## Centre for Energy Studies
## INDIAN INSTITUTE OF TECHNOLOGY DELHI

### ESL: 750: Economics and Planning of Energy Systems

*Time: Two Hours*          *Major Test*          *Maximum Marks: 50*

Note: Please answer all questions. Marks assigned to each question are indicated at the end of the question within brackets.

1.  The present per capita annual primary energy consumption in a country is 10750 MJ. Estimate the likely value of the annual primary energy consumption per capita four years later if the GDP of the country is expected to grow at a rate of 8% and the energy-GDP elasticity is 1.05.          [3]

2.  Determine the equivalent primary energy demand for pumping 500 m³ of water using an electric pump from a 30 m deep well with the following information.
    (a)  the efficiency of the electric motor pump is 75%
    (b)  electrical transmission and distribution losses are estimated at 20%.
    (c)  electricity is generated in coal thermal power plants at an efficiency of 40%.          [3]

3.  A rural household is planning to replace its traditional biomass cookstove by an improved biomass cookstove. Estimate the amount of primary energy saved due to such a replacement using the following information.
    (a)  there are five adult members in the household
    (b)  each family member needs a daily useful energy of 2.5 MJ for cooking.
    (c)  biomass with a calorific value of 15 MJ/kg is used for cooking
    (d)  the efficiency of biomass utilization in the traditional stove is 10% and it is 30% with the improved cookstove
    (e)  the cooking is undertaken 365 days of the year.          [4]

4.  A box type cooker costs Rs. 5000/- and, on an average basis (over the year), saves 200 ml of kerosene daily. For a discount rate of 10% and an estimated useful life of 10 years of the solar cooker, determine the price of kerosene for which the lifecycle cumulative present values of costs and benefits are equal. Assume that the annual operation, maintenance and repair costs of the solar cooker are negligible.          [3]

5.  The intersectoral and other transaction details of a hypothetical two- sector economy are given below:

    |          | Sector 1 | Sector 2 | Final Demand |
    |----------|----------|----------|--------------|
    | Sector 1 | 1000     | 2000     | 17000        |
    | Sector 2 | 3000     | 4000     | 33000        |

    What should be the required gross outputs of Sector 1 and Sector 2 if their final demands are changed to 20,000 and 50,000 units respectively?

    It is given that $\begin{bmatrix} 0.95 & -0.05 \\ -0.15 & 0.90 \end{bmatrix}^{-1} = \begin{bmatrix} 1.154 & 0.064 \\ 0.192 & 1.218 \end{bmatrix}$          [4]

6.  An economy presently produces one million metric tonnes of steel at an average energy cost of 80 MJ/kg with an overall energy utilization efficiency of 40%. Estimate the primary energy consumption of the steel industry three years later if the steel demand is expected to grow at a uniform annual rate of 5% and the energy utilization efficiency of the industry is expected to improve by 25% of its current value in the third year. **[3]**

7.  **Please explain difference(s) between**
    (a)  Behavioural reaction and Efficiency reaction (of consumers to change in the price of a commodity).
    (b)  Availability of Renewable and Non-renewable energy resources.
    (c)  Future trends in marginal cost of production of Renewable and Non-renewable energy sources.
    (d)  Inter-fuel and Interfactor substitution.
    (e)  Trend analysis and Econometric methods of energy demand forecasting.
    (f)  Simple payable period and Discounted payback period.
    (g)  Cross Elasticity of Energy Demand and Price Elasticity of Energy Demand.
    (h)  Physical control and Pricing (as energy policy instruments).
    (i)  Inferior and Superior goods.
    (j)  Useful energy and Final energy. **[10]**

8.  **Please explain why**
    (a)  Knowledge of Price Elasticity of Energy Demand and the Cross Elasticity of Energy Demand is necessary for using energy pricing as a policy instrument?
    (b)  effect of possible escalation in the price(s) of fuel(s) in future must be included in financial evaluation studies of renewable energy systems?
    (c)  market prices of fossil fuels may include scarcity rent?
    (d)  energy pricing often necessitates a compromise between mutually conflicting objectives?
    (e)  pricing of petroleum fuels requires consideration/adjustment at different interfaces?
    (f)  a sensitivity analysis is often carried out as a part of financial/economic evaluation exercise?
    (g)  it is necessary to provide information about the spatial, temporal and quality related aspects of energy demand besides the quantity of energy consumed?
    (h)  using a single energy intensity value for the entire economy is erroneous?
    (i)  electricity pricing should include time of use considerations?
    (j)  users of coal located far off from the mines may prefer to use higher grade coals? **[10]**

9.  Derive an expression for the present worth factor if the cash flows are in geometric progression. Give an example of its use in financial evaluation of a renewable energy system. **[3]**

10. Briefly discuss the possible effects of energy price increase and/or restricted energy availability on the economy. **[4]**

11. What are the limitation(s) of Input-Output table based energy demand forecasting method. **[3]**