NON-SOLAR RENEWABLE ENERGY
(REEN 5102)

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) For a 1st order reaction system with rate constant 0.01 s^{-1}, the half-life is equal to _____.
(a) 0.069 s (b) 6.9 s (c) 0.7 s (d) 0.68 s

(ii) Michaelis-Menten constant is the concentration of the substrate at which the rate of the reaction is _____.
(a) maximum (b) becoming constant
(c) half of the maximum reaction rate (d) both (a) and (b)

(iii) The function of impeller within the fermenter is _____
(a) continuous stirring of media
(b) distribution of oxygen throughout the system
(c) to prevent cell from settling down
(d) all of these.

(iv) _____ enzymes are used for delignification process for biomass.
(a) Lignin peroxidase (b) Manganese peroxidase
(c) Laccase (d) All of these

(v) Standard wind turbine blade profiles are in the form of _____
(a) airfoil (b) thin strip (c) thick strip (d) both (b) and (c).

(vi) Cut-in speed is the _____ speed at which a wind turbine starts to produce useful energy.
(a) minimum rotor (b) minimum wind
(c) maximum rotor (d) maximum blade tip

(vii) Proximate analysis of lignocellulosic biomass includes the measurement of _____
(a) moisture and ash (b) fixed carbon and volatile matter
(c) moisture and volatile matter (d) both (a) and (b).

(viii) Enzyme inhibition can be categorised as _____.
(a) Competitive (b) Noncompetitive
(c) Uncompetitive (d) All of these

(ix) Which of the following option is not used for algae drying during its harvesting?
(a) Rotary drying (b) Flash drying
(c) Solar drying (d) Freeze drying.

(x) Bacterial microorganisms for bioethanol production is/are _____.
(a) *Zymomonasmobilis* (b) *Pichiastipitis*
(c) *Klebsiellaoxytoca* (d) Both (a) and (c)

Fill in the blanks with the correct word

(xi) Low value of Michaelis-Menten constant ensures substrate-enzyme _____.

(xii) The studies made in hydropower generation are _____, feasibility study and design study.

(xiii) Power in wind is proportional to (velocity)$^{(\_\_)}$.

(xiv) B20 indicates 20% biodiesel is mixed with _____ of petroleum diesel.

(xv) Approximately _____ tons of carbon-di-oxide is required to grow 1 ton of algal biomass.

Group - B

2. (a) Through a refinery, fuel ethanol is flowing in a pipe at a velocity of 1 m/s and a pressure of 101.3 kPa. The refinery needs the ethanol to be at a pressure of 2 atm (202.6kPa) on a lower level. How far must the pipe drop in height in order to achieve this pressure? Assume the velocity does not change. (Hint: Use the Bernoulli equation. The density of ethanol is 789 kg/m^3 and gravity g is 9.8 m/s^2). *[(CO2)(Analyse/HOCQ)]*

(b) What is the basic difference in Rushton type and pitch-blade type impeller? The rotational speed of an impeller inside a bioreactor is 50 rpm, impeller diameter is 0.15 m. If the power number is 6.5, calculate the effective torque generated at the tip of the impeller. *[(CO2)(Analyse/HOCQ)]*

(c) Write the differential form of continuity equation for a fluid flow inside a rectangular box. *[(CO2)(Remember/LOCQ)]*

5 + (2 + 3) + 2 = 12

3. (a) What are the yield coefficients we can analyse in order to understand the efficiency of an aerobic fermentation process? Which one we must not have with anaerobic fermentation? *[(CO1)(Remember/LOCQ)]*

(b) "It is given that during a fermenter design the recommended baffle width is D/12, when Re > 1000, while the baffle width is D/24, when 500 < Re < 1000. D= Tank diameter" - Justify the appropriateness of the statement with proper reasoning. *[(CO2)(Apply/IOCQ)]*

(c) "In case with the noncompetitive inhibition of enzyme, affinity for enzyme remains unchanged even after inhibition, while the maximum reaction rate gets decreased." – Justify the appropriateness of the statement based on the Michaelis-Menten model. *[(CO1)(Apply/IOCQ)]*

(3 + 1) + 4 + 4 = 12

Group - C

4. (a) What are the benefits one can have with steam explosion over mechanical comminution during the pretreatment of lignocellulosic biomass? *[(CO3)(Remember/LOCQ)]*

(b) "A large variation in dry solid output (~2-27%) during the harvesting of algal species with filtration attributes to the molecular size of the species and the efficiency of the filtration process" – Justify the appropriateness of the statement. *[(CO3)(Apply/IOCQ)]*

(c) What are the limitations of open pond culture for algal growth? *[(CO3)(Remember/LOCQ)]*

3 + 4 + 5 = 12

5. (a) Elaborate bubble column and stirred tank bioreactors along with the diagram. *[(CO3)(Remember/LOCQ)]*

(b) Write down the starch to ethanol conversion reactions with *Saccharomyces cerevisiae.* *[(CO3)(Remember/LOCQ)]*

(3 + 3 + 2 + 2) + 2 = 12

Group - D

6. (a) Explain the significance of wind speed vs. duration curve for energy estimation at a specific location. *[(CO2)(Analyse/IOCQ)]*

(b) With the help of a neat sketch, describe the yawing mechanism of wind turbine. *[(CO2)(Remember/LOCQ)]*

6 + 6 = 12

7. (a) In what ways generation and transmission efficiencies may affect the wind energy production? *[(CO2)(Analyse/IOCQ)]*

(b) Write brief notes on:
(i) Shadow flicker, (ii) SCADA system. *[(CO2)(Remember/LOCQ)]*

6 + (3 + 3) = 12

Group - E

8. (a) A Pelton wheel has a mean bucket speed of 10 m/s with a jet of water flowing at the rate of 0.7 m^3/s under a head of 30 m. The buckets deflect the jet through an angle of 160°. Calculate the power given by water to the runner and the hydraulic efficiency of the turbine. Assume the coefficient of nozzle as 0.98 and g=10 m/s^2. *[(CO4)(Analyse/HOCQ)]*

(b) What is the significance of specific speed of turbine? *[(CO4)(Apply/IOCQ)]*

(c) What are the functions of penstocks and tailrace in hydropower plant?

[(CO4)(Remember/LOCQ)]

6 + 3 + 3 = 12

9. (a) What are the differences we have between Francis and Kaplan turbine?

[(CO4)(Remember/LOCQ)]

(b) With a Kaplan turbine developing power of 9100 kW, net available head is 0.56 m, speed ratio is 2.09, flow ratio is 0.68, efficiency is equal to 86% and diameter of boss is 1/3rd diameter of runner. Find the diameter of runner and its speed.

[(CO4)(Analyse/HOCQ)]

(c) What is surge tank and why it is important in Dam? *[(CO4)(Remember/LOCQ)]*

4 + 6 + (1 + 1) = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	48.96	28.12	22.92

Course Outcome (CO):

After the completion of the course students will be able to

1. Solve the fundamentals of reaction engineering problem as applicable to biomass energy.
2. Understand basic fluid flow phenomena for the application in wind turbine and hydro power etc.
3. Identify different technologies in generating energy from biomass.
4. Describe the process used in harnessing and implementation of wind energy.
5. Categorize hydraulic turbines in generating hydropower.

**LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.*