**Mathematical Modeling (Math445) Assignment (30%)**

1. Describe the differences between model simplification and model refinement.
2. Compare and contrast modeling process and hypothesis testing.
3. Define each of the following terms:
4. Dimensional analysis method
5. Dimensional compatibility
6. Dimensional constant
7. Complete set of solutions
8. Dimensionless products
9. Dimensionally homogeneous equation
10. If a function f under an investigation has n arguments, how many dimensionless products will be considered in MLT system of units, where
11. n=5?
12. n=7?
13. n=k? (k is a positive integer)
14. State Buckingham’s theorem.
15. Describe the seven basic steps in the dimensional analysis methodology.
16. Your grandparents have an annuity. The value of the annuity increases each month by an automatic deposit of 1% interest on the previous month’s balance. Your grandparents withdraw Birr 1000 at the beginning of each month for living expenses. Currently they have Br.50, 000 in the annuity.
17. Model the annuity with a dynamical system.
18. What will be the balance in the annuity after the fifth month?
19. Find the volume flow rate $\frac{dV}{dt}$ of blood flowing in an artery as a function of the pressure drop per unit length of artery $\frac{dP}{dL}$ , the radius r of the artery, the blood density $ρ$ , and the blood viscosity .
20. The population of a hypothetical country increases at a rate proportional to its number of inhabitants present at any time t. If the population of the country was 50 million in 1950 and 75 million in1990, when will the population be double the number in 1950?
21. Suppose that $k=0.2hr^{-1}$ and that the smallest effective concentration is 0.03mg/ml. A single dose that produces a concentration of 0.1mg/ml is administered. Approximately how many hours will the drug remain effective?
22. A 3kg object is attached to a spring and will stretch the spring 392mm by itself. The medium exerts a damping force of 45Newtons when then the velocity is 50cm/s. The system experiences a resonance under a forcing function of the form $F\left(t\right)=10cos⁡(ωt)$. If the object is initially displaced 20cm downward from its equilibrium position and given a velocity of 10cm/s upwards, find the displacement at any time t.
23. Assume the relevant factors related to the force F opposing the fall of a raindrop through air are: Viscosity(**µ**), Velocity( **v**), and the Diameter( **r**) of the drop. Assume that density is neglected.

 Find an equation relating the force **F** with the rest variables (**µ** , **v**,and **r**), you need to develop a model for $F.$

1. Solve the following. (Use simplex method)

Min. z = 2x1 + 2x2+6x3

Subjects to: 3x1 + 2x2 +x3 ≤ 3 , 2x1 + x2 +3x3 ≥3 and x1 , x2 ,x3≥ 0