M.TECH/RE/1ST SEM/REEN 5102/2021

NON-SOLAR RENEWABLE ENERGY
(REEN 5102)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

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

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) Monod constant, K_s, is equal to substrate concentration where the specific growth rate is _____ of the maximum specific growth rate
(a) 50% (b) 33% (c) 25% (d) 10%

(ii) Michaelis-Menten constant value mostly lies between _____
(a) 1 and 0.1 (b) 0.1 and 0.01
(c) 0.01 and 0.000001 (d) 0.1 and 0.000001

(iii) Maximum specific growth rate is specified, when _____. S: Substrate concentration; K_s: Monod constant
(a) $S>K_s$ (b) $S>>K_s$ (c) $S=K_s$ (d) both (a) and (c)

(iv) During harvesting of *Chlorella vulgaris* with nano-aminoclays recovery efficiency is around _____
(a) 99% (b) 80% (c) 70% (d) 85%

(v) PAH generation is below 20% _____.
(a) with B100 biodiesel (b) with B20 biodiesel
(c) with both B20 and B100 (d) with 85% ethanol blended B20

(vi) Tip speed ratio of a wind turbine is the ratio between
(a) blade tip speed and rotor angular speed
(b) blade tip speed and incoming wind speed
(c) rotor angular speed and incoming wind speed
(d) rotor angular speed and downstream wind speed

(vii) The power available in the wind will be _____ , if the wind speed is doubled
(a) doubled (b) 4 times (c) 8 times (d) 16 times

(viii) The wind turbine rotor having a low value of solidity _____
(a) runs slower (b)runs faster
(c)produces high torque (d) has low efficiency

(ix) Subcritical flow in an open channel is defined, where the Froude number is _____
(a) less than 1 (b) more than 1
(c) equal to 1 (d) both (b) and (c)

(x) Francis turbine operating below _____ of rated discharge is prone to vibration and/or power surges.
(a) 40% (b) 30% (c)50% (d) 60%

Group - B

2. (a) What are the factors that influence the rate of a chemical reaction? [(CO1) (Remember/LOCQ)]

(b) For a first order chemical reaction, below table is showing the average rate variation with the reactants present at that instant. F ind out the half-life for the reaction.

Reactant's concentration (M)	0.1	0.0905	0.082	0.0741	0.0671	0.0549
Average rate of the reaction (M/s)x10^4	1.9	1.7	1.6	1.4	1.22	1.01

[(CO1) (Apply/IOCQ)]

(c) "If an enzyme can catalyze a reaction with two similar substrates (e.g., glucose and fructose) in the cell, it will prefer that substrate for which the enzyme has lower K_M value." – Comment on the appropriateness of the statement after constructing the Michelis-Menten model for an enzymatic reaction. [(CO1) (Evaluate/HOCQ)]

3 + 5 + 4 = 12

3. (a) What are different types of enzyme inhibitions one can identify in an enzymatic reaction? [(CO1) (Understand/LOCQ)]

(b) A microorganism is growing at its maximum specific growth rate. The conditions are the following.

Time (d)	0	1	2	3	4	5
Biomass (mg/L)	50	75	111	166	248	369

Calculate the maximum specific growth rate and the population size after 25 days (Assume that the same maximum specific growth rate conditions are maintained). [(CO1) (Apply/IOCQ)]

(c) "A PFR can be approximated as the infinite CSTRs in series." – Justify the appropriateness of the statement based on the material balance against PFR. [(CO1) (Create/HOCQ)]

3 + (3 + 2) + 4 = 12

Group - C

4. (a) Make a comparative analysis on the limitations we have with flat-plate and tubular photobioreactor. [(CO3) (Understand/LOCQ)]
   (b) 50 g of lignocellulosic biomass was taken for proximate analysis and kept in a hot air oven at 105°C for 2 h. 20% weight loss was seen after drying in the oven. When the sample was kept in muffle furnace at around 950°C, there is around 30% weight loss.At the end of the analysis 7 g of ash was obtained. Find out the percentage of volatile matter, ash and fixed carbon on dry basis. [(CO3) (Apply/IOCQ)]
   (c) In a gasifier-engine arrangement, what are the operational hazards that can be felt if the cooler will be installed before cyclone separator? Explain with a schematic diagram for gasifier-engine arrangement. [(CO3)(Evaluate/HOCQ)]

3 + 5 + 4 = 12

5. (a) What are the equilibrium reactions that can be observed in a gasifier? [(CO3) (Remember/LOCQ)]
   (b) "Hydrogen production is obvious in case with the metabolism within green algae. However, evolution of biohydrogen will not lower the demand to supply ratio" – Justify the appropriateness of the first statement and explain why the produced hydrogen fails to meet the ratio. [(CO3) (Analyze/IOCQ)]
   (c) "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)(Evaluate/HOCQ)]

3 + (3 + 2) + 4 = 12

Group - D

6. (a) Briefly describe the wind energy estimation methodology based on mean wind speed data over the year. [(CO4) (Understand/LOCQ)]
   (b) Why wind speed increases with elevation? [(CO4) (Analyze/IOCQ)]
   (c) Find out the annual energy output from a typical power density vs. duration curve considering inputs like cut-in and cut-out speeds. [(CO4) (Evaluate/HOCQ)]

5 + 3 + 4 = 12

7. (a) Briefly describe the importance of pitch controlling mechanism in wind turbines. [(CO2) (Understand/LOCQ)]
   (b) Why small wind turbines rotate faster than large wind turbines? [(CO2) (Analyze/IOCQ)]
   (c) Evaluate the merits and demerits of SCADA system for wind farms. [(CO2) (Evaluate/HOCQ)]

3 + 4 + 5 = 12

Group - E

8. (a) A storm over a catchment of area 5 km^2 had a duration of 14 hrs. The mass curve of rainfall of the storm is as follows:

Time from start of storm (h)	0	2	4	6	8	10	12	14
Accumulated rainfall (cm)	0	0.6	2.8	5.2	6.6	7.5	9.2	9.6

If the ϕ index of the catchment is 0.4 cm/h, determine the volume of the direct runoff from the catchment due to storm. [(CO4) (Apply/IOCQ)]

(b) Classify the micro, mini and small hydro projects based on their installed capacity limit. [(CO4) (Evaluate/HOCQ)]

(c) What is power evacuation and how it impedes small hydro projects development? [(CO4)(Understand/LOCQ)]

6 + 3 + 3 = 12

9. (a) The water available for a Pelton wheel is 4 m^3/s and the total head from reservoirto the nozzle is 250 m. The turbine has two runners with two jets per runner. Allthe four jets have the same diameters. The pipeline is 3000 m long. The efficiency, if power transmission through the pipeline and the nozzle is 91% and efficiency of each runner is 90%. The velocity coefficient of each nozzle is 0.975and coefficient of friction 4f for the pipe is 0.0045. Determine the power developed by the turbine and the diameter of the jet. [(CO4) (Apply/IOCQ)]

(b) Why the draft tube is a divergent tube, not a convergent one, at the outlet of the turbine? [(CO4) (Evaluate/HOCQ)]

(c) What is the difference between reaction and impulse turbines? [(CO4) (Remember/LOCQ)]

6 + 3 + 3 = 12

LINEAR GRAPH PAPER REQUIRED

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	32.23%	40.62%	27.15%

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

Department & Section	Submission Link
RE	https://classroom.google.com/c/NDIwMjIzMDk3MjI4/a/NDY3OTgwNTE5OTU1/details