UNIVERSITY OF GHANA

BSC. ENGINEERING FIRST SEMESTER EXAMINATIONS: 2018/2019

DEPARTMENT OF FOOD PROCESS ENGINEERING

FPEN 401: FOOD PLANT DESIGN AND ECONOMICS (3 Credits)

INSTRUCTIONS: ANSWER ANY FOUR QUESTIONS

TIME ALLOWED: THREE (3) HOURS

1.

a. Using the process data, design variables, and process specifications given below for a conveyor belt dryer, determine

i. The evaporating capacity (W)

ii. The drying air humidity (Y)

iii. The thermal efficiency

iv. The heating area

v. The specific rate of evaporation, and

vi. The recycle air flow rate

Process Data	Design variables	Process Specification
Specific heat (kJ/kg K) C_{pL} = 4.2 water C_{pV} = 1.90 water vapour C_{PA} = 1.00 air C_{PS} = 2.0 solid material Dry material= 3.73 ***Latent Heat (MJ/kg)*** H_o = 2.50 Steam condensation at 0°C ***Heat transfer Coefficient (KW/m²K)*** U_s = 0.1 air heater ***Density (kg/m³)*** ρ_w = 1000 ρ_a = 1 ρ_s = 1750	V = 2.5 m/s drying air velocity D = 2.0 m Dryer diameter	F = 750 kg/hr db Feed flow rate X_o = 0.85 kg/kg db initial moisture content X = 0.10 kg/kg db final moisture content d = 0.05m material characteristic size T_o = 26°C Ambient temperature T = 95 °C drying air temperature Y_o = 0.02 Ambient humidity T_s = 165°C Heating steam temperature P = 1.00 bar F = 1.3 F_a

2.

a. Discuss the different stages involved in the design of a food plant from beginning to completion.

b. Briefly discuss how the following parameters affect the equipment cost and operating cost for a conveyor belt dryer:

   i. High temperature,

   ii. Low humidity, and

   iii. High air velocity.

c. Suppose your uncle would like to be paid GH¢72,000 per year during his retirement which starts in 25 years. Assuming that the GH¢72,000 is an annual perpetuity and the interest rate is 5% per year. How much should he save per month for the next 25 years so that he can achieve his retirement goals?

d. Suppose you are paying GHC 41.77 per week for 12 years to repay a GHC 14,000 loan. What is the annual effective interest rate?

3.

a. Mr. Lala Kwame decides to pay GHC 40,000 annually to the 6 – year capital improvement to the Food Process Department for the purchase of laboratory equipment. His payment would start at the end of year 3 and continue through year 6. Determine the present value of his total payments if the interest rate is 14.2%.

b. Excellent bank has offered you, a GHC 60,000 35year loan to purchase an equipment in your Factory. The loan payments are to be made on monthly basis. The total payment at the end of the thirty five -year period is GHC 134,964.00. Determine the effective annual interest rate if the interest is compounded continuously.

c. Suppose your parents have decided that after your graduation at the end of the year they would start to save money to help pay for your younger sister to attend University to study Food Process Engineering. They plan to save money for 5 years before she starts college and to save during her university years. They plan to contribute GH¢4,000 per year at the start of each of her 4 university years. Your parents would thus make monthly payments for 8 years, 5 year prior to and 3 during your sister's university education. The monthly interest rate earned on their savings is 0.45%. How much must the monthly savings be under this condition?

4. Food Research Institute is considering investing in a new baby food product named Fura Special which is made from millet and rice. Using the following information below:

Working capital (C_w)	= 20% of C_T (Total initial capital investment)
Service life	= 10 years
Internal rate of return (IRR)	= 21%
Tax rate	= 25%
Depreciation	= 130,000 GHC/year

Year	Cashflow
1	300,000
2	350,000
3	400,000
4	420,000
5	415,000
6	480,000
7	520,000
8	405,000
9	500,000
10	480,000

a. Determine

i. C_T (total initial capital investment)

ii. Book value of the fixed initial capital investment (C_F) at the end of four years

b. For a hurdle rate of 14% determine

i. Return on initial investment (ROI)

ii. Net present value (NPV)

iii. Payback period (PBP)

iv. Comment on the financial viability of the project proposal.

5. Given the following information

• Production rate @ 100%	= 375,000kg/yr
• Total Initial Fixed Capital Investment (C_T)	= GH¢950,000
• Working Capital (C_W)	= 15% of Total Initial fixed Capital Investment (C_T)
• Manufacturing Cost at 100% Production	
- Raw Materials	= GH¢60,000
- Labour	= GH¢40,000
- Electricity	= GH¢16,000
- Water	= GH¢ 4,000
- Maintenance & Repair	= GH¢ 7,000
• General Expenses at 100% Production	
- Administration	= GH¢20,000
- Advertising & Distribution	= GH¢40,000
• Salvage Value	= 5% of Initial Fixed Capital Investment (C_F)
• Service Life	= 10 year
• Hurdle rate	= 13%
• Tax Rate	= 25%

Assume the production rate is 60% the first two years, 80% the next four years and 100% the remaining years, likewise the manufacturing cost and the general expenses. Determine:

a. The minimum price per kg that the product should be sold using

i. The Return on Investment (ROI) method

ii. The Net Present Value (NPV) method

b. What would be the new minimum selling price if the Manufacturing Cost and General Expenses are both increased by10 % and an inflation rate of 4 % is also accounted for.

Comment on your results.