

ELL 769 – Major Exam

Date: 28.08.2020, Marks: 60, Time: 120 minutes.

Problem 1: (2x8=16 marks)

1.1) A series RLC circuit has a negligible value of R and has a resonant frequency of f_{res} . It is excited from a sinusoidal source having a frequency of $2f_{res}$. The current drawn from the source is predominantly (resistive/capacitive/inductive). Write the correct answer.

1.2) The efficiency of a double conversion UPS is expected to be _____ (more/less/equal) than the efficiency of a line interactive UPS. (Fill in the blanks)

1.3) Write the name of one method by which you can control the speed of a DC machine. Write your answer in one line only.

1.4) A 100Ah, 2C battery is discharged at a rate of C20. The current drawn from the battery is

- (a) 10 A
- (b) 5 A
- (c) 20 A
- (d) 2 A

1.5) Which of the following statements is not correct for an LED lamp?

- (a) The lamp has reasonably good colour rendering index
- (b) The lamp has long lifetime
- (c) The lamp requires a choke
- (d) The lamp has high lumen efficiency

1.6) A single tuned RLC passive filter tuned at 7th harmonic frequency is used to improve the harmonic performance of a system. Which of the following statements is false?

- (a) The passive filter supplies reactive power at fundamental frequency.
- (b) The 5th harmonic impedance is more than 7th harmonic impedance for the passive filter.
- (c) The 5th harmonic impedance is less than 7th harmonic impedance for the passive filter.
- (d) A small amount of 7th harmonic current flows into the source.

1.7) The electrical wiring in India for single phase residential buildings follows the following convention:

- (a) Red-Phase, Green-Neutral, Black-Earth
- (b) Red-Earth, Green-Phase, Black-Neutral
- (c) Red-Neutral, Green-Earth, Black-Phase
- (d) Red-Phase, Green-Earth, Black-Neutral

1.8) Which of the following statements is false for a 3-phase induction motor, fed from a 3-phase supply?

- (a) The motor speed can be controlled by changing the supply voltage magnitude.
- (b) The motor always runs at sub-synchronous speed.
- (c) The motor speed falls if the load torque increases.
- (d) The motor requires a capacitor to start.

Problem 2: (4x6 = 24 marks)

Prob 2.1) A 220V, 50 Hz voltage source supplies a non-linear load. The current drawn by the non-linear load is given by,

$$I_L(t) = 5\sqrt{2} \sin(314.15t - 20^\circ) + 3\sqrt{2} \sin(1570.8t - 30^\circ) + 1\sqrt{2} \sin(2827.3t - 40^\circ).$$

- (a) What are the harmonic frequencies present in the load current? (2 marks)
- (b) What is the THD of the load current? (2 marks)

Prob 2.2) A balanced Delta-connected load takes a line current of 18A at a power factor of 0.85 leading from a 400 V (line-line), 3-phase, 50 Hz star connected supply.

- (a) Calculate the resistance part of each leg of the load.

Prob 2.3) A resistor R in series with a capacitor C is connected to 50 Hz, 240V source. Find the value of C so that R absorbs 300W and voltage across R is 100V.

Prob 2.4) An experiment is being conducted on a 100 kW, 230 V DC shunt generator. It has an armature resistance of 0.05 Ω and field resistance of 57.5 Ω . If the generator operates at rated voltage, the armature current measured at half full load will be close to _____ A. (Fill in the blanks)

Prob 2.5) A 12V, 60Ah, 3C battery is designed to be used for backup in an inverter supply. The battery is tested with 30A continuous load where it gives a backup time of 140 minutes.

- (a) What is the energy (in kWh) drawn from the battery? (2 marks)
- (b) What is the charge (in Ah) drawn from the battery? (2 marks)

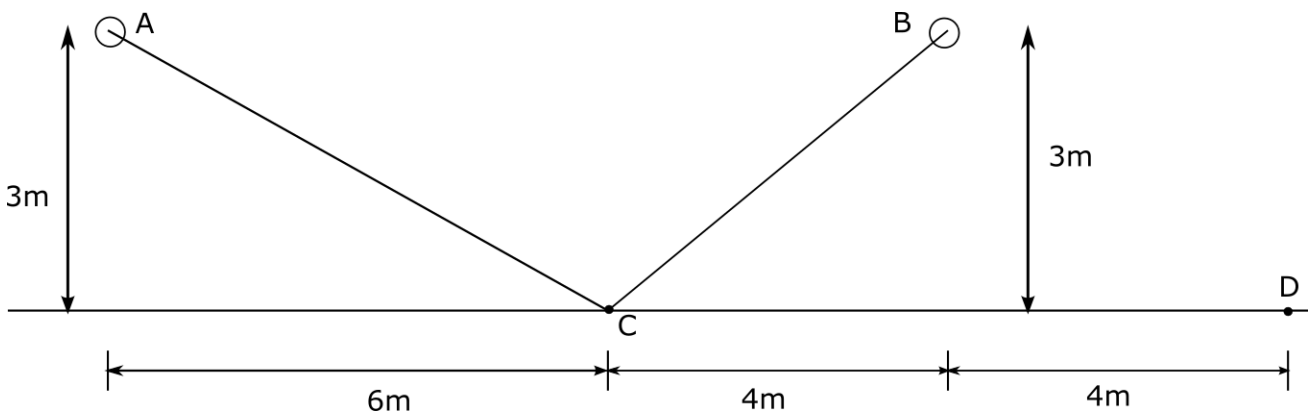
Prob 2.6) The air gap power of a 50Hz, 4 pole, 3-phase induction motor is 120 kW. The rotor emf has a frequency of 3 Hz. What is the rotor speed (in rpm) and the rotor copper losses? All other losses are neglected.

Problem 3: (10 marks)

A 3 phase induction motor is to be operated using a control circuit. The wiring diagram for the control circuit needs to be designed. Draw a control wiring diagram with correct marking for equipment and meeting the following specifications. You need not draw the motor power diagram.

- The motor should be started by the operator by pressing a START switch momentarily. When the motor is running, then a green lamp should glow. (2)
- The motor should be stopped by the operator by pressing a STOP switch momentarily. When the motor is stopped, then a red lamp should glow. (2)
- The motor should be tripped when a sustained overload happens. (1)
- The motor can be started from 3 locations but can be stopped only from one location. (3)
- Minimum number of components to be used in the diagram. (2)

Problem 4: (10 marks)



Two lamps are suspended 10m apart at points A and B at a height of 3m above a surface. The light source at A has a light intensity of 100 cd while the light source at B has a light intensity of 50 cd.

- (a) What is the illuminance on the surface at C?
- (b) What is the illuminance on the surface at D?