UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2009/2010

SUBJECT NAME	: ELECTRIC POWER SYSTEM
SUBJECT CODE	: DEK 3213
COURSE	: 3 DEE/DET/DEX
EXAMINATION DATE	: NOVEMBER 2009
DURATION	: 2 1/2 HOURS
INSTRUCTION	: ANSWER ANY FOUR (4) OUT OF SIX (6) QUESTIONS.

THIS PAPER CONTAINS OF 8 PAGES

Q1 (a) List and sketch the structure of electric power system (including the block diagram)

(6 marks)

(b) List five (5) non conventional sources of energy which are eco friendly and self sustainable.

(5 marks)

(c) Briefly describe how the thermal plant operates (use diagram to assist your explanation),

(14 marks)

Q2 (a) A 5 kVA, 400/200 V transformer has a 2 Ω reactance referred to the low voltage side. Considering the rated values as base quantities, express the transformer reactance in per-unit quantity. (3 marks)

(b) The single-line diagram of a three-phase system is shown in Figure Q2(b). Choose a common base of 100 MVA and 22 kV on the generator side. Draw an impedance diagram with all impedance in per-unit.

Devices ratings:

$G : 80\,MVA, 22\,kV, X = 20\%.$

$M : 66.5\,MVA, 10.45\,kV, X = 18.5\%$

$T_1 : 50\,MVA, 22 / 220\,kV, X = 10\%$

$T_2 : 40\,MVA, 220 / 11\,kV, X = 8\%$

$T_3 : 40\,MVA, 22 / 110\,kV, X = 8\%$

$T_4 : 40\,MVA, 110 / 11\,kV, X = 6\%$

Line 1 and line 2 have reactance of 48.4 Ω and 65.43 Ω respectively.

(22 marks)

Q3 A three-phase 50 Hz double circuit line is composed of ACSR Pheasant conductors arranged as shown in Figure Q3. Calculate:

(a) inductive reactance in Ω/km per phase.
(b) capacitive reactance in Ω.km per phase to neutral.
($k = 8.85 \times 10^{-12}$F/m)

(25 marks)

Q4 (a) Most of the faults that occur in power systems are unsymmetrical faults. One of them is line to line fault. Prove the equation below if fault occurs at line 'a' by using the equation of symmetrical voltage and current.

$$I_{a1} = \frac{E_a}{Z_1 + Z_2}$$

(14 marks)

(b) Calculate the three-phase symmetrical fault current and the corresponding fault level in MVA in Figure Q4(b) if fault occurs at:
(i) Point A
(ii) Point B
(Use MVA base of 10000 kVA)

(11 marks)

Q5 (a) When a fault occurs under minimum fault conditions there are several consequences of fault that have been identified. Explain three of the consequences.

(9 marks)

(b) State 5 benefits of microprocessor relay.

(10 marks)

(c) Circuit breaker is a device that receives a fault signal from relay and it will cause the network to be open circuited due to fault section circuit. There are a few conditions that must be considered during determining the circuit breaker. State three (3) condition in order to determine the circuit breaker.

(6 marks)

Q6 (a) The arrangement of one circuit of a 50Hz three-phase transmission line is shown in Figure Q6(a). The space between phase conductors, D is 3 m. The space for each conductors of three bundle conductors line is d = 0.08 m. The radius for each conductor is 0.05 m. Find:

(i) inductive reactance for 100 km.
(ii) capacitive reactance for 100 km

(15 marks)

(b) A three-phase fault occurs at point F in Figure Q6(b). Calculate the fault MVA for the system. The reactances are all in percentage. Choose 60 MVA as a base MVA.

(10 marks)

FINAL EXAMINATION

SEMESTER / SESSION : SEMESTER 1/2009/10
SUBJECT : ELECTRIC POWER SYSTEM

COURSE : 3 DEE/DET/DEX
SUBJECT CODE : DEK 3213

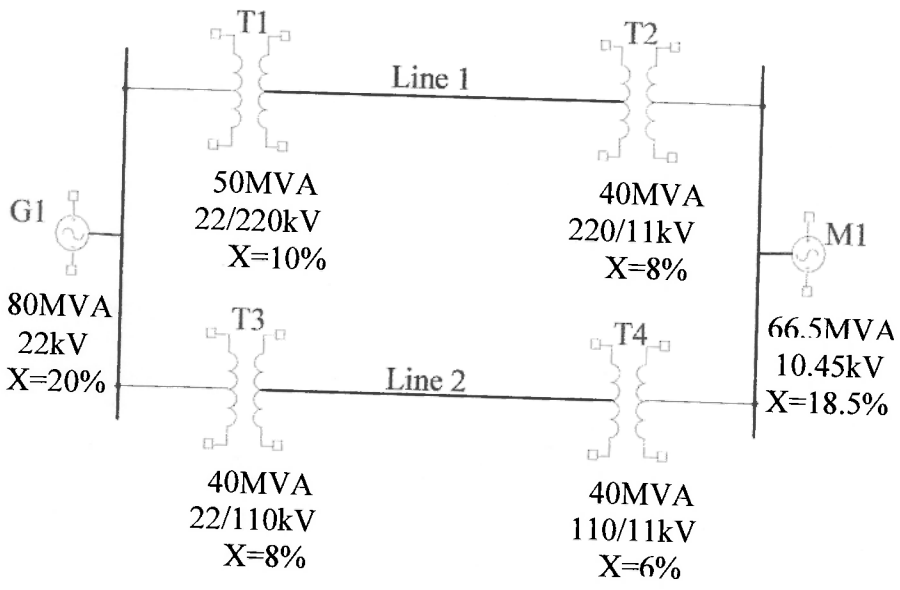

Figure O2(b)

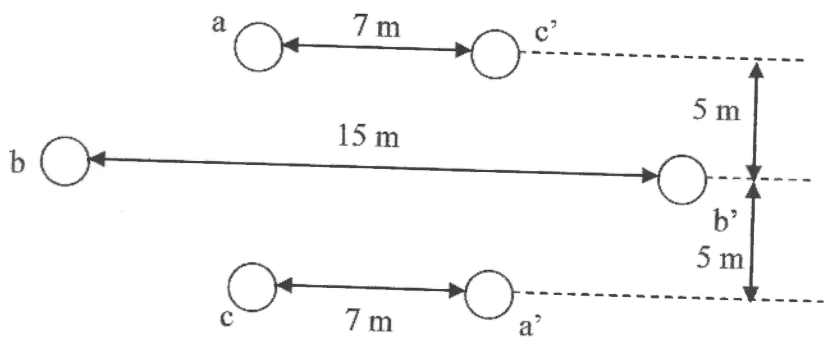

Figure O3

FINAL EXAMINATION

SEMESTER / SESSION : SEMESTER I/2009/10
SUBJECT : ELECTRIC POWER SYSTEM

COURSE : 3 DEE/DET/DEX
SUBJECT CODE : DEK 3213

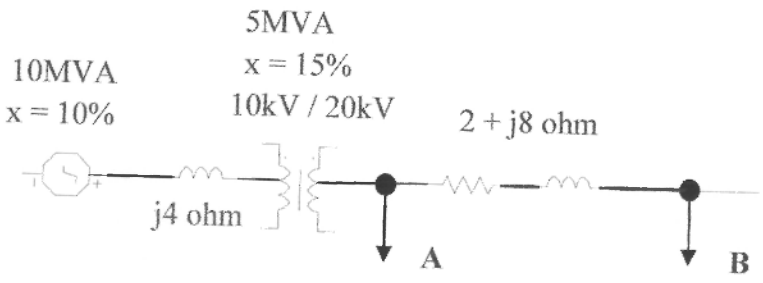

Figure Q4(b)

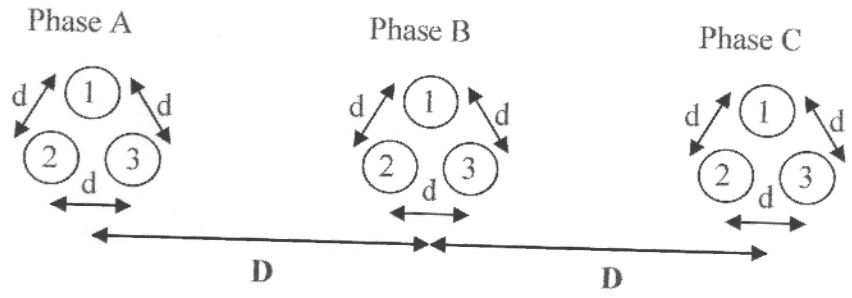

Figure Q6(a)

FINAL EXAMINATION

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SUBJECT : ELECTRIC POWER SYSTEM

COURSE : 3 DEE/DET/DEX
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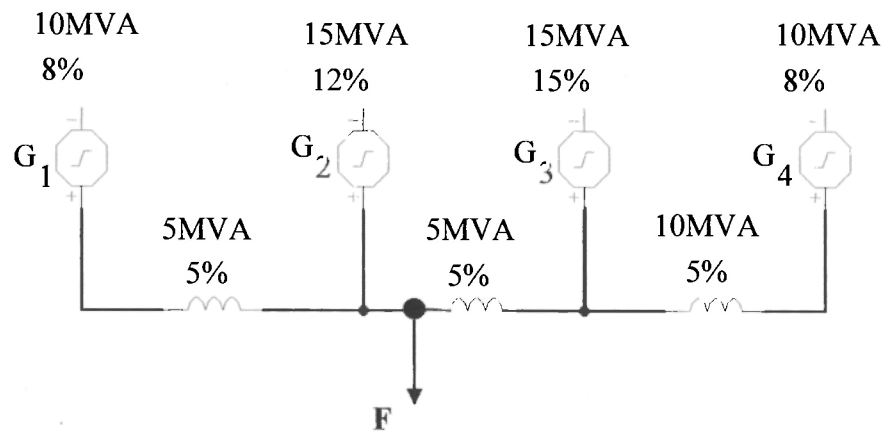

Figure Q6(b)

FINAL EXAMINATION

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Electrical characteristics of bare aluminum conductors steel-reinforced (ACSR)†

Code word	Aluminum area, cmil	Stranding Al/St	Layers of aluminum	Outside diameter, in	Resistance			GMR D_s, ft	Reactance per conductor 1-ft spacing, 60 Hz	
					Dc, 20°C, Ω/1,000 ft	ac, 60 Hz 20°C, Ω/mi	ac, 60 Hz 50°C, Ω/mi		Inductive X_a, Ω/mi	Capacitive X'_a, MΩ·mi
Waxwing	266,800	18/1	2	0.609	0.0646	0.3488	0.3831	0.0198	0.476	0.1090
Partridge	266,800	26/7	2	0.642	0.0640	0.3452	0.3792	0.0217	0.465	0.1074
Ostrich	300,000	26/7	2	0.680	0.0569	0.3070	0.3372	0.0229	0.458	0.1057
Merlin	336,400	18/1	2	0.684	0.0512	0.2767	0.3037	0.0222	0.462	0.1055
Linnet	336,400	26/7	2	0.721	0.0507	0.2737	0.3006	0.0243	0.451	0.1040
Oriole	336,400	30/7	2	0.741	0.0504	0.2719	0.2987	0.0255	0.445	0.1032
Chickadee	397,500	18/1	2	0.743	0.0433	0.2342	0.2572	0.0241	0.452	0.1031
Ibis	397,500	26/7	2	0.783	0.0430	0.2323	0.2551	0.0264	0.441	0.1015
Pelican	477,000	18/1	2	0.814	0.0361	0.1957	0.2148	0.0264	0.441	0.1004
Flicker	477,000	24/7	2	0.846	0.0359	0.1943	0.2134	0.0284	0.432	0.0992
Hawk	477,000	26/7	2	0.858	0.0357	0.1931	0.2120	0.0289	0.430	0.0988
Hen	477,000	30/7	2	0.883	0.0355	0.1919	0.2107	0.0304	0.424	0.0980
Osprey	556,500	18/1	2	0.879	0.0309	0.1679	0.1843	0.0284	0.432	0.0981
Parakeet	556,500	24/7	2	0.914	0.0308	0.1669	0.1832	0.0306	0.423	0.0969
Dove	556,500	26/7	2	0.927	0.0307	0.1663	0.1826	0.0314	0.420	0.0965
Rook	636,000	24/7	2	0.977	0.0269	0.1461	0.1603	0.0327	0.415	0.0950
Grosbeak	636,000	26/7	2	0.990	0.0268	0.1454	0.1596	0.0335	0.412	0.0946
Drake	795,000	26/7	2	1.108	0.0215	0.1172	0.1284	0.0373	0.399	0.0912
Tern	795,000	45/7	3	1.063	0.0217	0.1188	0.1302	0.0352	0.406	0.0925
Rail	954,000	45/7	3	1.165	0.0181	0.0997	0.1092	0.0386	0.395	0.0897
Cardinal	954,000	54/7	3	1.196	0.0180	0.0988	0.1082	0.0402	0.390	0.0890
Ortolan	1,033,500	45/7	3	1.213	0.0167	0.0924	0.1011	0.0402	0.390	0.0885
Bluejay	1,113,000	45/7	3	1.259	0.0155	0.0861	0.0941	0.0415	0.386	0.0874
Finch	1,113,000	54/19	3	1.293	0.0155	0.0856	0.0937	0.0436	0.380	0.0866
Bittern	1,272,000	45/7	3	1.345	0.0136	0.0762	0.0832	0.0444	0.378	0.0855
Pheasant	1,272,000	54/19	3	1.382	0.0135	0.0751	0.0821	0.0466	0.372	0.0847
Bobolink	1,431,000	45/7	3	1.427	0.0121	0.0684	0.0746	0.0470	0.371	0.0837
Plover	1,431,000	54/19	3	1.465	0.0120	0.0673	0.0735	0.0494	0.365	0.0829
Lapwing	1,590,000	45/7	3	1.502	0.0109	0.0623	0.0678	0.0498	0.364	0.0822
Falcon	1,590,000	54/19	3	1.545	0.0108	0.0612	0.0667	0.0523	0.358	0.0814
Bluebird	2,156,000	54/19	4	1.762	0.0080	0.0476	0.0515	0.0586	0.344	0.0776

†Most used multilayer sizes.

‡Data, by permission, from Aluminum Association, *Aluminum Electrical Conductor Handbook,* 2nd ed., Washington, D.C., 1982.

Table Q3