

INDIAN INSTITUTE OF TECHNOLOGY DELHI

Centre for Energy Studies

Major Test: ESL 330 (Energy Ecology and Environment)

Time: Two Hours

Semester I; 2008-2009

Maximum Marks: 40

Note: 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 (Please note that the total marks obtained out of 80 marks shall be normalized for the actual weightage of 40 marks for the Major test).

1. A hundred litre per day capacity domestic solar water heating system costs Rs. 30,000 to purchase and install. On an average basis it is used to heat 100 kg water from 15 °C to 60 °C on 200 days of the year thus saving electricity being used with an efficiency of 95% in an electric geyser. The electricity saved is produced in a coal thermal power plant operating with an overall efficiency of 30%. The unit cost of electricity for the user is Rs. 2.00 per kWh. Estimate the cost of CO₂ emissions mitigation with the use of the domestic solar water heating system if the calorific value of the coal used in electricity generation is 20 MJ per kg and its carbon fraction is 0.70. Assume that the useful life of the domestic solar water heating system is 20 years, the discount rate is 10% and that the prevailing transmission and distribution losses of electricity are 20%. Also ignore the embodied emissions in the domestic solar water heating system. [10]
2. A kerosene stove using family has a daily useful energy demand for cooking of 15 MJ. It replaces its existing stove by new energy efficient kerosene stove to improve the efficiency of kerosene utilization from 40% to 60%. At the same time the family decides to use a solar cooker also, which on an annual average basis, meets 30% of the useful energy demand for cooking. Ignoring the greenhouse gas emissions embodied in the new kerosene stove as well as that embodied in the solar cooker, estimate the total amount of CO₂ emissions mitigated annually due to the use of the two devices. [8]
3. A country envisages achieving an annual GDP growth rate of 8%. The energy GDP elasticity of the country is 1.2 and the incremental energy demand is to be met with the consumption of coal (calorific value 20 MJ per kg, carbon fraction 0.60). Estimate the incremental amount of carbon dioxide expected to be released during the next year in the country if the current primary energy demand of the country is 1250 PJ. [6]
4. Estimate the amount of carbon emissions per PJ of primary energy delivered by coal (calorific value 20 MJ per kg, carbon fraction of 0.60), butane (calorific value of 44 MJ per kg), natural gas (methane with calorific value of 46 MJ per kg) and octane (calorific value 42 MJ per kg). A country envisages replacing coal by natural gas in its industrial operations to meet primary energy demand of 30000 PJ. Estimate the amount of CO₂ emissions likely to be mitigated. [8]
5. The total mass of air in the atmosphere is 5.1×10^{18} kg. The density of air at standard temperature and pressure is 1.29 kg/m³. Estimate the tones of carbon in the atmosphere corresponding to a CO₂ concentration of 370 ppm (in 2000 AD). If the concentration of CO₂ was 280 ppm in 1850 AD and a total of 300 giga tonnes of carbon was released into the atmosphere between 1850 and 2000 AD, estimate the airborne fraction of carbon. [8]
6. What is clean development mechanism? Discuss the reasons justifying the need for such an arrangement. [6]
7. Why an exponential growth in the production of a depletable resource is not possible in the long term? Suggest an alternative more likely production curve for such a resource and discuss its important characteristics. [8]
8. Describe the condition(s) under which the use of a renewable energy technology would become a "No Regrets Option" for mitigation of carbon dioxide emissions. [4]
9. Discuss the relevance of embodied emissions in estimating the greenhouse gas mitigation potential of renewable energy technologies. [4]
10. Describe a model for estimating the average temperature of earth with its latitude dependence. Also discuss its strength and limitations. [6]
11. Explain the differences between
 - (a) Joint Implementation and Clean Development Mechanism
 - (b) Man subsidized solar powered ecosystems and Fuel powered urban industrial systems
 - (c) Spatial and economic implications of urbanization
 - (d) Energy efficiency and renewable energy utilization options (for mitigation of environmental emissions)
 - (e) Diversification of end use innovations and diversification of energy supply (as reasons for increase in environmental emissions)
 - (f) Threat to human health and safety and damage to economic resources (as the effects of environmental emissions)[12]