

**PRINCIPLES OF SUSTAINABLE ENGINEERING  
(CIV3121)**

**Time Allotted : 2½ hrs**

**Full Marks : 60**

*Figures out of the right margin indicate full marks.*

*Candidates are required to answer Group A and  
any 4 (four) from Group B to E, taking one from each group.*

*Candidates are required to give answer in their own words as far as practicable.*

**Group – A**

1. Answer any twelve:

**12 × 1 = 12**

*Choose the correct alternative for the following*

- (i) What is the main purpose of a "circular economy" in Sustainable Engineering?  
(a) To maximize resource extraction  
(b) To minimize waste and pollution by keeping materials in use for as long as possible  
(c) To encourage the use of single-use products  
(d) To prioritize economic growth over environmental protection
- (ii) The main objective of the Air (Prevention and Control of Pollution) Act, 1981 is to:  
(a) Regulate nuclear energy (b) Promote vehicular emissions  
(c) Control and prevent air pollution (d) Increase greenhouse gases
- (iii) Which of the following is NOT a green building material?  
(a) Fly ash bricks (b) Bamboo  
(c) Recycled concrete (d) Asbestos sheets
- (iv) Which of the following green building rating systems is Indian?  
(a) LEED (b) IGBC (c) BREEAM (d) Green Star
- (v) Which of the following concepts reduces the urban heat island effect?  
(a) Dark-coloured pavements (b) Green roofs and reflective pavements  
(c) Excessive use of asphalt (d) Removal of urban vegetation
- (vi) Solid waste mainly refers to:  
(a) Liquid wastes discharged from industries  
(b) Unwanted solid materials from human and animal activities  
(c) Gaseous emissions from vehicles  
(d) Ocean water pollution
- (vii) Which gas is responsible for stratospheric ozone depletion?  
(a) Carbon dioxide (b) Methane  
(c) Chlorofluorocarbons (CFCs) (d) Nitrogen

- (viii) In LCA, “cradle to grave” assessment means:  
 (a) From production to marketing  
 (b) From raw material extraction to end-of-life disposal  
 (c) From consumer use to recycling only  
 (d) From cradle manufacturing to cradle disposal
- (ix) As per UNEP programme, in order to keep 1.5°C temperature target alive, the world needs to cut to 2030 emissions by  
 (a) 50%                      (b) 20%                      (c) 80%                      (d) 42%
- (x) A green-certified laptop uses a battery with 50 Wh capacity. If the laptop is charged once daily from the grid (efficiency 90%), the daily and annual energy consumption of the grid (in kWh) :  
 (a) 1.2 kWh and 35 kWh/year                      (b) 0.0556 kWh and 20.29 kWh/year  
 (c) 0.2 kWh and 25 kWh/year                      (d) 1.5 kWh and 20.29 kWh/year

*Fill in the blanks with the correct word*

- (xi) One of the domestic policies aligned with MEA (Multilateral Environmental Agreement) obligations is \_\_\_\_\_.
- (xii) Worldwide agriculture, forestry and other land uses contributes to \_\_\_Gt of global emissions.
- (xiii) India have significantly expanded it’s renewable energy capacity, reaching \_\_\_ GW of non-fossil fuel based power generation.
- (xiv) LEED stands for \_\_\_\_\_.
- (xv) The process of converting waste into useful energy through incineration, gasification, and pyrolysis is called \_\_\_\_\_ conversion.

### **Group - B**

2. (a) Describe the main provisions and objectives of the Water (Prevention and Control of Pollution) Act, 1974 in India. How does it help in maintaining water quality?  
[[CIV3121.1, CIV3121.3, CIV3121.3](Understand/LOCQ)]
- (b) Elaborate on the Air (Prevention and Control of Pollution) Act, 1981. What mechanisms are in place to control air pollution under this Act?  
[[CIV3121.1, CIV3121.3, CIV3121.3](Understand/LOCQ)]
- 6 + 6 = 12**
3. (a) Solve the questions based on Sustainable Engineering:  
 (i) A wind turbine costs ₹12,00,000 and generates 9,000 kWh/year of electricity. The cost of grid electricity is ₹6.50/kWh.  
 Calculate: The energy payback time in years (based on cost savings).
- (ii) A green building uses water-efficient fixtures that reduce water consumption by 40%. If the original water use was 180 liters/person/day, and there are 50 occupants, calculate:  
 Calculate:  
 (a) Water saved per day    (b) Water saved annually  
[[CIV3121.1, CIV3121.3, CIV3121.3, CIV3121.5](Analyze/IOCQ)]

- (b) Elaborately explain the economic trends, carbon emissions and energy use for past 200 years worldwide. [[CIV3121.1](Understand/LOCQ)]  
**(2 + 2) + 8 = 12**

### Group - C

4. (a) Define environmental indicators in LCA, give at-least 4 examples. [[CO3](Analyse/IOCQ)]  
(b) Compare between midpoint and end point indicators with relevant examples. [[CO3](Analyse/IOCQ)]  
**4 + 8 = 12**
5. (a) Explain 'sanitary landfill' and 'incineration'. [[CO6](Analyse/IOCQ)]  
(b) Write in details about two 'waste to energy' technologies. Discuss in details about their differences. [[CO6](Apply/IOCQ)]  
**5 + 7 = 12**

### Group - D

6. Discuss in detail about 6 credit categories used in LEED, which is common among the rating systems. [[CO2, CO5](Analyse/IOCQ)]  
**(6 × 2) = 12**
7. (a) Explain LCC (Life Cycle Costing) in respect to green building. [[CO5, CO3](Apply/IOCQ)]  
(b) What are the different categories in which costs are incurred during the development of a green building. Explain hard cost and soft costs. [[CO5](Apply/IOCQ)]  
**2 + 6 + 4 = 12**

### Group - E

8. (a) Explain the working principle of solar energy systems. What are the major applications and limitations of solar energy in India? [[CIV3121.1, CIV3121.3, CIV3121.4, CIV3121.5, CIV3121.6](Analyse/IOCQ)]  
(b) A household requires 6 kWh/day of electricity. The average solar insolation in the region is 5.5 kWh/m<sup>2</sup>/day and the efficiency of the solar panel system is 18%. Calculate:  
(i) The total energy that can be generated per m<sup>2</sup> per day  
(ii) The total area of solar panels required to meet the household's daily electricity needs [[CIV3121.1, CIV3121.3, CIV3121.4, CIV3121.5, CIV3121.6](Analyse/IOCQ)]  
**(3 + 3) + 6 = 12**
9. (a) Explain the Green Computing. Also mention it's evolution. [[CIV3121.1, CIV3121.3, CIV3121.4, CIV3121.5, CIV3121.6](Understand/LOCQ)]

- (b) How does Green Computing helps in reducing environmental impact of digital technologies? Also vividly mention the objectives, approaches, advantages and disadvantages of Green Computing.

*[(CIV3121.1, CIV3121.3, CIV3121.4, CIV3121.5, CIV3121.6)(Understand/LOCQ)]*

**(3 + 3) + 6 = 12**

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Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	33.33	66.66	0