



UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 6 Examination in Engineering: December 2016

Module Number: EE6205

Module Name: Energy and Environment

[Three Hours]

[Answer all questions, each question carries 12 marks]

- Q1. a) i) What are the major hydro power complexes in Sri Lanka? Name two power plants in each complex.
- ii) State the objective behind establishing Sri Lanka Sustainable Energy Authority (SLSEA).
- iii) Discuss why Sri Lankan government recently decided to suspend the proposed Sampur coal-fired power plant project.
- [5.5 Marks]
- b) i) Briefly explain why income elasticity of energy demand in a developed country is relatively low compared to a developing country.
- ii) The cross price elasticity of demand of three products A, B and C referred to the price of electricity are given as 0, 1.4 and (-2.2) respectively. Comment on the three products and name one possible example for each.
- iii) Some energy-economy related data for two countries X and Y are given in Table Q1. Compare the energy utilization in X and Y in terms of energy intensity values and energy intensity index values. Take 2012 as the base year.

Table Q1

Year	Country X	Country Y
2012	Energy Intensity = 10.2 toe/ LKR million	Energy Intensity = 7.2 toe/ LKR million
2016	GDP = LKR billion 5,100 Energy consumption = 4.42×10^7 toe	GDP = LKR billion 15,300 Energy consumption = 1.15×10^8 toe

[6.5 Marks]

- Q2 a) i) Name four factors that need to be considered when designing a day lighting system for a building.
- ii) Briefly explain two methods that can be used to increase the efficiency of a system with electrical motors.
- iii) A 15 hp centrifugal pump with a nominal efficiency of 92% operates 1,500 hours annually at its rated speed. A throttling valve is used to regulate the flow to 60% on average. Calculate the electricity saving per year if the throttling valve is replaced with an Adjustable Speed Drive (ASD) with an efficiency of 95%. State the assumptions you make.

[5.5 Marks]

- b) i) State three power factor improvement methods.
- ii) A 3-phase, 50 Hz, 415 V motor delivers an output of 100 hp at a power factor of 0.72 lagging and efficiency of 92%. A bank of capacitors is connected in delta across the supply terminals where each of the capacitor units is built with five 1.2 mF capacitance connected in series. Calculate the new power factor if the total power loss in the capacitor bank is 4 kW.
- iii) Explain the three stages of an energy audit process.

[6.5 Marks]

- Q3. a) i) State four advantages of an interconnected grid system.
- ii) What are the factors that need to be considered when selecting base power plants and peak power plants? Briefly explain whether you agree or not with the present practices used in Sri Lanka.
- iii) The annual generation cost of a power station is represented by the formula Rs. $(a + b.kW + c.kWh)$ where the each term has its usual meaning. Calculate the values of a, b and c for a power station with an installed capacity of 200 MW, utilization factor of 0.8, annual load factor of 35% and following cost details.

- Wages of operating staff is Rs 4.2 million per annum
- Wages of clerical staff is Rs 1.8 million per annum
- Annual cost of fuel, lubrication oil and repairs is Rs 37 million
- Capital cost of building and equipment is Rs 80 million
- The annual interest on building and equipment is 15%
- Total fixed cost is Rs 7.3 million
- Scrap value of building and equipment after 25 years is Rs. 3 million

Use sinking fund method to calculate the annual depreciation charge with a compounded interest rate of 10%.

[6.0 Marks]

b) Human induced global warming is one of the most significant threats facing the world today.

- i) Explain the effects of global warming.
- ii) Discuss possible mitigation options related to global warming.

[3.0 Marks]

c) i) Name the current economic model in Sri Lankan energy sector and discuss the drawbacks of this model.

- ii) "In order to achieve a high economic efficiency for energy sector, a proven regulatory body is a must." Comment on this statement.

[3.0 Marks]

Q4 a) i) Classify the hydro-electric power plants based on the nature of the load.

ii) Describe the safety measures implemented for the safe operation of a hydro power plant.

iii) Explain the water hammer phenomenon with respect to hydro-electric power plants and state how this problem is overcome in a hydro-electric power plant.

iv) Briefly describe the different types of dams which can be constructed in a hydro-electric power station.

v) Hydro-electric power projects have both positive and negative socio economic impacts. Comment on this statement.

[9.0 Marks]

b) i) Explain what is meant by nuclear fission.

ii) What is the purpose of using a moderator in a nuclear power plant?

iii) Explain the importance of maintaining a controlled nuclear fission and how it is achieved in a nuclear power plant.

[3.0 Marks]

Q5 a) i) Define the term 'thermal efficiency'.

ii) Explain why the thermal efficiency of a steam power plant is low.

iii) Graphically illustrate the effects of increased pressure and temperature on the efficiency and cost of a steam power plant.

iv) Compare and contrast the condensing and non-condensing type steam power plants.

v) A steam power station with a capacity of 100 MW uses coal of calorific value 6400 kCal/kg. The thermal efficiency of the station is 30% and electrical generation efficiency is 92%. Determine the coal requirement per hour when the plant is working at full load.

[7.0 Marks]

- b) i) Draw the schematic diagram of a simple gas turbine power plant.
- ii) Explain how the efficiency of a simple gas turbine power plant can be improved.
- iii) What is a closed cycle power plant?
- iv) Explain the advantages of a closed cycle power plant over an open cycle gas turbine power plant.

[5.0 Marks]