 V, three-phase, 1600 A service consists of four 600 kcmil XHHW copper conductors per phase (assume steel conduit). The length of the conductor is 30.5 m and the load is 900 kVA @ 0.9 lagging power factor. Express the voltage drop in volts and percent.

(8 marks)

(b) A 225 kVA, 415-240 V, three-phase transformer has a resistance of 2.3 % and a reactance of 3.5%. The actual load on the transformer is 150 kVA @ 0.9 lagging power factor. Determine the voltage drop at the specified load condition in volts and percent.

(8 marks)

(c) Determine the maximum circuit length permitted for a 240 V, single-phase branch circuit consisting of #12 AWG copper conductor (assume steel conduit) if the voltage drop is not to exceed 3 %. The loading on the circuit is 16 A @ 0.95 lagging power factor.

(9 marks)

Q5 (a) Explain briefly the colour rendering index of a lamp.

(3 marks)

(b) An industrial plant has an incandescent lighting load comprising of 140 units of 60 W lamp and 180 units of 100 W lamp. Calculate the energy savings and payback period if all the incandescent lamps are to be replaced by 1 X 36 W fluorescent lamps. Lighting is required for 4000 hours/year and the cost of electricity is RM 0.218 per kWh. Replacement cost is RM 13.5 per unit and consider each of the ballast consumption is 12 W.

Given data

100 W incandescent lamp	=	2200 lumens
60 W incandescent lamp	=	1320 lumens
36 W fluorescent lamp	=	2650 lumens

(12 marks)

(c) A workshop measuring 15 m by 25 m by 3.5 m high used for simple bench fitting of small parts, needs a general illumination at bench level of 400 lx. The following schemes are suggested:

Scheme 1 : 80 W fluorescent luminaires emitting 40 lm/W
Scheme 2 : 200 W tungsten filament luminaires emitting 13 lm/W.

Assuming the utilisation factor to be 0.65 and the light loss factor (also known as maintenance factor) to be 0.8, calculate the number of luminaries to be installed for each scheme. For each case, draw a scale plan giving the suggested layout of the luminaries showing their spacing.

(10 marks)

Q6 (a) State what is meant by the term 'earth' as applied to an electrical installation. Explain the objective of earthing and the method of carrying it out. List the other alternatives method to earthing that could be employed.

(8 marks)

(b) State five common causes of excessive resistance in the earth continuity paths of consumers' installations.

(5 marks)

(c) In a single phase circuit protected by a 60 A cartridge fuse having a fusing factor of 1.5, a fault occurs in an appliance which causes a current of 75 amperes to flow through the earth continuity path, and due to poor contact of a lock nut and bush connecting a steel conduit to a metal box, the resistance of this conduit connection alone is 0.75 Ω. Regulation D22 regarding the basic earthing requirements is enclosed at the back of the question booklet.

State:

(i) whether the fuse will rupture
(ii) the amount of heat produced at the metal box
(iii) the degree of risk (if any), of a fire developing

(6 marks)

(d) With the aid of a schematic diagram explain briefly the operation of an earth leakage current operated circuit breaker.

(6 marks)

TABLE Q4

Alternating-Current Resistance and Reactance for 600-Volt Cables, 3-Phase, 75°C (167°F) – Three Single Conductors in Conduit

Size (AWG or kcmil)	Ohms to Neutral per Kilometer / Ohms to Neutral per 1000 Feet														Size (AWG or kcmil)
	X_L (Reactance) for All Wires		Alternating-Current Resistance for Uncoated Copper Wires			Alternating-Current Resistance for Aluminum Wires			Effective Z at 0.85 PF for Uncoated Copper Wires			Effective Z at 0.85 PF for Aluminum Wires			
	PVC, Aluminum Conduits	Steel Conduit	PVC Conduit	Aluminum Conduit	Steel Conduit	PVC Conduit	Aluminum Conduit	Steel Conduit	PVC Conduit	Aluminum Conduit	Steel Conduit	PVC Conduit	Aluminum Conduit	Steel Conduit	
14	0.190 0.058	0.240 0.073	10.2 3.1	10.2 3.1	10.2 3.1	- -	- -	- -	8.9 2.7	8.9 2.7	8.9 2.7	- -	- -	- -	14
12	0.177 0.054	0.223 0.068	6.6 2.0	6.6 2.0	6.6 2.0	10.5 3.2	10.5 3.2	10.5 3.2	5.6 1.7	5.6 1.7	5.6 1.7	9.2 2.8	9.2 2.8	9.2 2.8	12
10	0.164 0.050	0.207 0.063	3.9 1.2	3.9 1.2	3.9 1.2	6.6 2.0	6.6 2.0	6.6 2.0	3.6 1.1	3.6 1.1	3.6 1.1	5.9 1.8	5.9 1.8	5.9 1.8	10
8	0.171 0.052	0.213 0.065	2.56 0.78	2.56 0.78	2.56 0.78	4.3 1.3	4.3 1.3	4.3 1.3	2.26 0.69	2.26 0.69	2.30 0.70	3.6 1.1	3.6 1.1	3.6 1.1	8
6	0.167 0.051	0.210 0.064	1.61 0.49	1.61 0.49	1.61 0.49	2.66 0.81	2.66 0.81	2.66 0.81	1.44 0.44	1.48 0.45	1.48 0.45	2.33 0.71	2.36 0.72	2.36 0.72	6
4	0.157 0.048	0.197 0.060	1.02 0.31	1.02 0.31	1.02 0.31	1.67 0.51	1.67 0.51	1.67 0.51	0.95 0.29	0.95 0.29	0.98 0.30	1.51 0.46	1.51 0.46	1.51 0.46	4
3	0.154 0.047	0.194 0.059	0.82 0.25	0.82 0.25	0.82 0.25	1.31 0.40	1.35 0.41	1.31 0.40	0.75 0.23	0.79 0.24	0.79 0.24	1.21 0.37	1.21 0.37	1.21 0.37	3
2	0.148 0.045	0.187 0.057	0.62 0.19	0.66 0.20	0.66 0.20	1.05 0.32	1.05 0.32	1.05 0.32	0.62 0.19	0.62 0.19	0.66 0.20	0.98 0.30	0.98 0.30	0.98 0.30	
1	0.151 0.046	0.187 0.057	0.49 0.15	0.52 0.16	0.52 0.16	0.82 0.25	0.85 0.26	0.82 0.25	0.52 0.16	0.52 0.16	0.52 0.16	0.79 0.24	0.79 0.24	0.82 0.25	1
1/0	0.144 0.044	0.180 0.055	0.39 0.12	0.43 0.13	0.39 0.12	0.66 0.20	0.69 0.21	0.66 0.20	0.43 0.13	0.43 0.13	0.43 0.13	0.62 0.19	0.66 0.20	0.66 0.20	1/0
2/0	0.141 0.043	0.177 0.054	0.33 0.10	0.33 0.10	0.33 0.10	0.52 0.16	0.52 0.16	0.52 0.16	0.36 0.11	0.36 0.11	0.36 0.11	0.52 0.16	0.52 0.16	0.52 0.16	2/0
3/0	0.138 0.042	0.171 0.052	0.253 0.077	0.269 0.082	0.259 0.079	0.43 0.13	0.43 0.13	0.43 0.13	0.289 0.088	0.302 0.092	0.308 0.094	0.43 0.13	0.43 0.13	0.43 0.13	3/0
4/0	0.135 0.041	0.167 0.051	0.203 0.062	0.220 0.067	0.207 0.063	0.33 0.10	0.36 0.11	0.33 0.10	0.243 0.074	0.256 0.078	0.262 0.080	0.36 0.11	0.36 0.11	0.36 0.11	4/0
250	0.135 0.041	0.171 0.052	0.171 0.052	0.187 0.057	0.177 0.054	0.279 0.085	0.295 0.090	0.282 0.086	0.217 0.066	0.230 0.070	0.240 0.073	0.308 0.094	0.322 0.098	0.308 0.094	250
300	0.135 0.041	0.167 0.051	0.144 0.044	0.161 0.049	0.148 0.045	0.233 0.071	0.249 0.076	0.236 0.072	0.194 0.059	0.207 0.063	0.213 0.065	0.269 0.082	0.282 0.086	0.269 0.082	300
350	0.131 0.040	0.164 0.050	0.125 0.038	0.141 0.043	0.128 0.039	0.200 0.061	0.217 0.066	0.207 0.063	0.174 0.053	0.190 0.058	0.197 0.060	0.240 0.073	0.253 0.077	0.262 0.080	350
400	0.131 0.040	0.161 0.049	0.108 0.033	0.125 0.038	0.115 0.035	0.177 0.054	0.194 0.059	0.180 0.055	0.161 0.049	0.174 0.053	0.184 0.056	0.217 0.066	0.233 0.071	0.246 0.075	400
500	0.128 0.039	0.157 0.048	0.089 0.027	0.105 0.032	0.095 0.029	0.141 0.043	0.157 0.048	0.148 0.045	0.141 0.043	0.157 0.048	0.164 0.050	0.187 0.057	0.200 0.061	0.213 0.065	500
600	0.128 0.039	0.157 0.048	0.075 0.023	0.092 0.028	0.082 0.025	0.118 0.036	0.135 0.041	0.125 0.038	0.131 0.040	0.144 0.044	0.154 0.047	0.167 0.051	0.180 0.055	0.193 0.059	600

Source: Electrical Systems Design, Theodore R. Bosela (2003)

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TABLE Q2(a): FLA for 1-phase motors

HP	115 V	200 V	208 V	230 V
1/6	4.4	2.5	2.4	2.2
1/4	5.8	3.3	3.2	2.9
1/3	7.2	4.1	4.0	3.6
1/2	9.8	5.6	5.4	4.9
3/4	13.8	7.9	7.6	6.9
1	16	9.2	8.8	8
11/2	20	11.5	11	10
2	24	13.8	13.2	12
3	34	19.6	18.7	17

Table Q6(c)

Regulation D22 (Basic Earthing Requirements)
States that earth leakage protection may be provided by means of fuses or excess current circuit breakers if the earth fault current available to operate the protective device and so make the faulty circuit dead exceeds: 1. 3 times the current rating of any semi enclosed fuse or any cartridge fuse having a fusing factor exceeding 1.5, used to protect the circuit, or 2. 2.4 times the rating of any cartridge fuse having a fusing factor not exceeding 1.5, used to protect the circuit, or 3. 1.5 times the tripping current of any excess current circuit breaker used to protect the circuit.