**MEC3040: Final exam F’19 - Key**

This exam Is divided into two sections:

* 75%: short answer (75%)
* 25%: essays (3 prepared ahead) an 1 at the end of this exam

***Section 1: Biodiesel***

**Module 6: Biodiesel basics to sustainability**

1. Interest in using bio-oils and biodiesel has ‘revived’ several times during the fossil fuel era: first in the 1970s and again today. Describe and discuss the reasons for each of these two revivals.

2. What issue(s) prevents straight vegetable oils (SVO) from being used as an effective transportation fuel? What physical property is the origin of this problem?

3. What is B5? What is it used for? What is its great advantage over B100?

4. The sustainability of biodiesel is controversial.

(a) What factor do you believe has the greatest impact on biodiesel’s sustainability?

(b) Is this fuel’s sustainability related to EREOI?

**Module 7: Biodiesel feedstock, processing and production**

5. Transesterification is used to convert triacylglcyerols to biodiesel. Describe this process and be sure to mention these:

* The purpose of titration of feedstock
* The reactant(s) needed
* Stoichiometry
* Co-products or by-products

6. When bio-oil is extracted from virgin feedstock co-products and byproducts are also produced.

(a) Give examples of a few and their uses.

(b) Are co- and byproducts generally included when considering EROEI values?

7. Many believe that algae can be produced using sunlight and wastewater and will provide abundant feedstock for biodiesel (or renewable diesel) production. Give three pros and three cons to producing advanced biofuels from algae.

8. Between 2005 and 2011, the number of companies proposing to make algal biofuels skyrocketed. This was later referred to as an ‘algal biofuel bubble’. Why? What does that term mean?

**Module 8: Biodiesel uses and future**

9. ASTM testing of petro diesel and biodiesel reveals some similarities and some differences. Give examples of two similarities and two differences.

10. To mitigate climate change we need to focus on ‘greening’ both transportation and heating fuels. If you had a source of sustainable biodiesel would you use it for transportation or heating? Why?

**Biodiesel extra credit question**

A. Biodiesel is notably less toxic than fossil fuels derived from petroleum. Based on that difference, create a hypothesis about the level of toxicity of renewable diesel.

***Section 2: Anaerobic digestion***

**Module 9: Introduction to anaerobic digestion (AD)**

11. Anaerobic digestion is more common in Europe than the US, though each has similar climates and is facing the challenge of global climate change.

Give two reasons for this very different level of implementation of this renewable energy technology.

12. Anaerobic digestion produces a number of co-products and byproducts. Give two examples of each and explain why you have categorized each as co-product or byproduct.

13. Renewable natural gas (RNG; aka biomethane)

(a) What’s the difference between biogas and RNG?

(b) Biogas must be combusted to produce energy. What is an alternative way of producing energy from RNG?

14. How and why could anaerobic digestion of all of Vermont’s food waste **increase** the State’s water quality problems?

**Module 10: AD technical factors and operation**

15. There are two pathways to creating methane in the final phase of the AD process: (1) splitting acetic acid (VFA) and (2) converting carbon dioxide to methane with hydrogen gas. Which pathway predominates, creating more methane?

16. Most AD systems, both plug-flow and complete-mix, have hydraulic retention times of 20-30 days. What does this mean? What is hydraulic retention time or HRT?

17. AD operators strive for homeostasis. What does that word mean and why is it far more critical to the AD process than in other forms of renewable energy?

18. The Ripley ratio

(a) What is it? What does it tell an operator?

(b) How do you measure it?

(c) If you were an AD operator how often would you test the Ripley ratio?

**Module 11: AD feedstock and energy modeling**

19. While manure has low energy levels it’s a highly valued AD feedstock. Why? What does it bring to the party?

20. Describe the ideal AD feedstock using three parameters and suggest how you would determine the optimal values for each for the goals you have to reach as an AD operator

**AD extra credit question**

B. In the hydrolysis tank, the first phase of anaerobic digestion, \_\_\_\_\_\_(a)\_\_\_\_\_\_ are converted into \_\_\_\_\_\_\_(b) .

What words or terms belong in each blank?

(a)

(b)

**Required essay question**

This course covers three bioenergy technologies in some detail: solid biomass (generally burned); biodiesel; and anaerobic digestion (or biomass). Our current energy system’s infrastructure is based on fossil fuels. Be sure to answer these questions in the process of crafting your answer.

(a) In what way do these three bioenergy technologies mesh well with fossil fuel infrastructure?

(b) In what ways do these three bioenergy technologies not fit into fossil fuel infrastructure?

(c) Are there bioenergy modifications that allow a better fit with our existing fossil fuel infrastructure?