

**Centre for Energy Studies**  
**Indian Institute of Technology Delhi**  
**ESL 750: Economics and Planning of Energy Systems**

**Time: One Hour**

**Minor Test - I (2014-2015 batch)**

**Maximum Marks: 20**

*Please answer all questions. The marks assigned to each question for the purpose of evaluation are indicated within square brackets at the end of the question. In case any additional information is required to solve the numerical question(s), please make suitable assumption(s) and mention the same explicitly in your answer to the question(s).*

1. Explain the relevance of internalizing economic considerations in
  - (a) Deciding the thickness of insulation around a hot water storage tank
  - (b) Deciding the spacing between risers of flat plate solar collector [4]
2. Explain the difference(s) between (any three)
  - (a) Inferior and Superior Goods
  - (b) Compliments and Substitute Goods
  - (c) Fossil Energy Replacement Ratio and Petroleum Replacement Ratio
  - (d) Physical Control and Pricing as Energy Policy Measures [3]
3. A country is envisaging to install coal based additional thermal power generation capacity of 75000 MW. The plants are expected to use coal of calorific value 20MJ/kg, carbon fraction 0.55, ash content 35% and average annual coal utilization efficiency of 35%. Estimate the following for the additional power generation capacity based on coal if the new capacity installed is expected to operate with an average annual capacity utilization factor of 0.96:
  - (a) Annual incremental amount of coal required
  - (b) Annual amount of carbon dioxide emissions likely to be released into the atmosphere
  - (c) Annual amount of ash likely to be produced. If 50m high cylindrical storage ponds are to be used for storing the ash produced, estimate the land area for storing the ash produced in a period of 40 years (assuming that the ash is not being used for any productive purposes). [4]
4.
  - (a) A 100 lpd domestic solar water heating system is expected to save 2000 kWh annually and the current unit price of electricity is Rs. 5.00 per kWh. While the annual amount of electricity saved is likely to reduce by 0.5% every year during the 25 year useful life of the solar water heating system, the unit price of electricity is likely to increase at an annual rate of 10%. Estimate the annual monetary benefits likely to accrue to the user of the solar water heating system during 20<sup>th</sup> year of its operation.
  - (b) The calorific value of methane is 38 MJ/m<sup>3</sup>. If biogas produced by anaerobic digestion of cattle manure contains 60% methane, determine its calorific value.
  - (c) A household can earn assured return at the rate of 15% annually on the investment made. The prevailing rate of inflation is 4% per year. Estimate the time value of money for the household.
  - (d) The energy embodied in a box type solar cooker is estimated at 24000 MJ and its useful life is expected to be 12 years. What should be the minimum acceptable value of net annual energy delivered by the solar cooker for its energetic feasibility?
  - (e) The efficiency of solar energy utilization in a basin type solar distillation unit is 45%. If the daily solar radiation availability is 5.0 kWh/m<sup>2</sup> and the latent heat of vaporization of water is 2.25 MJ/kg, determine the solar collection area required to produce 36 kilograms of distilled water daily.
  - (f) LPG (calorific value 42 MJ/kg) is used in a burner having an efficiency of utilization of 50%. If the cost of a 14 kg LPG cylinder is Rs. 882.00 determine the contribution of LPG use to the unit cost of useful thermal energy delivered by the combustion of LPG in the burner.
  - (g) For a 150 MW (peak) capacity plant, what would be the reduction in the land area required for installation of solar cells if solar cells with an efficiency of 30% are to be used in place of 15% efficient solar cells?
  - (h) It is proposed to operate a 100 MW capacity fuel-wood fired power plant with an annual capacity utilization of 96%. Wood with a calorific value of 16 MJ/kg is used in the power plant with an efficiency of utilization of 30%. Determine the area of a fuel-wood plantation that would meet the fuel-wood requirement of the plant if the annual sustainable yield of fuel-wood is 2000 kg per hectare of plantation.
  - (i) Households in a village own 120 cattle and each cattle discharges 15 kg cattle dung on a daily basis. The degree of confinement of the cattle is 0.8 and 8% cattle dung is lost during collection in the cattle shed. If 10% cattle dung is diverted to other applications at the household level determine the size (daily biogas production capacity) of a community biogas plant that uses the entire amount of 25 kg dung is to be fed to the biogas plant on daily basis for each cubic meter of the daily biogas production capacity. [9]