UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, April/May 2018

Course: Electrical Utilities (EPEC-7015) **Semester: II**
Program: M Tech Energy Systems
Time: 03 hrs. **Max. Marks: 100**
Instructions: In Q9 of section B attempt any one question
In Q11 of Section C attempt any one question

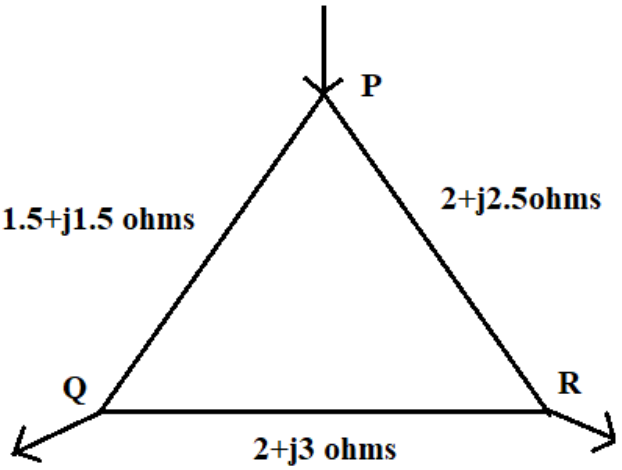
SECTION A

S. No.		Marks	CO
Q1.	Discuss any two-tariff structures designed to reduce the gap between demand and supply of electrical energy.	**(4)**	**CO1**
Q2.	Discuss the methodology adopted by Indian utilities to calculate AT&C losses.	**(4)**	**(CO2)**
Q3.	Describe in breif the methodology to calculate the losses in transformer and suggest one method to reduce the losses in transformer.	**(4)**	**(CO3)**
Q4.	A 3-phase AC load draws 10 kW of power at 400 Volts and 16 A line current. Calculate the power factor of the load.	**(4)**	**(CO4)**
Q5.	The company "Save Electricity the Smart Way" sells a gadget that lowers voltage of your electric water storage heater by 20% and saves electricity by 20%. The heater rated 2 kW at 230 V. Do you agree with the claim of the company? Support your opinion.	**(4)**	**(CO2)**

SECTION B

Q6.	**(a)** A 3 phase, 415 V, 75 kW induction motor is drawing 40 kW at a 0.7 PF. Calculate the capacitor rating requirements at motor terminals for improving PF to 0.95. Also, calculate the reduction in current drawn and kVA reduction, from the point of installation back to the generating side due to the improved PF. **(b)** A process plant consumes 150000 kWh per month at 0.9 Power Factor. Determine the percentage reduction in distribution losses per month if Power Factor is improved up to 0.96 at load end.	**(7)** **(3)**	**(CO2)** **(CO4)**
Q7.	An efficiency assessment test was carried out for a standard squirrel cage induction motor in a process plant. The motor specifications are as under. Motor rated specification:50 HP/ 415 Volt, 60 Amps, 1475 rpm, 3 phase, delta connected The following data was collected during the no load test on the motor. **Voltage= 415 Volts Current = 20 Amps Frequency = 50 Hz** **Stator resistance per phase= 0.275 Ohms** **No load power= 1110 Watts** Calculate the following: (i) Iron plus friction and windage losses. (ii) Stator resistance at 120oC. (iii) Stator copper loss at operating temperature at 120oC. (iv) Full load slip and rotor input assuming rotor losses are slip times rotor	**(10)**	**(CO3)**

	input. (v) Motor input assuming that stray losses are 0.5% of the motor rated power. (vi) Motor full load efficiency and full load power factor.		
Q8.	A generating station has a maximum demand of 75MW and a yearly load factor of 40%. Generating costs inclusive of station capital costs are Rs. 60 per annum per kW demand plus 4 paise per kWh transmitted. The annual capital charges for transmission system are Rs. 20,00,000 and for distribution system Rs. 15,00,000 the respective diversity factor being 1.2 and 1.25. The efficiency of transmission system is 90% and that of the distribution system inclusive of substation losses is 85%. Find the yearly cost per kW demand and cost per kWh supplied. **(1)** At the substation **(2)** at the consumer premises.	**(10)**	**(CO1)**
Q9	**(i)** A 37.5 kW rated induction motor burns out in a process plant. The financial manager of the plant wants to rewind the motor for Rs.10,000 to save money. The Energy Manager wants to buy a new energy efficient motor for Rs.50,000/- after selling burnt out motor for Rs. 8,000. He claims that he can save much more money in the next five years than the cost difference of the above two options. Other data is as under: **Operating hours/year = 7800** **Rewound motor efficiency at 75% loading = 89%** **New energy efficient motor efficiency at 75% loading = 94%** **Motor loading = 75%** **Electricity cost = Rs.5/kWh** **(i)** How much money does the energy manager actually save over 5 years and what is the simple pay back period ? The financial manager claims the financial risk is still too high because operating hours may go down drastically from 7800 to 3000 hrs in the next 5 years. The energy manager still insists that even if the motor's annual operating hours become 1/3rd of the annual 3000 operating hours as predicted by financial manager, the proposal will still recover the cost difference within next 5 years (ignoring interest burden). Do you agree with the energy manager's claim?	**(10)**	**(CO3)**
	OR		
Q9	Consider a ring main distributor PQR. The impedance of the sections PQ, QR and RP are 1.5+j1.5, 2+j3 and 2+j2.5 ohms. Power is fed at point P while at Q and R loads of 50 ampere at 0.6 pf and 100 ampere at 0.8 pf are drawn, the power factors are with respect to voltage at point P. Calculate the currents in each sections.	**10**	**CO4**



SECTION-C

Q10. A chemical plant has a contract demand of 5000 kVA with the power supply company. The average maximum demand of the plant is 4150 kVA at a power factor of 0.89. The maximum demand is billed at the rate of Rs.400/kVA. The minimum billable maximum demand is 75 % of the contract demand. An incentive of 0.5 % reduction in energy charges component of electricity bill are provided for every 0.01 increase in power factor over and above 0.95. The average energy charge component of the electricity bill per month for the company is Rs.20 lakhs. The plant retains the services of an energy auditor to recommend the optimum limit of power factor improvement to reduce the demand charges and electricity bill .
What would be recommendations/conclusion of energy auditor on the following:
a) Optimum power factor improvement limit
b) Power factor capacitor kVAr required,

c) Annual reduction in maximum demand charges and energy charge component due to PF improvement incentive.

d) Simple payback period if the cost of power factor capacitors is Rs.900/kVAr.

20 **(CO1)**

Q11 **(i)** In UPES following information was obtained after the lighting audit

Sr. No	Lighting Fixture	Wattage (W)	Number	Status
1	CFL	36	2000	Working
2	Florescent Tube	40	1500	50 Not working
3	LED	28	40	10 Not working

It is proposed to reduce the energy consumption of University by taking suitable measures in lighting system. Identify various energy conservation measures in lighting system along with the cost benefit analysis and life cycle cost of each measure. Make suitable assumptions if any. Identify the best option for UPES based on the information provided by two vendors by stating the benefits for selecting the identified Vendor.

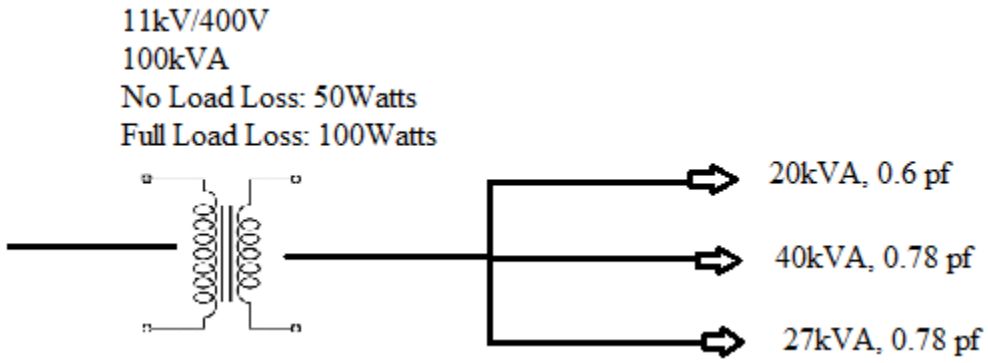
Details of new retrofits provided by two vendors

20 **(CO5)**

Sr. No	Details of the Product	Vendor A	Vendor B
1	LED wattage	9Watts	9Watts
2	LED Cost (per unit)	120 Rs	130Rs
3	LED Maintenance Cost	100 Rs	60 Rs
4	LED Life	2800hrs	2300 hrs
5	LED Tubelight	28Watts	28Watts
7	LED tubelight Cost (per unit)	200 Rs	220 Rs
8	LED tubelight Maintenance Cost	120 Rs	70 Rs
9	LED tubelight Life	2000Hrs	25000 Hrs

OR

(ii) Calculate the distribution losses in the figure shown below



Electrical Loads are supplied from three cables 100m in length each having the resistance of 3.42 Ω/km. Determine the reduction in distribution losses if power factor of all loads is improved to 0.99. Calculate the total investment required to reduce the distribution losses assuming APFC is available at the rate of 1800Rs/kVAr and determine the annual savings with paybak.

20 **(CO2)**

Name:

Enrolment No:

UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, April/May 2018

Course: Electrical Utilities (EPEC-7015) **Semester: II**
Program: M Tech Energy Systems
Time: 03 hrs. **Max. Marks: 100**
Instructions: In Q9 of section B attempt any one question
In Q11 of Section C attempt any one question

SECTION A

S. No.		Marks	CO
Q1.	List down the steps for analyzing the industrial electricity bill.	**(4)**	**(CO1)**
Q2.	Briefly explain the function of Automatic Power Factor Correction system with its benefits.	**(4)**	**(CO2)**
Q3.	List four energy conservation options available in Electrical Distribution System.	**(4)**	**(CO4)**
Q4.	A 7.5 kW, 415 V, 14A, 4 pole, 50 Hz, 3 Phase squirrel cage induction motor has a full load efficiency of 91%. Find the following if the motor operates at full load rated values. **a) input power in kW b) power factor**	**(4)**	**(CO3)**
Q5.	In an industrial office building lighting system, the ILER ratio has been improved from 0.6 to 0.8 for reducing lighting power consumption by modifying fittings layout. The initial lighting circuit load was 5KW. Calculate the percentage of waste reduction and annual energy savings if operating period is 10 hours and 360 days /year	**(4)**	**(CO5)**

SECTION B

Q6.	A 4-pole 415 V 3-phase, 50 Hz induction motor runs at 1440 RPM at .88 pf lagging and delivers 10.817 kW. The stator loss is 1060 W, and friction & windage losses are 375 W. Calculate : A) Slip B) Rotor Copper loss C) Line current D) Efficiency	**(10)**	**(CO3)**
Q7.	Two system of tariff are available for a factory working 8 hours a day for 300 working days in a year. (i) High-Voltage supply at 5 paise per unit plus Rs. 4.5 per month per kVA of maximum demand. (ii) Low voltage supply at Rs. 5 per month per kVA of maximum demand plus 5.5 paise per unit.	**(10)**	**(CO1)**

	The factory has an average load of 200 kW at 0.8 pf and maximum demand of 250 kW at the same power factor. The high voltage equipment costs Rs.50 per kVA and the losses can be taken as 4%. Interest and depreciation charges are 12%. Calculate the difference in the annual costs between the two systems.		
Q8.	A consumer has a steady load of 500kW at a power factor of 0.8 lagging. The tariff in force is Rs. 60 per kVA of maximum demand plus 5 paise per kWh. If the power factor is improved to 0.95lagging by installing phase advancing Equipments, calculate i) The capacity of the phase advancing equipment. ii) The annual savings effected The phase advancing equipment costs Rs. 100 per kVAr and the annual interest and depreciation together amount to 10%.	**(10)**	**(CO2)**
Q9	Discuss in details various energy saving measures available in lighting system. Also List down the step to determine the performance of the Lighting System by LPD and ILER method.	**(10)**	**(CO5)**
	OR		
Q9	Discuss the impact of transformer loading on the performance of the transformer. Determine the financial benefits of using energy efficient cables in distribution system by giving one example.	**10**	**CO4**
	SECTION-C		
Q10.	i) A substation supplies power by four feeders to its consumers. Feeder no.1 supplies six consumers whose individual daily maximum demands are 70kW, 90kW, 20kW, 10kW and 20kW while the maximum demand on the feeder is 200kW. Feeder no 2 supplies four consumers whose daily maximum demands are 60kW, 40kW, 70kW and 30kW, while the maximum demand on the feeder is 160 kW. Feeder no. 3 and 4 have a maximum demand of 150kW and 200kW respectively while the maximum demand on the station is 600kW. Determine the diversity of four feeders. ii) A customer is offered power at Rs. 50 per annuam per kVA of maximum demand plus 5 paise per unit. Customer proposes to install a motor to carry his estimated maximum demand of 300bhp. The motor available has a power factor of 0.83 at full load. How many units will be required at 30% load factor and what will be annual	**10** **10**	**(CO1)** **(CO2)**

	bill. Motor efficiency is 90%		
Q11	**i)** A 50 kW induction motor with 86% full load efficiency is being considered for replacement by a 89% efficiency motor. What will be the savings in energy if the motor works for 6000 hours per year and cost of energy is Rs. 4.5kWh. **ii)** Discuss in detail the working and construction of following Equipments of sub station **a.** Shunt capacitor **b.** Circuit Breaker **c.** Reactors **d.** Wave Traps	**10** **10**	**(CO3)** **(CO4)**
	OR		
	i) Explain in detail various energy conservation options available in Lighting System. List down various controls available for lighting and explain any two in detail. **ii)** The Motor of a 30hp condensate pump has got burnt beyond economical repairs. Two alternatives have been proposed to replace it by Motor A- Cost = Rs. 1,50,000; Efficiency at full load = 90%; Efficiency at half load = 86% Motor B- Cost = Rs. 1,00,000; Efficiency at full load = 85%; Efficiency at half load = 82% The life of each motor is 20 years and its salvage value is 10% of the initial cost. The rate of interest is 5% annually. The motor operates at full load for 25% of the time and at half load for the remaining period. The annual maintenance cost of Motor-A is Rs. 10,500 and that of Motor- B is Rs. 6000. The energy rate is Rs. 2.5 per kWh. Based on your analysis which motor you will recommend and why.	**10** **10**	**(CO5)** **(CO1)**