UNIVERSITY OF BUEA

COLLEGE OF TECHNOLOGY

ENTRANCE EXAMINATION INTO THIRD YEAR OF BTECH PROGRAM

SPECIALTY: ELECTRICAL TECHNOLOGY
DATE: 25/09/19 **TIME:** 08.00 – 12.00
TIME ALLOWED: 4 HOURS **COEFFICIENT:** 4
INSTRUCTIONS: Answer **ANY FOUR** questions

Question 1 /25marks

1. Define the following: base load, peak load, busbar and substation. **(5marks)**
2. Name 4 types of substations and state typical applications in each case. **(5marks)**
3. What are the elements of a typical substation? **(5marks)**
4. The transmission line from the power station's substation is supported at two towers at a height of 45m across a river. The horizontal distance between towers is 200m. If the tension on the conductor is 10kN and the weight of the cable is 0.8kg/m, find the clearance at the mid-way between towers. **(5marks)**
5. The reservoir area of the hydro-electric power plant is 4 sq km with a storage capacity of 10 million cubic-metres. The water head is 100m and the turbine and alternator efficiencies are 0.89 and 0.92 respectively. The rate of flow is $200m^3/s$. Water density is $1000kg/m^3$; take g as $9.81m/s^2$. Estimate the energy generated by the plant. **(5marks)**

Question 2 /25marks

1. Describe the operation of a typical MHD system. **(3marks)**
2. What is the importance of the **inverter** in the MHD circuit? **(3marks)**
3. The generating station has the following daily load cycle

Time (hrs)	0 - 5	5 – 9	9 – 12	12 – 16	16 – 20	20 - 24
Load (MW)	60	120	100	80	160	60

3.1. Draw the load curve **(3marks)**
3.2. What is the maximum demand? **(2marks)**
3.3. Find the units generated per day **(3marks)**
3.4. Calculate the average load **(2.5marks)**
3.5. Determine the load factor **(2.5marks)**

4. The fuel used has a calorific value of 12500kcal/kg. The efficiency of the system is 50%. For an average load of 100MW, calculate:
4.1. The mass of fuel required per hour **(3marks)**
4.2. The electric energy generated per tonne (1000kg) of the fuel. **(3marks)**
(Note: 1kWh =3.6MJ= 860kcal)

Question 3 /25marks

A single circuit 220kV, 150km three phase line operated at 50Hz is arranged as shown in figure 1. The conductor diameter is 6cm. Find:

1. The inductive reactance per km of the line **(7.5marks)**
2. The capacitance per km of the line. Take $k = 8.85 \times 10^{-12}$. **(7.5marks)**
3. The capacitive susceptance per phase **(5marks)**
4. The charging current and reactive power at the end of the line **(5marks)**

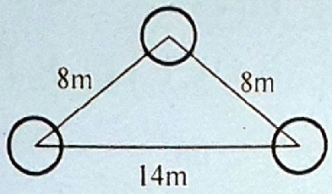

Figure 1

Question 4 /25marks

From figure 2, find;

1. Find the sending-end voltage (terminal voltage of synchronous machine) using the **per-unit method.** **(15marks)**
2. The short circuit current and power (fault level) if one (3-phase short circuit) occurred at the 33kV busbar. Take base power as 100MVA. **(10marks)**

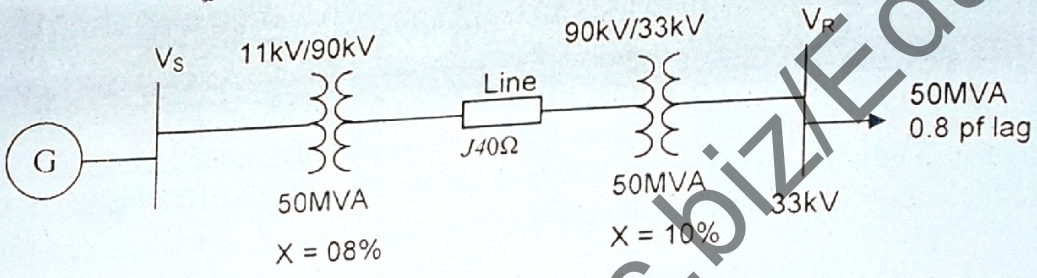

Figure 2

Question 5 /25marks

Figure 3 shows the floor plan of a sewing factory and figure 4 shows the load distribution specifications. It is supplied from a 380V 3-phase 4-wire system.

1. Determine the minimum rated power of the standby power plant **(5marks)**
2. Determine the line current and power factor of the whole installation. **(5marks)**
3. A reactive power plant is to be installed to improve the overall power factor to 0.96 lagging. Determine the reactive power to be supplied by the plant. **(5marks)**
4. A 4-core PVC insulated copper cable is used to supply the store some 150m away from the supply intake. The cable is run in a conduit and enclosed in a thermally insulating wall. The ambient temperature is 25°C and the voltage drop must not exceed 5% of the rated value. Determine the cross sectional area of the cable. See tables for ambient correction factors and voltage drop/ampere/meter extracted from IEE table **(5marks)**
5. The level of illumination required in the factory is 353*lx*. The factory is 6.85m high and the lamps are to be hung 1m from the ceiling. 250W, 220V, 60lm/W high pressure mercury vapour lamps (MBF). The fittings absorb 10% of the light output from the lamps. The utilization factor is 85% and the depreciation factor is 1/3
   - 5.1. Determine the number of fittings required in the factory. **(2.5marks)**
   - 5.2. Using a suitable scale of your choice, show the layout of the lamps. **(2.5marks)**

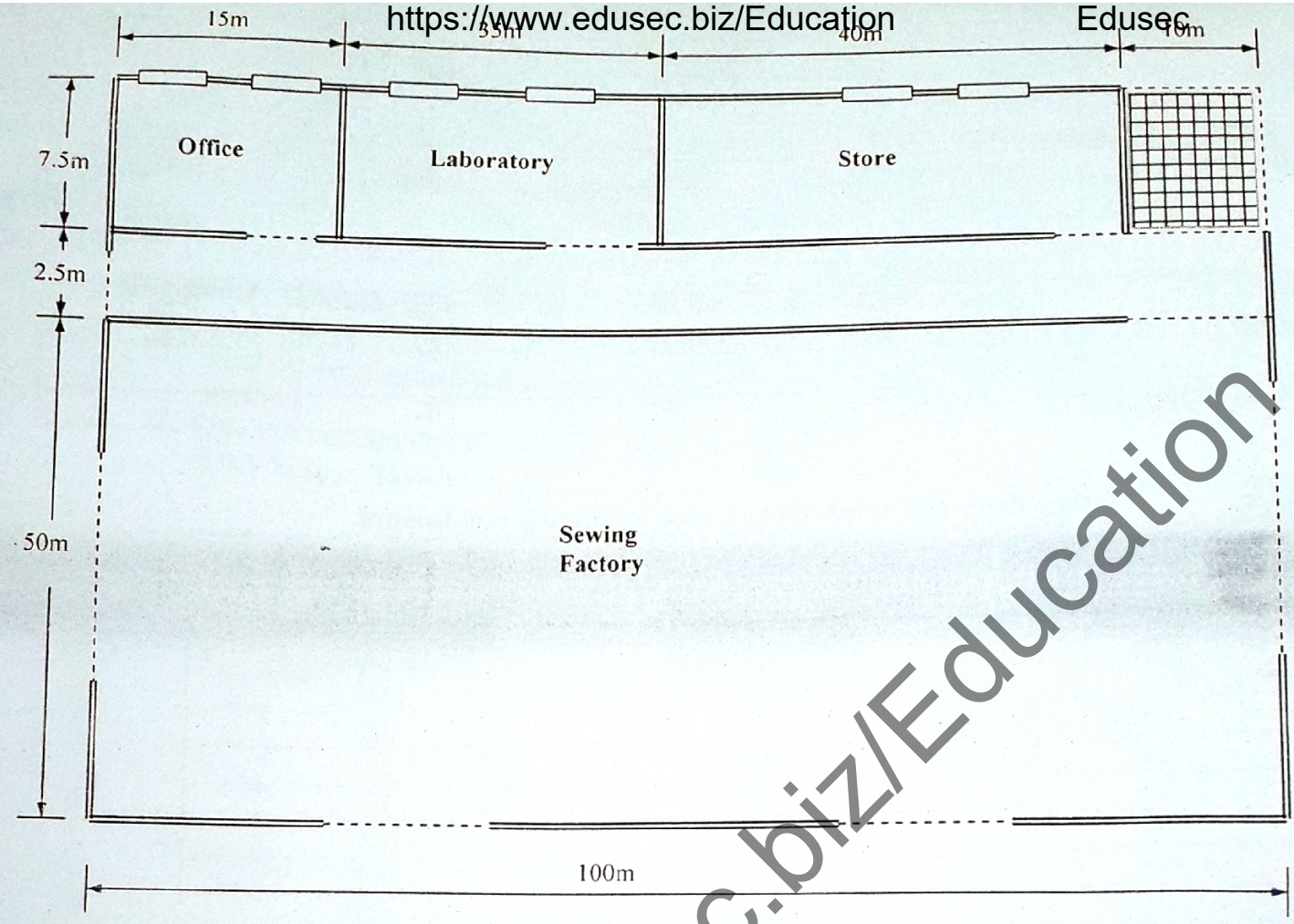

Fig. 3

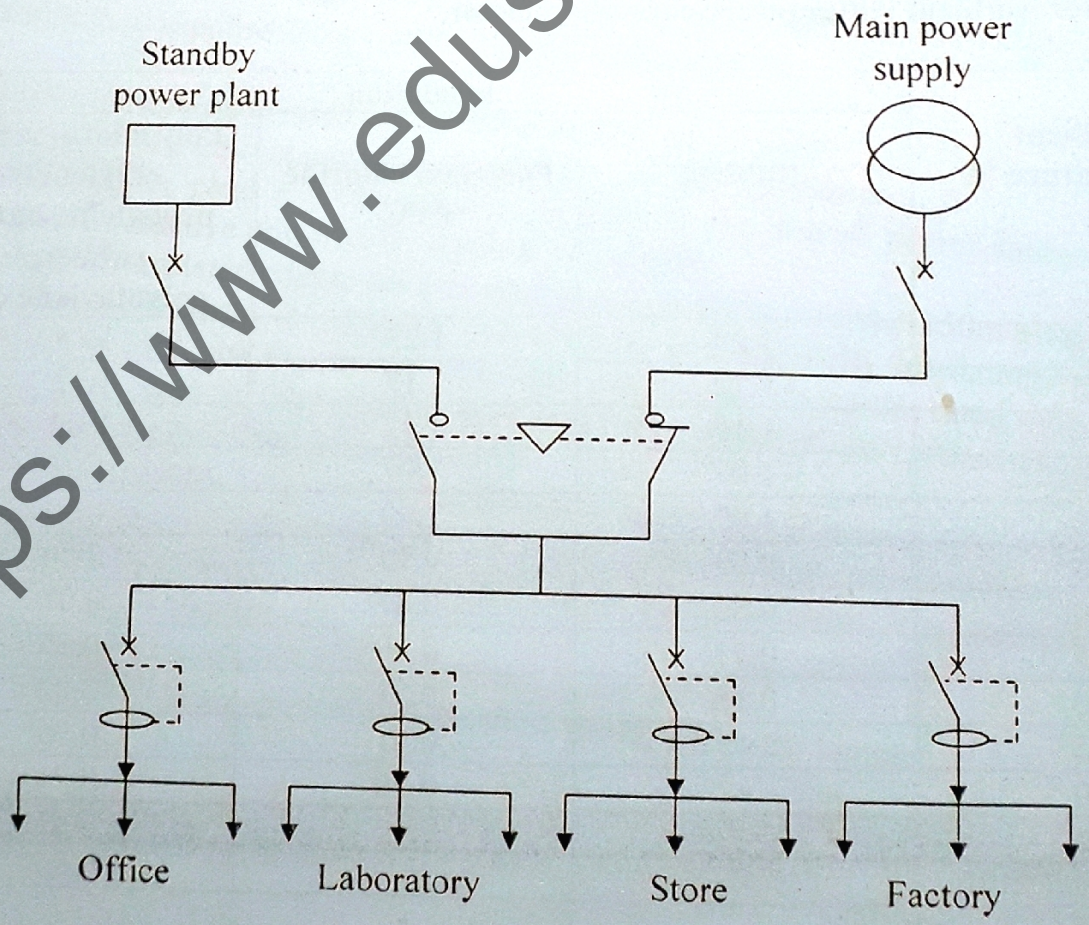

Fig. 4

The requirements for each block are are shown in table 1 below.

Area	*Requirements*	*Useful power*	*Power factor*	*Efficiency*
Office	Lights, sockets, computers, air conditioners	10.5kW	0.87	0.85
Laboratory	Lights, sockets, computers, air conditioners, lab equipment	15kW	0.84	0.85
Store	Lights, sockets	2kW	0.86	0.83
Factory	Lights, sockets, machines	200kW	0.7	0.86
Area Lighting	Lights	3kW	1	1

Table 2 **Voltage drop per ampere per meter for copper conductors**

- Ambient temperature: 30°C and conductor operating temperature (max): 70°C

Conductor cross-sectional area	**2-core cable Single phase ac**	**3 or 4-core cable Three phase ac**
mm^2	mV	mV
1	44	38
1.5	29	25
2.5	18	15
4	11	9.5
6	7.3	6.4
10	4.4	3.8
16	2.8	2.4

Table 3 Table for **Ambient temperature correction factor**

Ambient temperature °C	**Insulation**		
	Rubber	**Polyvinyl chloride PVC**	**Polychloroprene, ethylene-propylene, butyl rubber, polyethylene etc**
10	1.29	1.22	1.15
15	1.22	1.17	1.12
20	1.15	1.12	1.08
25	1.07	1.07	1.04
30	1.00	1.00	1.00
35	0.93	0.93	0.96
40	0.82	0.87	0.91
45	0.71	0.79	0.87
50	0.58	0.71	0.82
55	-	0.61	0.76
60	-	0.50	0.71
65	-	-	0.61
70	-	-	0.50
75	-	-	-
80	-	-	-

Table 4 Table for **Ratings for 1-core PVC insulated cables (type: H 07 V) with or without sheath**

- Ambient temperature: 30°C and conductor operating temperature (max): 70°C

Conductor CSA	Enclosed in conduits, in thermally insulating wall, etc		Enclosed in conduits on a wall or in trunking etc		*Clipped direct	
	2-cables single phase	3 or 4 cables three phase	2-cables single phase	3 or 4 cables three phase	2-cables single phase	3 or 4 cables three phase
mm^2	A	A	A	A	A	A
1	11	10.5	13.5	12	15.5	14
1.5	14.5	13.5	17.5	15.5	20	18
2.5	19.5	18	24	21	27	25
4	26	24	32	28	37	33
6	34	31	41	36	47	43
10	46	42	57	50	65	59
16	61	56	76	68	87	79
25	80	73	101	89	114	104