Indian Institute of Technology Delhi
Centre for Energy Studies
2017-2018
ESL 330: Energy, Ecology and Environment

Minor-II Examination
Duration: 60 minutes

Marks: 20
4th October 2017

Answer all questions

1. (a) Write two important precursors for photochemical oxidants?
   (b) How electricity is generated in a fuel cell vehicle and what are the major exhaust components?
   (c) How sulphur oxides damage the trees?
   (d) Write the advantages and disadvantages of three-way-catalytic converter. **[1+1+1+1]**

2. (a) Explain the strokes of a four stroke internal combustion engine.
   (b) Calculate the stoichiometric ratio for complete combustion of gasoline.
   (c) Find the settling velocity of a spherical droplet of water with diameter 2 μm, and estimate the residence time of such particles if they are uniformly distributed in the lower 1000 m of atmosphere. $\eta = 1.81 \times 10^{-5} \frac{kg}{m\,s}$ **[2+2+2]**

3. (a) Explain the working principle of a reverse-flow cyclone and a duct type electrostatic precipitator (ESP) with diagrams. **[2+2]**
   (b) A horizontal parallel-plate or duct type ESP consists of a single-duct 7 m high and 6 m deep (length) with a 0.3 m plate-to-plate spacing. A collection efficiency of 90% is obtained with a flow rate of 2 m^3/s. The inlet loading is 100 gr/m^3. Calculate the following:
   (i) The bulk velocity of the gas (assume a uniform distribution)
   (ii) The outlet loading. **[1+1]**

4. Suppose within a square city having length L on each side, pollutants are emitted at a rate of q_s per unit area. The mixing height is restricted to H and the wind is bringing clean air at a steady speed u along an edge of the city. Using a box model show that pollutant concentration $C(t)$ at time t can be derived as $C(t) = C_0(1 - exp(-\alpha t))$, where $C_0 = q_s L/uH$ and $\alpha = u/L$. Assume that the initial (at $t=0$) pollutant concentration is zero, the pollutant emitted are conservative and that there is complete and instantaneous mixing in the box. Draw the necessary diagram. **[3+1]**

$V = \frac{vC_0 - vC}{}$

at time $t = 0$
$C_0 = 0$

at time $t = 1$ s
$C_0 = \frac{q_s \times L^2}{m^2} = \frac{\left(\frac{q_s L^2 g}{s} \times \frac{1}{L^2 H m^3} + \frac{0 g}{m^3} \times u \times L^2 \frac{m^3}{s}\right)}{}$