Paper 3: Energy Efficiency in Electrical Systems

Section A

Tick the most appropriate answer of the following questions in the front page. 1 x 50 =50

1. Reactive compensation is applied for
   A. reducing line current
   B. improving the transmission efficiency
   C. both A and B
   D. none of the above
2. Which of the following devices produce harmonics to the system
   A. TV sets
   B. GSL lamps
   C. capacitor
   D. inductor
3. Synchronous motor can be used as VAR compensator, when it is operated in
   A. over-excited condition
   B. under-load condition
   C. under-excited condition
   D. no-load condition
4. The reduction of utility load primarily during daily peak demand is known as
   A MTP analysis
   B. valley filling
   C. load shifting
   D. peak clipping
5. For voltage boosting in distribution networks the capacitors used is
   A series capacitors
   B. shunt capacitors
   C. both (A) and (B)
   D. none of these
6. The monitor and control of energy management system is done by using
   A. DAC
   B. smart meter
   C. SCADA
   D. all of these
7. What is the source of heat generation in cables?
   A. copper loss in conductor
   B. losses in metallic sheathings
   C. dielectric losses in cable insulation
   D. all of these
8. The thickness of insulation layer provided on the conductor in cables depends on
   A. operating voltage
   B. system configuration
   C. current to be carried
   D. all of these
9. The responsibility of maintaining current distortion in the distribution line belongs to the
   A. utility
   B. both
   C. industrial customer
   D. none of these
10. The dielectric loss of an electrical system is 50 Watts. What will be the dielectric loss if the voltage of the system is doubled?
   A. 25 watts
   B. 100 watts
   C. 50 watts
   D. 200 watts
11. The torque developed by a single-phase motor at starting is

A less than the rated torque C. zero
B. more than the rated torque D. none of the above

12. Which lamp has the best color rendering index (CRI)?
A. LED C. fluorescent
B. incandescent D. high pressure sodium

13. The speed regulation of a synchronous motor is always
A positive C. negative
B. zero D. none of these

14. Filament lamps normally operate at a power factor of
A. unity C. 0.8 lagging
B. 0.5 lagging D. 0.8 leading

15. Synchronous motors are normally used for
A. low speed, high torque load C. high speed, high torque load
B. low speed, low torque load D. high speed, low torque load

16. The unit of installed lighting load efficacy is
A. lux/m^2 C. lux/W
B. $lux/W/m^2$ D. $lux/m^2/W$

17. Which of the following motor is used for elevator?
A. induction motor C. synchronous motor
B. capacitor start single phase motor D. all of these

18. In the blocked rotor test, slip is equal to
A. 0 C. 0.5
B.1 D.2

19. Which method of speed control has minimum efficiency?
A Field control method C. Voltage control method
B. Armature control method D. None of these

20. On open circuiting the rotor of a squirrel cage induction motor, the rotor will
A make noise C. run at normal speed
B. run at dangerously high speed D. not run

21. Which one of the following is more energy efficient fluorescent lamp?
A. T3 C. T5
B. T8 D. Tl2

22. If a single phase motor runs slow, it may be due to
A. overload C. low frequency
B. low voltage D. all of these

23. LED has the disadvantages of
A. temperature dependence C. blue hazard
B. high initial price D. all of these

24. While performing no load test on a 3 phase induction motor, a curve is plotted between input power and the applied voltage. This curve is extended backward to intersect the y axis. The intersection point yields

A. core loss
B. friction and windage loss
C. no load loss
D. no load copper loss

25. The basic function of electronic ballast is
A. to ignite the lamp
B. to supply the power to the lamp
C. to stabilize the gas discharge
D. all of these

26. The life of a fluorescent tube is affected by
A. low-voltage
B. high-voltage
C. frequency of switching and blinking
D. all of these

27. The Flicker effect of fluorescent lamps is more pronounced at
A. lower voltages
B. lower frequencies
C. higher voltages
D. higher frequencies

28. The illuminance is 10 Lux for a lamp at l meter distance. What will be the illuminance at half the distance?
A. 5 Lux
B. 40 Lux
C. 20 Lux
D. will remain unchanged.

29. Which one of the following plants has the least operating cost?
A. steam plants
B. hydro plants
C. nuclear plants
D. diesel plants

30. For fans, the relation between discharge and speed is indicated by-
A. $\frac{Q_1}{Q_2} = \frac{{N_1}^2}{{N_2}^2}$
B. $\frac{Q_1}{Q_2} = \frac{N_1}{N_2}$
C. $\frac{Q_1}{Q_2} = \frac{{N_1}^3}{{N_2}^3}$
D. None of these

31. Isothermal efficiency of a multistage compressor depends on
A. No of stages
B. delivery pressure
C. suction pressure
D. all of these

32. For an air flow network, system resistance is a function of –
A. density of the gas
B. speed of the blower
C. velocity of the gas
D. both (A) & (B)

33. Typical efficiency of industrial compressed air system-
A. about 10 %
B. about 80 %
C. about 20 %
D. about 90 %

34. Which one of the following compressor has the best performance at part load condition?
A. reciprocating compressor
B. rotary Vane Compressor
C. centrifugal compressor
D. rotary screw compressor

35. Free Air Delivery (FAD) corresponds to air flow rate at
A. ISO condition
B. inlet condition
C. outlet condition
D. SATP condition

36. For a typical 100 kW compressor, tentative size of air receiver is
    A. 500 L
    B. 5000 L
    C. 2500 L
    D. 10000 L
37. Why make-up water is added in cooling tower circuit?
    A. to make air more humid
    B. to clean air
    C. to replenish water lost due to evaporation
    D. None of theses
38. Water enters and leaves a cooling tower at 45°C and 33°C respectively. If the WBT of incoming air is 24°C, the range of cooling tower is
    A. 12ºC
    B. 9ºC
    C. 21ºC
    D. None of these
39. Cooling tower performance is subject to
    A. biological fouling
    B. scale formation
    C. corrosion
    D. all of these
40. The rating required for a DG set with 400 kW connected load and with diversity factor of 0.8, 80% loading and 0.8 power factor is
    A. 520kVA
    B. 625 kVA
    C. 500 kVA
    D. 400 kVA
41. The temperature of the exhaust gas in a DG set
    A. increases with DG set loading
    B. decreases with DG set loading
    C. is independent of the DG set loading
    D. is always constant during its operation
42. One of the purposes of sub-cooling the liquid refrigerant is to
    A. reduce compressor discharge pressure
    B. ensure that only liquid enters the
    C. increase cooling effect
    D. reduce the size of the condenser expansion valve
43. Friction losses in a pumping system is
    A. proportional to 1/Q
    B. proportional to $1/Q^3$
    C. proportional to $1/Q^2$
    D. proportional to $1/Q^4$
44. The moving part of a centrifugal pump is called
    A. impeller
    B. diffuser
    C. suction nozzle
    D. volute
45. If we heat air without changing absolute humidity, % relative humidity will
    A. increase
    B. decrease
    C. no Change
    D. can't say
46. One ton of refrigeration (TR) is equal to
    A. 3024 Kcal/h
    B. 3.51 kW
    C. 12000 BTU/h
    D. all
47. COP of absorption refrigeration systems is
    A. between 4-5
    B. less than 1.1
    C. above 1.1
    D. always 2.5

48. The specific energy for a centrifugal chiller producing chilled water at 5.5°C and condenser water temperature around 30°C is the order of

A. 0.65 - 0.8 kW/TR
B. 1.0 kW/TR
C. 1.15 - 1.25 kW/TR
D. 0.45 - 0.55 kW/TR

49. The refrigerant temperature after the expansion device compared to after condenser in the vapor compression refrigeration cycle is

A. higher
B. lower
C. same
D. none

50. In general, designed chilled water temperature drop across the chillers is

A. 0ºC
B. 6ºC
C. 12ºC
D. 25ºC

Section B: Short Question

1. Name different types of losses in Induction motor and mention how to minimize each loss. 05

2. A leather processing industry has installed 3 identical transformers (1 MVA capacity each) for 1.8 MVA load. The No load loss and the full load loss of each of the transformer are 3 kW and 12 kW, respectively. Estimate the annual energy saving when 3 transformers are in parallel operation in comparison with 2 transformers. 05

3. What are the general energy saving opportunities of lightning? 05

4. Estimate the A/F ratio of typical Diesel ($C_{14.4}H_{24.9}$) 05

5. List different type of blowers. Which type of blower is used for material conveying system? 05

6. Draw typical Pump characteristics curve and show the operating point 05

7. Mention energy saving opportunities in cooling tower. 05

8. In a DG set, the generator is rated at 1000 kVA, 0.9 PF, and 1500 rpm. If the full load specific energy consumption of this DG set is 5.0 kWh per liter of fuel then how much fuel is consumed while delivering full load output for 8 hours. 05

Section C: Long Descriptive Question

1. Explain the steps of lightning system audit. 10

2. The specification of a three phase induction motor is given below; Rated power = 50hp, voltage=380V, current=65A, speed=1480rpm, f=50 Hz, P=4, connection=delta. No load test data, V_o= 380V, I_o=17.32A, P_o=998.4W, temperature=300C, Stator phase resistance at 300C, R_s = 0.25 ohms, (i) calculate iron plus F&W loss of the motor (ii) calculate full load slip and rotor input assuming rotor losses are equal to slip times rotor input. (iii) determine the motor input assuming that star losses are 0.5% of the motor's rated power. (iv) calculate motor full load efficiency and full load power factor. 10

3. Estimate the higher and lower heating values of methane combustion using the following data;

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- Gaseous fuels/species at 298 K:

Gas	H_2	N_2	O_2	H_2O	CO	CO_2	CH_4
$\bar{h}_f^o$ (MJ/kmol)	0.0	0.0	0.0	-241.8	-110.5	-393.5	-74.8

- Water:
  $\overline{h}_{fg}$ = 44.02 MJ/kmol = 2.445 MJ/kg

4. A large shopping mall has installed 6 reciprocation compressors with rating of 120 TR (each). 5 of these 6 compressors are in use for 12 hours per day. Due to higher energy cost, the authority has decided to replace the reciprocating compressors with screw compressors. Specific power consumption of reciprocating and screw compressors is 0.9 kW/TR and 0.6 kW/TR, respectively. Determine the following; 10
   I. Power consumption of the reciprocating and screw compressors,
   II. Annual cost savings (for 330 days of operation) from reduced energy consumption. Present unit cost of electricity is Taka 5.0 per kWh.

5. Consider three loads are connected to the source as Fig. l. Hence, 10

i) determine overall power factor of the system,

ii) draw the power triangle representing total real, reactive and apparent power respectively,

iii) find the value of the capacitance to make the overall power factor to unity.

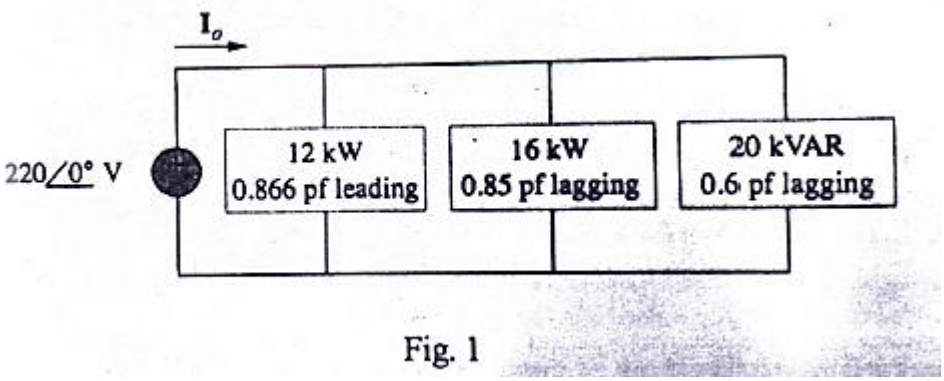

Fig. 1

6. Draw a block diagram to show the key components of a LiBr system used in typical HVAC systems. Mention some of the merits and demerits of 10 such system. 10