CEE 3502 – MIDTERM 2 – April 7th, 2020

This is an open-book, examination, you are **only allowed to use your notes, a calculator and the Rittmann textbook.**
Your answers including all working are due back to Dr. Haig via email (sjhaig@pitt.edu) no later than 2pm on April 9th 2020.

ACADEMIC INTEGRITY PLEDGE: Please read this and sign your name on the dotted line below. If you cannot print and sign this, please write the following sentence on your first page of answers and sign your name. *"I attest that I have read, understood and will follow the academic integrity pledge outlined by Dr. Haig"* SIGNATURE.

I will complete this exam in a fair, honest, respectful, responsible and trustworthy manner. This means that I will complete the exam as if Dr. Haig was watching my every action. I will act accordingly to the professor's instructions, and I will neither give nor receive any aid or assistance other than that authorized. I know that the integrity of this exam and this class is up to me, and I pledge to not take any action that would break the trust of my classmates, Dr. Haig, or undermine the fairness of this class.

The submission of another person's intellectual effort on an exam represents a violation of the University of Pittsburgh's policy on Academic Integrity. Students suspected of violating this agreement will be required to participate in the outlined procedural process as initiated by the instructor, with a minimum sanction of a zero score for the exam being imposed.

Shengbin Jia
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START OF EXAM: The value of each question is given at the beginning of each problem statement. There is 1 question in total. Exam is out of 88.

1) You are to evaluate an existing activated sludge process. Typical influent values are: $Q = 1000 m^3/d$ $S^0 = 300$ mg BOD/L $X_v^0 = 0$ The current volume of the aeration basin is 300 m^3 and the return MLSS (X_v^{return}) is 9,000 mgVSS/L. Historically, the clarifier has worked well ($X_v^{eff} = 8$ mg VSS/l) and the plant has operated at a θx of 6 days. Estimated kinetic parameters are: Y = 0.5 g VSS_a/g BOD fd = 0.8 qhat = 18g BOD/g VSS_a-d K = 9mg BOD/l b =0.1/d

a. (4 points) Calculate $[\theta_x^{min}]_{lim}$
b. (4 points) What safety factor is the process running?
c. (4 points) Calculate the effluent substrate concentration and Smin.
d. (4 points) Calculate θ
e. (4 points) Calculate BOD loading (kg/day)
f. (4 points) Calculate U in kg BOD/kg VSS_a-d
g. (4 points) Calculate the concentration of active and inactive biomass in the reactor.
h. (4 points) Calculate the fraction of active biomass (X_a/X_v)
i. (4 points) Calculate the kg of total biomass in the reactor.
j. (4 points) Calculate the food:microorganism (F/M) ratio
k. (4 points) Calculate the total sludge production rate ($\Delta Xv/\Delta t$)
l. (4 points) Calculate the total sludge wasting flow rate (Q^w). Assume the concentration of biomass being wasted is the same as being returned from the settler.
m. (4 points) Calculate the recycle ratio R
n. (4 points) Calculate the required recycle flow ate
o. (4 points) Calculate the volumetric loading rate (kg BOD/m^3-d)
p. (4 points) Assuming the effluent VSS exerts a BOD (1.42 mg COD/mg VSS), calculate the effluent BOD.
q. (4 points) Calculate the oxygen demand (kg/d) required by the waste sludge.
r. (4 points) Calculate the oxygen supply rate (kg O_2/d) needed for the reactor.
s. (4 points) Assuming a field oxygen transfer efficiency of 1.3 kg O_2/kWh, estimate the power necessary to supply the necessary oxygen each day.
t. (4 points) Calculate the mass of N (12.4% by mass of biomass) and P (2.5% by mass of biomass) required by the reactor per day.
u. (8 points) Describe one specific way that you could modify the reactor's operation to improve performance. Discuss tradeoffs associated with your operational decision.

END OF EXAM