UNIVERSITY OF JOHANNESBURG

PROGRAM	:	NATIONAL DIPLOMA ENGINEERING: ELECTRICAL
SUBJECT	:	**ELECTRICAL DISTRIBUTION III**
CODE	:	**ELD 3221**
DATE	:	SUMMER EXAMINATION 2014 1 November 2014
DURATION	:	(SESSION 1) 08:00 - 11:00
WEIGHT	:	40:60
TOTAL MARKS	:	100

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MODERATOR	:	DR. C. RICHARDS
NUMBER OF PAGES	:	4 PAGES

INSTRUCTIONS TO STUDENTS

WORK IN PENCIL WILL NOT BE MARKED.
ALL WORK WITH THE EXCEPTION OF DIAGRAMS MUST BE IN BLUE OR BLACK INK.
ONE MARK EQUALS ONE PERCENT.
NO UNITS NO MARKS.
QUESTIONS MAY BE ANSWERED IN ANY ORDER.
DO NOT SPLIT QUESTIONS.
PLEASE ANSWER ALL QUESTIONS.
USE THREE DECIMAL PLACES.
ONLY ONE POCKET CALCULATOR PER CANDIDATE MAY BE USED.

QUESTION 1

1.1 Based on the cost of fuel transportation; the overall efficiency; maintenance and the cost related to transmission and distribution, discuss the advantages or disadvantages of coal-fired power station over diesel generation of power. (6)

1.2 A diesel engine power plant has 1 x 700 kW and 2 x 500 kW generating units. The fuel consumption is 0.28 kg per kWh and the calorific value of fuel oil is 10200 kcal/kg. Determine:

1.2.1 The fuel oil required for a month of 30 days, if the plant capacity factor is 40%. (4)

1.2.2 The overall efficiency of the plant. (2)

[12]

QUESTION 2

2.1 At the end of a power distribution system, a certain feeder supplies three distribution transformers. Each transformer is supplying a group of customers whose connected loads are as given in table 1 below:

Transformer	Load	Demand Factor	Diversity of groups
Transformer 1	10 kW	0.65	1.5
Transformer 2	12 kW	0.6	3.5
Transformer 3	15 kW	0.7	1.5

Table 1

If the diversity factor among the transformers is 1.3, calculate the maximum load on the feeder. (6)

2.2 A base load station having a capacity of 18 MW and a standby station having a capacity of 20 MW share a common load. Determine the annual load factors and plant capacity factors of the two power stations from the following information:
(Assume the maximum demand on the base load station is equal to installed capacity)
Annual standby station output = 7.35 x 10^6 kWh
Annual base load station output = 101.35 x 10^6 kWh
Peak load on standby station = 12 MW
Hours of use by standby station per year = 2190 hours

(6)

[12]

QUESTION 3

3.1 The maximum demand of a power station is estimated to be 100 MW at the load factor of 30%. The following generation schemes are proposed to be at the station:

1. A steam station in conjunction with a hydro-electric station, the latter supplying 100 x 10^6 kWh per annum with a maximum output of 40 MW.
2. A steam station capable of supplying the whole load.
3. A hydro-station capable of supplying the whole load.

Analyse and compare the overall cost per kWh generated, given the following information in table 2:

	Steam	Hydro
Capital cost/kWh installed	R 1250.00	R 2500
Interest and depreciation on capital investment	12%	10%
Operating cost/kWh	R0.05	R 0. 015
Transmission cost/kWh	negligible	R 0.002

Table 2

(10)

3.2 A generating station has a maximum demand of 75 MW and a yearly load factor of 40%. The generating costs are inclusive of the station capital costs of R 60.00 per annum per kW demand plus R 0.04 per kWh transmitted. The annual capital charges for transmission system are R 2 000 000 and for distribution system R 1 500 000. The respective diversity factors are 1.2 and 1.25. The efficiency of transmission system is 90% and that of the distribution system inclusive of substation losses is 85%. Calculate the yearly cost per kW demand and cost per kWh supplied at the substation as well as at the consumer premises. (10)

[20]

QUESTION 4

4.1 State five disadvantages of a low power factor. (5)

4.2 Give five disadvantages related to the use of synchronous condensers in power factor improvement. (5)

4.3 A factory has an average demand of 50 kW and an annual load factor of 0.5. The power factor is 0.75 lagging. The tariff is R100 per kVA of maximum demand per annum plus R 0.05 per kWh. If loss- free capacitors costing R 600.00 per kVAR are to be used, find the value of power factor at which maximum saving will result. The interest and depreciation together amount to 10%. Determine the annual saving effected by improving the power factor to the given value. (5)

[15]

QUESTION 5

5.1 A 132 kV line with 1.956 cm of conductor diameter is built so that corona takes place if the line voltage exceeds 210 kV rms. If the value of potential gradient at which ionisation occurs can be taken as 30 kV per cm, find the spacing between the conductors (assume smooth conductors). (5)

5.2 A 100 km long, three-phase, 50Hz transmission line has the following line constants:
Resistance/phase/km = 0.1 Ω
Reactance/phase/km = 0.5 Ω
Susceptance/phase/km = 10×10^{-6} S
If the line supplies a load of 20 MW at 0.9 power factor lagging at 66 kV at the receiving end, determine by nominal π method the following:

5.2.1 The sending end power factor. (6)

5.2.2 The percentage regulation of the line. (2)

5.2.3 The transmission efficiency. (2)

5.3 A 132 kV, 50 Hz, three-phase transmission line delivers a load of 50 MW at 0.8 power factor lagging at the receiving end. The generalised constants of the transmission line are: $A = D = 0.95\angle 1.4°; B = 96\angle 78°; C = 0.0015\angle 90°$
Calculate the regulation of the line and the charging current using the nominal T method. (6)

[21]

QUESTION 6

6.1 List the main components of an overhead power line and describe their respective role. (10)

6.2 An insulator string consists of three units, each having a safe working voltage of 15 kV. The ratio of self-capacitance to shunt capacitance of each unit is 8:1. Determine the maximum safe working voltage of the string as well as the string efficiency. (10)

[20]

TOTAL = 100