Form No. T611

Philadelphia University
Faculty of Engineering

Student Name:
Student Number:

Dept. of Renewable Energy Engineering
Midterm Exam, Second Semester: 2021/2022

Course Title: Bioenergy Systems	**Date: 9/5/2022**
Course No: (611541)	**Time Allowed: 75 Minutes**
Lecturer: Dr. Mohammad Abu-Naser	**No. of Pages: 3**

Question 1: ***(5Mark)***

Objectives: This question is related to Basic Concepts

a) Write the equation of photosynthesis in words and in chemical symbols

Words:

$$\text{Carbon Dioxide} + \text{Water} \rightarrow \text{Glocuse} + \text{Oxygen}$$

Chemical symbols:

$$CO_2 + H_2O \rightarrow C_6H_{12}O_6 + O_2$$

b) Mention the three challenges facing agriculture in general

1. Limited fresh water supply
2. Limited agricultural land
3. Limited fertilizers supply especially phosphorous and potassium and other nutrients

Question 2: ***(5Mark)***

Objectives: This question is related to Biomass Sources

a) Give three examples of starch-based biomass sources

Corn, Cassava, Sweet Potato

b) Give three examples of cellulose-based biomass sources

Bagasse, Wheat straw, switch grass

c) Give two examples of sugar-based biomass sources

Sugarcane, sugar beet

d) Give two examples of oil-based biomass sources

Jatropha, soybean

Question 3: ***(5Mark)***

Objectives: This question is related to Theory of Ethanol Production

a) Write the equation of fermentation in words and in chemical symbols

Words:

$$\text{Glocuse} \rightarrow \text{Ethanol} + \text{Carbon Dioxide}$$

Chemical symbols:

$$C_6H_{12}O_6 \rightarrow C_2H_5OH + CO_2$$

b) Calculate the theoretical ethanol yield from 1 kg of corn which has 25 percent moisture and contains 70 percent starch on a dry basis.

One kg of corn contains: 1kg-0.25kg = 0.75 kg dry mass

Starch content of 1 kg of corn is: 0.7*0.75 = 0.525 kg

Theoretical Ethanol yield from 1 kg of corn is: 0.525 kg * 1.111 * 0.511

= 0.3 kg ethanol/kg corn

Question 4: ***(5Mark)***

Objectives: This question is related to Technologies of Ethanol Production

What are the two technologies for ethanol production from corn? and compare between them in terms of

Name of Technology	Dry Milling	Wet Milling
Capital cost	Lower	Higher
Facility size	Smaller	Larger
Flexibility of products	DDGS, ethanol	More flexible: corn oil, corn gluten meal, corn gluten feed, corn syrups, ethanol
Separation of non-starch components (start, end)	End	Start

Question 5: ***(5Mark)***

Objectives: This question is related to Cellulosic Ethanol Production

Write the main six steps for the biochemical approach of ethanol production from cellulose, and mention the main three challenges that makes it costly a process

Steps:

1. Harvesting
2. Size reduction
3. Pretreatment
4. Cellulose hydrolysis
5. Microbial fermentation
6. Distillation

Challenges:

1. cellulosic biomass sources require new mechanisms for efficient harvesting
2. high energy demand for the mechanical cutting of large/rigid pieces
3. high cost of enzymes (most expensive)

Question 6: ***(5Mark)***

Objectives: This question is related to Theory of Biodiesel Production

a) Mention the main advantages/disadvantages of biodiesel compared to diesel

Advantages

1. Renewable
2. Better lubricity and reduced emissions

Disadvantages

1. Poor cold climate performance
2. Higher cost

b) Define the Transesterification process, and what are the main two purposes it achieves in terms of fuel properties?

Transesterification is a reaction between triacylglyceride and methanol to yield glycerol and methylester

This will make the biodiesel

- Less viscous
- Have higher cetane number