13th NATIONAL CERTIFICATION EXAMINATION – September, 2012 FOR ENERGY MANAGERS & ENERGY AUDITORS

PAPER – 3:	**Energy Efficiency in Electrical Utilities**	
Date: 16.9.2012 Max. Marks: 150	Timings: 0930-1230 HRS	Duration: 3 HRS

Section – I: OBJECTIVE TYPE **Marks: 50 x 1 = 50**

(i) Answer all **50** questions
(ii) Each question carries **one** mark

1	In a 22 kV feeder, if the voltage is raised from 22 kV to 66 kV for the same loading conditions, the voltage drop in the same feeder system would be lowered to a) 1/2 <u>b) 1/3</u> c) 1/9 d) unpredictable value
2	Normally, the efficiency of distribution transformer at full load varies anywhere between a) <u>96 to 99 %</u> b) 80 to 85 % c) 60 to 70% d) 50%- 60%
3	What is the reduction in distribution loss if the current flowing through the distribution line is reduced by 10%? a)10% b) 90% c<u>) **19%**</u> d) 81%
4	Power factor is the ratio of a) kVAr/kW b) $(kW^2+kVAr^2)^{1/2}/kW$ <u>c) kW/ $(kW^2+kVAr^2)^{1/2}$</u> d) kVAr/ $(kW^2+kVAr^2)^{1/2}$
5	The electricity bill shows an average power factor of 0.72 with an average kW demand of 627. How much kVAr is required to improve the power factor to 0.95? (Given Data: tan Φ1 = 0.964, tan Φ2 = 0.329) a) <u>398</u> b) 144 c) 95 d) 627
6	Where transformer loading is known, the actual transformer loss at a given load can be computed as: a) No Load Loss+ (Actual kVA Load/rated kVA) X Load Loss <u>b) No Load Loss+ (Actual kVA Load/rated kVA)^2 X Load Loss</u> c) No Load Loss+ (Actual kVA Load/rated kVA) X Load Loss^2 d) [No Load Loss+{ (Actual kVA Load/rated kVA) X Load Loss}]^2

7	Direct current motors are used in special applications where a) high torque starting or where smooth acceleration over a broad speed range is required. b) low torque starting or where steady acceleration over a narrow speed range is required. c) normal torque starting or where high acceleration over a broad speed range is required. d) low torque starting or where smooth acceleration over a broad speed range is required.
8	A 3-phase, 415 volts, 50 Hz, 100 kW, 6 pole squirrel cage induction motor with a rated slip of 2% will have a full load rotor speed of (a) 1470 rpm (b) 980 rpm (c) 1020 rpm (d) none of the above
9	In an induction motor the loss which is independent of motor load a) I^2R loss of stator b) I^2R loss of rotor c) friction and windage loss d) all of the above
10	Rewinding can affect which of the following factors that contribute to deterioration in motor efficiency: a) winding and slot design and winding material selection b) heat applied to strip windings, damage the insulation between laminations, thereby increasing eddy current losses c) change in the air gap may affect power factor and output torque d) all the above
11	If measured Line Current of a 3 phase induction motor is 25.98 A, what will be the Phase Current? **a)** 15 A **b)** 45 A **c)** 8.96 A d) 30 A
12	The efficiency of compressed air system is around a) 90% b) 60% c) 50% d) **10%**
13	The basic function of air dryer in a compressed air system is to a) remove remaining traces of moisture after the aftercooler b) store and smoothen pulsating air output c) reduce the temperature of the air before it enters the next state to increase efficiency d) prevent dust from entering compressor
14	Select the correct statement for reciprocating air compressors: a) for every 4°C drop in the inlet air temperature, the increase in energy consumption is by 1%. b) for every 4 °C rise in the inlet air temperature, the decrease in energy consumption is by 1% c) for every 4 °C rise in the inlet air temperature, the increase in energy consumption is by 1% d) the energy consumption remains same irrespective of inlet air temperature

15	Which of the following parameters is not required for evaluating volumetric efficiency of the compressor? a) FAD b) Cylinder bore diameter c) Stroke length d) Power input
16	Which of the following will not occur if a reciprocating compressor is operated at a lower discharge pressure? a) lower power consumption b) less load on the piston rods and hence reduced maintenance costs c) lower leakage losses d) lower free air delivery than rated
17	Which type of energy efficient dryer can be opted if a user in a plant requires compressed air at a dew point of -40°C ? a) heatless purge type dryer b) heat of compression dryer c) aftercooler d) refrigerant dryers
18	A 1.5 TR room air conditioner having EER (W/W) of 3.0 , will draw input power of______ kW a) 1.75 b) 3.00 c) 1.50 d) 2.00
19	Identify the wrong statement from the following regarding Vapour Compression Refrigeration system a) condenser rejects heat to atmosphere b) evaporator removes heat from process or space c) compressor sends superheated vapor to condenser **d) high pressure sub-cooled liquid refrigerant returns back to evaporator**
20	The head developed by a centrifugal pump is not directly proportional to a) Impeller diameter b) Shaft speed c) Number of impellers d) **Diameter of discharge port**
21	Which of the following is incorrect in the case of cooling towers a)"Range" is the difference between the cooling tower water inlet and outlet temperature. b) "Approach" is the difference between the cooling tower outlet cold water temperature and ambient wet bulb temperature. d)'Range' is a better indicator of cooling tower performance. e) Cooling capacity is the heat rejected in kCal/hr or TR
22	Identify the correct statement: **a) the Specific Ratio of Compressors is higher than Blowers** b) the Specific Ratio of Fans is higher than Blowers c) the Specific Ratio of Compressors is lower than Fans d) the Specific Ratio of Blowers is higher than Compressors
23	Two energy auditors made following statements regarding Vapour compressor Refrigeration system and what will be your judgement?

	Statement A: Reducing condensing temperature by 5.5°C, results in a 20 – 25% decrease in compressor power consumption Statement B: 5.5°C increase in evaporator temperature reduces compressor power consumption by 20 – 25% a) statements A & B are TRUE b) statements A & B are FALSE c) statement A is TRUE & B is FALSE d) statement A is FALSE & B is TRUE
24	Decreasing the rpm of a fan at partial loading by 10% results in: **a) decrease of 10% in flow rate and decrease of 27% in power requirement** b) decrease of 10% in flow rate and decrease of 19% in power requirement c) decrease of 10% in flow rate and increase of 10% in power requirement d) increase of 10% in flow rate and no appreciable change in power requirement
25	The power drawn by a centrifugal fan is a) inversely proportional to fan efficiency b) directly proportional to fan efficiency c) inversely proportional to static pressure d) inversely proportional to flow rate
26	The frictional loss in a piping system is proportional to a) flow **b) flow^2** c) 1/flow d) 1/flow^2
27	For the same flow, through which of the following diameter pipes, the pump will work with maximum pressure? **a) 100 mm** b) 150 mm c) 200 mm d) 250 mm
28	It is possible to run pumps in parallel if their ________________ are similar. a) suction heads b) discharge heads c) closed valve heads d) none of the above
29	Input power to the motor driving a pump is 20 kW. The motor efficiency is 0.9 and pump efficiency is 0.7. The power transmitted to the water is a) 12.6 kW b) 18.0 kW c) 14.0 kW d) 31.75 kW
30	Small by-pass lines are installed in pumps some times to _____. a) increase flow b) control pump delivery head c) prevent pump running at zero flow d) reduce pump power consumption
31	The refrigeration load in TR when 10 m^3/hr of water is cooled from a 15 ^{o}C to 7 ^{o}C is about a) 10 b) 8 c) 26.5 d) none of the above
32	The order of movement of thermal energy in HVAC system is: a) Indoor air - Chilled water - Refrigerant-Condenser water- Cooling tower b) Chilled water - Indoor air - Refrigerant-Cooling tower - Condenser water c) Indoor air - Condenser water - Chilled water - Cooling tower - Refrigerant d) Indoor air - Chilled water – Refrigerant - Cooling tower - Condenser water
33	In a cooling tower, Statement A: Surface of heat exchange is the surface area of the water droplets, which is in

	contact with air. Statement B: Area of heat exchange is the surface area of the fill sheets, which is in contact with air. a) statements A & B are false b) statement A is True & B is false c) statements A & B are True d) statement A is false & B is True
34	If the evaporation loss is 16 m^3 /hr per cell and Cycles of Concentration is 3, the blow down requirement in m^3 /hr per cell of a cooling tower: **a) 8** b) 5.33 c) 4 d) 2
35	Cycles of Concentration (C.O.C) of a cooling tower will depend on a) TDS in circulating water b) TDS in make-up water c) both a & b d) none of the above
36	The Solar Heat Gain Coefficient (SHGC) of window of a building is 0.30. This means: a) That the window allows 70 % of the sun's heat to pass through into interior of the buildings **b) That the window allows 30 % of the sun's heat to pass through into the building interior** c) That 70 % of the sun's heat is incident on the window d) That the window reflects back to exterior a minimum of 30 % of the sun's heat
37	FRP fans consume less energy than aluminium fans because a) they are lighter b) they have better efficiencies c) they encounter less system resistance d) they deliver less air flow
38	The hydraulic power in a pumping system depends on a) motor efficiency b) pump efficiency c) both motor and pump efficiency d) none of the above
39	The most energy intensive heat transfer loop of a Vapour Compression Refrigeration System is: a) Indoor air loop b) Chilled water loop c) Refrigerant loop d) Condenser water loop
40	The efficiency of a pump does not depend on a) suction head b) discharge head c) motor efficiency d) density of fluid
41	The power factor of a squirrel cage induction motor a) decreases at low motor loading b) decreases at high motor loading c) remains constant and is independent of load d) cannot be predicted
42	The slip of a synchronous motor will be a) more than the induction motor b) less than the induction motor c) zero d) load dependent

43	In BEE Star labeled distribution transformers, which of following losses are defined? a) <u>total loss at 50% and 100% loading</u> b) total loss at 75 % loading c) total loss at 75% and 100% loading d) total loss at 100% loading
44	To optimize the voltage level fed to the lighting feeder, the best option is to install. a) <u>servo stabilizer for lighting feeder</u> b) "exclusive" transformer for lighting c) microprocessor based controllers d) high frequency (HF) electronic ballasts
45	Which one of the following device will help to eliminate the hunting problems normally associated with capacitor switching? a) <u>Intelligent Power Factor Controller</u> b) maximum demand controller c) soft starter d) eddy current drives
46	Which one of the following is an incorrect statement? a) fluorescent lamp is an electric discharge lamp b) electronic ballasts make use of semi-conductor devices c) electronic ballasts have very low internal loss d) <u>fluorescent lamps can produce light by direct connection to the power source</u>
47	A 2500 MW super thermal power station generated 15786 million units in the year 2011-12. Its Plant Load Factor (PLF) is: a) 60% b) 65% <u>c) 72%</u> d) 79%
48	Which of the following statements is not true of maximum demand controller a) switches off non-essential loads in Logical sequence. b) alarm is sounded when demand approaches a preset value. c) <u>voltage level is closely regulated</u> d) plant equipment selected for the load management can be programmed
49	The main reason for using Variable Frequency Drive (VFD) for capacity control in electrical motor driven centrifugal fans with fluctuating load is : a) improved power quality **b) <u>fan capacity is proportional to its speed whereas the power drawn by the fan is proportional to the cube of its speed</u>** c) improved power factor d) precise closed loop process control
50	Select the incorrect statement: a) harmonics occur as spikes at intervals which are multiples of the supply frequency b) harmonics are multiples of the fundamental frequency c) <u>induction motors are the major sources of harmonics</u> d) transformers operating near saturation level create harmonics

Section – II: SHORT DESCRIPTIVE QUESTIONS **Marks: 8 x 5 = 40**

(i) Answer all <u>Eight</u> questions
(ii) Each question carries <u>Five</u> marks

S-1	List any five industrial applications of a heat pump.
Ans	Industrial heat pumps are mainly used for: 1. Space heating 2. Heating of process streams 3. Water heating for washing, sanitation and cleaning 4. Steam production 5. Drying/dehumidification 6. Evaporation 7. Distillation 8. Concentration
S-2	A pump is delivering 64 m^3/hr of water with a discharge head of 26 metres. The water is drawn from a sump where water level is 3 metres below the pump centerline. The power drawn by the motor is 8.89 kW at 88% motor efficiency. Find out the pump efficiency
Ans	Hydraulic power P_h = Q (m^3/s) xTotal head, h_d - h_s (m) x r (kg/m^3) x g (m/s^2) / 1000 Q = 64/3600 m^3/s , h_d - h_s = 26 – (-3) = 29 m Hydraulic power P_h = (64/3600) x 29 x 1000 x 9.81 / 1000 = 5.0576 kW Pump shaft power = 8.89 kW x 0.88 = 7.8232 kW Pump efficiency = hydraulic power / pump shaft power = 5.0576 / 7.8232 = 64.65 %
S-3	How do the Time-Of-Day (TOD) metering and billing benefit the utilities as well as consumers?
Ans	ToD meter records demand, time, and energy and the ToD tariff are set in such a way that higher rates at peak load periods and lower rates at off-peak load periods. The billing as per ToD tariff benefits the consumers to avail maximum power and energy at off-peak hours at lowest tariff ; and the higher peak period tariff dis-incentivise for increased drawl at peak period. This results effective maximum demand reduction to the utility, and in turn savings in peak time power procurement at higher rate as well as maximising the load factor for resulting better financials to the utility.
S-4	Explain briefly the difference between static and dynamic head of a centrifugal pumping system.
	Static head is simply the difference in height of the supply and destination reservoirs and it is independent of flow. Dynamic head is the friction loss, on the liquid being moved, in pipes, valves and equipment in the system. The friction losses are proportional to the square of the flow rate.

S-5

Compute AT & C (Aggregate Technical and Commercial) Losses for the following data:

S. No.	Description	Annual Data
1	Input Energy = (Import-Export), MU	11
2a	Energy Billed (Metered), MU	7
2b	Energy Billed (Un-Metered), MU	1
2c	Total Energy Billed	8
3	Amount Billed (Rs. lakhs)	450
4a	Gross Amount Collected (Rs. lakhs)	460
4b	Arrears Collected (Rs. lakhs)	40

Ans

Estimation of AT & C Losses

S. No.	Description		Annual Data
1	Input Energy = (Import-Export), MU	Ei	11
2a	Energy Billed (Metered), MU	E1	7
2b	Energy Billed (Un-Metered), MU	E2	1
2c	Total Energy Billed (E1 + E2)	Eb	8
3	Amount Billed (Rs. lakhs)	Ab	450
4a	Gross Amount Collected (Rs. lakhs)	AG	460
4b	Arrears Collected (Rs. lakhs)	Ar	40
4c	Amount Collected without Arrears (Rs. lakhs)	Ac=AG-Ar	420
5	Billing Efficiency (BE)	= Eb/Ei *100%	72.7%
6	Collection Efficiency(CE)	=Ac/Ab *100%	93.3%
7	AT& C Loss	{1- (BE *CE) *100%	32.17%

S-6

A DG set is operating at 700 kW load with 450°C exhaust gas temperature. The DG set generates 7.8 kg of exhaust gas/ kWh generated. The specific heat of gas at 430°C is 0.25 kCal/ kg°C. A heat recovery boiler is installed after which the exhaust temperature drops to 220°C. How much steam will be generated at 3 kg/ cm^2 with enthalpy of 650.57 kcal/ kg. Assume boiler feed water temperature as 65°C.

Ans

= 700 kWh x 7.8 kg gas generated/ kWh output x 0.25 kCal/ kg °C x (450°C-220 °C) =3,13,950 kCal/hr

Steam generation = 3,13,950 kCal/hr / (650.57 – 65) = 536.14 kg/ hr.

S-7

An energy audit of a fan was carried out. It was observed that the fan was delivering 18,500 Nm^3/hr of air with static pressure rise of 45 mm WC. The power measurement of the 3-phase induction motor coupled with the fan recorded 2.9 kW/ phase on an average. The motor operating efficiency was assessed as 88% from the motor performance curves. What would be the fan static efficiency?

Ans

Q = 18,500 Nm^3 / hr.= 5.13888 m^3/sec ,
SP = 45 mmWC,
η_{St} = ?,

	Power input to motor= 2.9x3=8.7 kW Power input to fan shaft=8.7 x0.88=7.656 kW $\text{Fan static } \eta = \dfrac{\text{Volume in m}^3\text{/sec x } \Delta P_{st} \text{ in mmWc}}{102 \text{ x Power input to shaft}}$ $= \dfrac{5.13888 \times 45}{102 \times 7.656}$ $= 0.296$ $= 29.6\%$
S-8	List down any 5 energy conservation opportunities in compressed air system
Ans	§ Ensure air intake to compressor is not warm and humid by locating compressors in well-ventilated area or by drawing cold air from outside. Every 4^{0}C rise in air inlet temperature will increase power consumption by 1 percent. § Clean air-inlet filters regularly. Compressor efficiency will be reduced by 2 percent for every 250 mm WC pressure drop across the filter. § Keep compressor valves in good condition by removing and inspecting once every six months. Worn-out valves can reduce compressor efficiency by as much as 50 percent. § Install manometers across the filter and monitor the pressure drop as a guide to replacement of element. § Minimize low-load compressor operation; if air demand is less than 50 percent of compressor capacity, consider change over to a smaller compressor or reduce compressor speed appropriately (by reducing motor pulley size) in case of belt driven compressors. § Consider the use of regenerative air dryers, which uses the heat of compressed air to remove moisture. § Fouled inter-coolers reduce compressor efficiency and cause more water condensation in air receivers and distribution lines resulting in increased corrosion. Periodic cleaning of inter-coolers must be ensured. § Compressor free air delivery test (FAD) must be done periodically to check the present operating capacity against its design capacity and corrective steps must be taken if required. § If more than one compressor is feeding to a common header, compressors must be operated in such a way that only one small compressor should handle the load variations whereas other compressors will operate at full load. Any other relevant point

-------- End of Section – II ---------

Section – III: LONG DESCRIPTIVE QUESTIONS **Marks: 6 x 10 = 60**

(i) Answer all Six questions
(ii) Each question carries Ten marks

L-1

a) In a cooling tower, the cooling water circulation rate is 1200 m^3/hr. The water enters the cooling tower at 38^{o}C. The ambient wet bulb temperature is 26^{o}C. The cooling tower operates with an approach of 4^{o}C. If the blowdown rate of the cooling tower is 1 % of the circulation rate, calculate the evaporation loss and COC.

b) A medium scale industry has a load of 450 kVA. It has installed two transformers of 500 kVA each. The no load loss and full load copper loss are 760 W and 5400 W respectively. From the energy efficiency point of view the management wants to take a decision on whether to operate a single transformer on full load or two transformers equally sharing the load. What is your recommendation ? Why?

Ans

a) Leaving cold water temperature = 26 + 4 = 30^{o}C
Evaporation Loss (m^3/hr) = 0.00085 x 1.8 x circulation rate (m^3/hr) x (T_1 –T_2)

= 0.00085 x 1.8 x 1200 x 8

= 14.69 m^3/hr

Blowdown = 12 m^3/hr
Blowdown = Evaporation loss / (COC – 1)
12 = 14.69 / (COC – 1)
COC = 2.224

b)

1 x 500 kVA	
Transformer loss at 450	No load loss + [kVA load/Rated kVA]^2 x full load loss
	760 + 4374
	5134 W
2 x 500 at 50% load	2 x {760 + [225/500]^2 x 5400}
	3707 W

Two transformers are better because the losses are the least.

L-2	Fill in the blanks for the following 1. A motor which can conveniently be operated at lagging as well as leading power factors is the___________ motor 2. A 50 Hz, 3-phase induction motor has a full load speed of 1440 r.p.m. The number of poles of the motor are______ 3. In a centrifugal pump the velocity energy is converted to pressure energy by _____ 4. In a centrifugal pump if the liquid to be pumped has density twice that of water, then the horse power required (as compared to that while pumping water) will be______ times 5. The friction loss in a pipe carrying a fluid is proportional to the fifth power of _________ 6. A 10 MVA generator has power factor 0.866 lagging. The reactive power produced will be ______ MVAR 7. Totally-enclosed, fan cooled (TEFC) motors are______ efficient than Screen – protected, drip-proof (SPDP) induction motors 8. Low speed Squirrel cage induction motors are normally ______efficient than high speed squirrel cage induction motors 9. Harmonics in electricity supply are multiples of the ________frequency 10. For the same rating, slip ring induction motors are normally _________efficient than squirrel cage induction motors
Ans	1. Synchronous 2. 4 3. volute or diffuser 4. 2 5. pipe diameter 6. 5 7. more 8. less 9 fundamental 10 less
L-3	a) Calculate the free air delivery (FAD) in m^3/min of a compressor for the following observed data: Receiver capacity: 0.25 m^3 Initial pressure: 1 kg/cm^2 (g) Final pressure: 7 kg/cm^2 (g) Initial temperature: 32 ^oC Final temperature: 52 ^oC Additional holdup volume: 0.05 m^3 Compressor pump up time: 2.1 minutes b) Identify the following statements as applicable to Vapor Compression Refrigeration System

	(VCR) or to Vapor Absorption Refrigeration System(VAR). I. The system operates under vacuum - ________(VCR/VAR) II. Uses water as a refrigerant - ________(VCR/VAR) III. Uses large amount of high-grade energy - ________(VCR/VAR) IV. COP decreases considerably with decrease in evaporator pressure - ________(VCR/VAR) V. The system can work on lower evaporator pressures also without affecting the COP - ________(VCR/VAR)
Ans	Q $= \frac{P_2 - P_1}{P_0} \times \frac{V}{t} \times \left(\frac{273 + t_1}{273 + t_2} \right)$ $= \frac{7-1}{1.026} \times \frac{(0.25+0.05)}{2.1} \times \left(\frac{273+32}{273+52} \right)$ **= 0.784 m^3/min** I. The system operates under vacuum VAR II. Uses water as a refrigerant VAR III. Using large amount of high-grade energy VCR IV. The COP decreases considerably with decrease in evaporator pressure. VCR V. The system can work on lower evaporator pressures also without affecting the COP VAR
L-4	The measured values of a water cooled 20 TR package air conditioning plant are given below: Average air velocity across suction side filter: 2.5 m/s Cross Sectional area of suction: 2.4 m^2 Inlet air : Dry Bulb:20 deg. C, Wet Bulb: 14 deg. C; Enthalpy: 9.37 k Cal per kg Outlet air: Dry Bulb: 12.7 deg. C, Wet Bulb: 11.3 deg. C; Enthalpy: 7.45 k Cal per kg Specific volume of Air: 0.85 m^3/kg Power drawn: by Compressor : 18.42 k W by Pump : 2.1 k W by Evaporator Fan : 1.25 k W Calculate the following: i. Air Flow rate ii. Cooling effect delivered iii. Compressor kW/TR iv. Overall kW/TR v. Overall Energy Efficiency ratio in W/W
Ans	i. Air flow rate = 2.5*2.4 = 6 m^3/sec = 21600 m^3/hr ii. Cooling Effect delivered = [(9.37-7.45)*21600]/(0.85*3024) = 16.13 TR = 56.73 kW iii. Compressor kW/TR = 18.42 /16.13 = 1.13 iv. Overall kW/TR = (18.42+2.1+1.25)/16.13 = 1.35 v. Energy Efficiency Ratio(EER) in W/W = 56.73/21.77 = 2.606

L-5	**a)** How do you calculate the velocity of air/gas in a duct using the average differential pressure and density of the air/gas? b) A no load test was conducted in a delta connected 37 kW induction motor. Nameplate data- 3 Phase, 415 V, 50 Hz, 55 Amp Measured data at no load: Voltage, V = 415 Volts; Current, I = 17 Amps; Frequency, F = 50 Hz; Stator phase resistance at 30°C = 0.24 Ohms/ phase No load power = 955 Watts i. Find out Iron Loss plus Friction Loss plus Windage Loss ii. Stator Copper Loss at name plate ratings(full load), considering stator temperature =120 °C iii. No load power factor of the motor
Ans	a) **Ans:** **Velocity V, m/s =** $\dfrac{C_P \times (2 \times 9.81\, \Delta p \times \gamma)^{1/2}}{\gamma}$ **C_p = Pitot tube constant, 0.85 (or) as given by the manufacturer** **Δp = Average differential pressure measured by pitot tube by taking** **measurement at number of points over the entire cross section of the duct.** **γ = Density at air/ gas at test condition** **b)** Let Iron Loss plus Friction Loss plus Windage Loss be P_i+fw Stator Copper Loss, P_{st}, 30°C = 3X $(17/\sqrt{3})^2$X0.24 = 69.36 Watt P_i+fw = P_{nl} - P_{st}= 955 – 69.36 = 885 .64 Stator resistance at 120 °C = 0.24x[(120+235)/[(30+235)] = 0.322 Ohms Stator Copper Loss at name plate ratings = 3x$(55/\sqrt{3})^2$ X0.322 = 974.05 Watt No load power factor= 955/(1.7321x415x17)=0.078
L-6	Answer any **two** of the following : (i) two most important electrical parameters, which are to be monitored for safe operation of Diesel Generator set (ii) Slip method of motor load assessment (iii) Five options for electricity distribution loss optimization (iii) Five energy conservation opportunities in pumping system
Ans	**(i)** two most important electrical parameters, which are to be monitored for safe operation of Diesel Generator set are **KVA and kW**
	(ii) Slip method of motor load assessment
	In the absence of a power meter, the slip method can be used which requires a tachometer. The percentage loading can be calculated as follows:

	$$Load = \frac{Slip}{S_s - S_r} * 100\%$$ Where: Load = Output power as a % of rated power Slip = Synchronous speed - Measured speed in rpm S_s = Synchronous speed in rpm at the operating frequency S_r = Nameplate full-load speed Slip also varies inversely with respect to the motor terminal voltage squared. A voltage correction factor can, also, be inserted into the slip load equation. The voltage compensated load can be calculated as shown $$Load = \frac{Slip}{(S_s - S_r) \, x \, (V_r / V)^2} \, x \, 100\%$$ Where: Load = Output power as a % of rated power Slip = Synchronous speed - Measured speed in rpm S_s = Synchronous speed in rpm S_r = Nameplate full-load speed V = RMS voltage, mean line to line of 3 phases V_r = Nameplate rated voltage
	iii) **Five options for electricity distribution loss optimization**
	• minimising length of distribution lines • adequate Size of Conductors • installaing Distribution Transformers (DTR) at load center on the Secondary Distribution System • Maintaining high Power Factor • High Voltage Distribution System (HVDS) • Incorporating Amorphous Core Transformers Any other relevant point
	iv) **Five energy conservation opportunities in pumping system**
	• Ensure adequate NPSH at site of installation • Operate pumps near best efficiency point. • Modify pumping system/pumps losses to minimize throttling. • Adapt to wide load variation with variable speed drives • Stop running multiple pumps - add an auto-start for an on-line spare or add a booster pump in the problem area. • Conduct water balance to minimise water consumption • Replace old pumps by energy efficient pumps Any other relevant point

……. End of Section – III …………..…