

**University of Ruhuna- Faculty of Technology****Bachelor of Engineering Technology Honours Degree****Level 3 (Semester I) Examination, July 2023****Academic year 2021/2022****Course Unit: ENT3112 Electrical Power Systems****Duration: 2 hours**

- 
- Closed book examination.
  - All symbols have their usual meanings.
  - Answer all **Four (04)** questions.
  - This paper contains four questions on **four (04)** pages.
  - Calculators are allowed for this examination.

1)

- a) List down **two** renewable energy sources and **two** non-renewable energy sources.  
(4 marks)
- b) Write down **two** reasons why electrical energy is more suitable than other forms of energy for power systems.  
(2 marks)
- c) Draw the flow diagram of a **steam turbine power plant** to illustrate the working principle.  
(5 marks)
- d) Explain the **three** types of hydro power plants based on construction.  
(6 marks)
- e) A power plant is located at a mean head of 30 m and has a catchment area of 5000 km<sup>2</sup> with an estimated average annual rainfall of 1.25 m. (Density of water - 1000 kgm<sup>-3</sup> and Acceleration of Gravity - 9.81 ms<sup>-2</sup>)
  - i) Calculate the average power in kW that can be generated from a hydro-electric project considering generator and turbine overall efficiency as 70 %.
  - ii) If the load factor is 40 %, calculate the rating of installed generators.  
(8 marks)

2)

a) List **two** properties of conducting materials used for overhead line alternating current (AC) transmission.

(2 marks)

b) Explain **two** reasons why the direct current (DC) transmission is more suitable than alternating current (AC) transmission for long distance.

(4 marks)

c) Draw a single line diagram of a three-phase, 50 Hz grid substation consisting of a step-down transformer, two circuit breakers, two isolators, a surge arrester, two voltage transformers, and four current transformers.

(10 marks)

d) Large scale capacitor banks are located near to a grid substation. Give two reasons for that.

(4 marks)

e) A three phase, 4 kW induction motor has a power factor of 0.77 lagging. A capacitors bank is connected across the supply terminals to increase the power factor up to 0.95 lagging. Determine the kVAR rating of the capacitors connected.

(5 marks)

3)

a) Write down the most common earthing system used in Sri Lanka and draw the circuit diagram of that earthing system.

(5 marks)

b) Describe the function and the tripping mechanism of a Miniature circuit breaker (MCB).

(4 marks)

c) Write down **two** main parameters that a utility company should take into account when planning electricity tariffs.

(4 marks)

- d) Table 01 and Table 02 give rates applied to supplies at each individual point of supply delivered and metered at 400/230 V nominal and where the contract demand exceeds 42 kVA. Calculate the monthly payment for the customer.

Table 01: Rates applied to supplies.

Time Intervals	Energy Charge (LKR/kW)	Fixed Charge (LKR/month)	Demand Charge per month (LKR/kVA)
Peak (18.30-22.30 hrs)	40.00	5000.00	1500.00
Day (5.30-18.30 hrs)	37.00		
Off-peak (22.30 – 5.30 hrs)	34.00		

Table 02: Units measured in each interval for the month under consideration.

Time Intervals	Units (kWh)
Peak (18.30-22.30 hrs) (kW)	200
Day (5.30-18.30 hrs) (kW)	520
Off-peak (22.30 – 5.30 hrs) (kW)	150
kVA	110

(5 marks)

- e) An electric supply company having a maximum load of 50 MW generates  $18 \times 10^7$  units (kWh) per annually and the supply consumers have an aggregate demand of 75 MW.

The annual expenses including capital charges are:

For fuel = Rs 90 lakhs,

Fixed charges concerning generation = Rs 28 lakhs,

Fixed charges concerning transmission = Rs 32 lakhs and distribution

Assume 90% of the fuel cost is essential to running charges. The loss in the transmission and the distribution is 15% from kWh generated. Deduce a two-part tariff to find the actual cost of supply to the consumers.

(7 marks)

4)

- a) Explain the importance of an Environment Impact Assessment (EIA). (2 marks)
- b) Briefly explain two environmental impacts caused by the construction of hydro power station with an option for mitigation. (4 marks)
- c) Explain two common problems when renewable energy is used as an electricity generating source. (4 marks)
- d) A power station has to meet the following demand for different groups.  
Group A: 200 kW between 8 A.M. and 6 P.M.  
Group B: 100 kW between 6 A.M. and 10 A.M.  
Group C: 50 kW between 6 A.M. and 10 A.M.  
Group D: 100 kW between 10 A.M. and 6 P.M. and then between 6 P.M. and 6 A.M.
- i) Draw daily load curve and load duration curve according to the given details.
- ii) Determine
- a. Maximum demand
  - b. Average demand
  - c. load factor
  - d. Diversity factor
  - e. Annual energy production
- (15 marks)

.....End of the paper.....