THE PAPUA NEW GUINEA UNIVERSITY OF TECHNOLOGY

DEPARTMENT OF MINING ENGINEERING

2021 FIRST SEMESTER EXAMINATION

THIRD YEAR MINING ENGINEERING

MN311 – Bulk Materials Handling in Mines

DATE: ***TUESDAY, 8TH JUNE, 2021***

TIME: ***12:50 AM***

TIME ALLOWED: **3 HOURS**

INFORMATION FOR CANDIDATES:

1. You have 10 minutes to read this question paper you **SHOULD NOT** begin writing during this period.
2. There are **FOUR** questions altogether. Answer **ALL FOUR** questions. Marks to each question are shown on the paper.
3. **ALL** answers must be written on the answer book provided. No other written material will be accepted.
4. Write your **NAME** and **NUMBER** clearly on the **ANSWER BOOK**. Do this **NOW**.

QUESTION 1.

a) (i) Define what bulk materials is in a short paragraph and explain what bulk materials handling is.

(5marks)

b) (i) State at least two main purposes of stockpile and explain each concisely.

(5marks)

(ii) Conical stockpiles and windrows radial stockpiles are two most common stockpiling techniques used at the mines. State and explain briefly the common factors influencing the choice of each so as to differentiate between each.

(5marks)

c) Conical stockpiles and windrows radial stockpiles are two most common stockpiling techniques used at the mines. State and explain concisely the common factors influencing the choice of each so as to differentiate between each.

(5marks)

d) Consider that a gold mine, is expected to process 700,000 tonne of ore per year, if the following are true for this mine design a conical stockpile (ie. specify size & space requirements) with a single draw-point to cater for production surges;

- Mine operating schedule is;
  2 shifts per day, 7days per week, and 50 weeks per year, production hours per shift is 10hrs, and mill operating availability factor on average is 95%.
- Planned shutdown:
  Shut down for maintenance is 1 shift (10hrs) per day, and such incidences are planned for 4 times in a year.
- Unplanned Production surges:
  Unplanned production surges is expected to average 6 hours at any one time, therefore a stockpile is required to cater for such production surges ahead of the mill.
- Material properties;
  Bulk density is 1700kg/m^3, and angle of repose of 35^0.
- Draw-point design:
  The angle of draw-off is 45^0.

Useful formula; $R = \frac{Tan^2(A)}{(Tan\,A + Tan\,B)^2}$, *(all symbols carry the usual meaning)*

(10marks)

QUESTION 2:

a) For bins/hopper designs; the flow patterns of bulk solids in bins/hoppers are mainly of two types, state what they are and briefly describe each with the help of a neat sketch.

(5marks)

b) They are two types of bin/hopper designs, namely mass-flow design and funnel-flow design. State the general features of each design comparatively and explain the circumstances or conditions under which each should be applied.

(5marks)

c) Describe what a flow function is and explain concisely its purpose/ use.

(5marks)

d) You are required to design a bin/hopper to hold 150 tonnes of bulk solids as surge capacity whose bulk density is 2000kg/m^3 and the flow-property is shown by figure1 below. Assuming that the anticipated design type is mass-flow, the critical flow factor (ff_c) is 1.0, hopper type is conical with hopper angle of 20^0, and the anticipated bin width of 3.5m, specify the bin/hopper design dimensions.

Hint; calculate the discharge outlet diameter using the flow function shown by figure 1 first. Useful formula:

$Ba \geq \frac{2\sigma_{yc}}{\rho_b g}$, *(all symbols carry usual meaning).*

(10marks)

QUESTION 3:

a) (i) With the help of a neat sketch explain the basic operating principles of a belt conveyor system.

(5marks)

(ii) Explain the cause(s) of belt splitting, and rapid wear of the belt and wing idlers in a conveyor belt system and explain very briefly how it can be rectified.

(5marks)

(iii) Explain why belt tensioning is required after certain periods of time of belt operation, and state and describe a method of belt tensioning.

(5marks)

b) Consider that a copper mine is to use belt conveyor as an alternative cost effective way to transport ore from the pit to the mill at a production rate of 1000 t/hr. Crushed copper ore from an in-pit primary crusher will be conveyed over a distance of 1000m to the secondary crusher stockpile at the mill at an inclination of 6^0 against gravity. The combination of belt-width and belt-speed that gives the optimum belt conveyor operation is 800mm and 2.2ms^{-1} respectively. Properties of the material include; crushed ore is lumpy and moderately abbrassive, bulk density is 2300kg/m^3, angle of reposose is 38^0, and angle of surcharge is 25^0. The idlers to use are of 127mm sizes, and 3-roll idlers sets manufactured for average duty roles. (Also use additional information provided in chart-form below by figure 2).

Determine;

(i) Power required at the drive drum and

(ii) motor power of a motor having an efficiency rating of 90%.

(10 marks)

Useful formulae: $Mc = m_{ic} + m_{ir} + (2 \times m_b \times \cos\alpha)$, $F_{fb} = 0.025 \times Mc \times g \times L$;

$F_{fL} = 0.025 \times M_L \times g \times L$; $F_{st} = (M_L) \times g \times H$; $F_N = K_{SR} \times F_H$. *(all symbols carry the usual meanings,* $M_L = \frac{m_s}{v}$, $K_{SR} = 0.09$*)*

Question 4:

a) (i) With the help of a neat sketch explain the total slurry system when handling mineral concentrate from the mine to utilisation plants.

(5marks)

(ii) Explain so as to distinguish between the two types of slurries; Non-settling slurry and Settling slurry.

(5marks)

b) Mine tailings from the mill at a copper-gold mine is to be transported in a slurry form where the flow regime is described as a heterogeneous slurry over a distance of 300m to the tailing pond. The inlet elevation is 1715 RL and the outlet elevation is 1700 RL, and minor head loses due to bends, vulves and pipe pittings is 2m. The slurry has the following properties; slurry density is 1450kg/m^3, slurry viscocity is 1.5cp (centi-poise), yeild stress is 30dyne/cm^2, concentration of solids by volume is 30%, slurry transport velocity is 1.6m/s. The particle drag coefficient is said to be 0.4, solids S.G is 2.5 and particle shapes are predominantly spherical. Other parameters to consider in design includes; pipe internal dia. is 20cm, pipe relative roughness is 0.00001, and water is to be used as the carrier fluid whose viscousity is 1.016cp.

Given the above conditions:

(i). Estimate the friction factor of the flow using Moody's chart given by figure 3.

(ii). Calculate the total pump discharge pressure (show your workings clearly)

(iii). Determine the critical velocity if critical Reynolds Number, Re_c is said to be 1.9×10^5.

(iv) Calculate tonnes of tails delivered per hour

Note: You must show all working. Usueful Formulae, use where appropriate. Also use appropriate charts given below to help with your work (all symbols carry usual meaning)

$$Re = \frac{\rho v D}{\mu}$$

$$H = f\,\frac{L\,v^2}{2Dg}$$

$$\frac{J - J_w}{J_w C_v} = 81\left[\frac{gD(S_s - 1)}{v^2}\,\frac{1}{\sqrt{C_d}}\right]^{1.5}$$

NHe = (τ_y/μ_{sl}) x (D/v) x Re

Unit conversions

1cp = 1 x 10^{-3} Pa s, Pa s – Pascal seconds

1dyne = 1 x 10^{-5} N (kgm/s^2)

(5 + 5 + 5 + 5 marks)

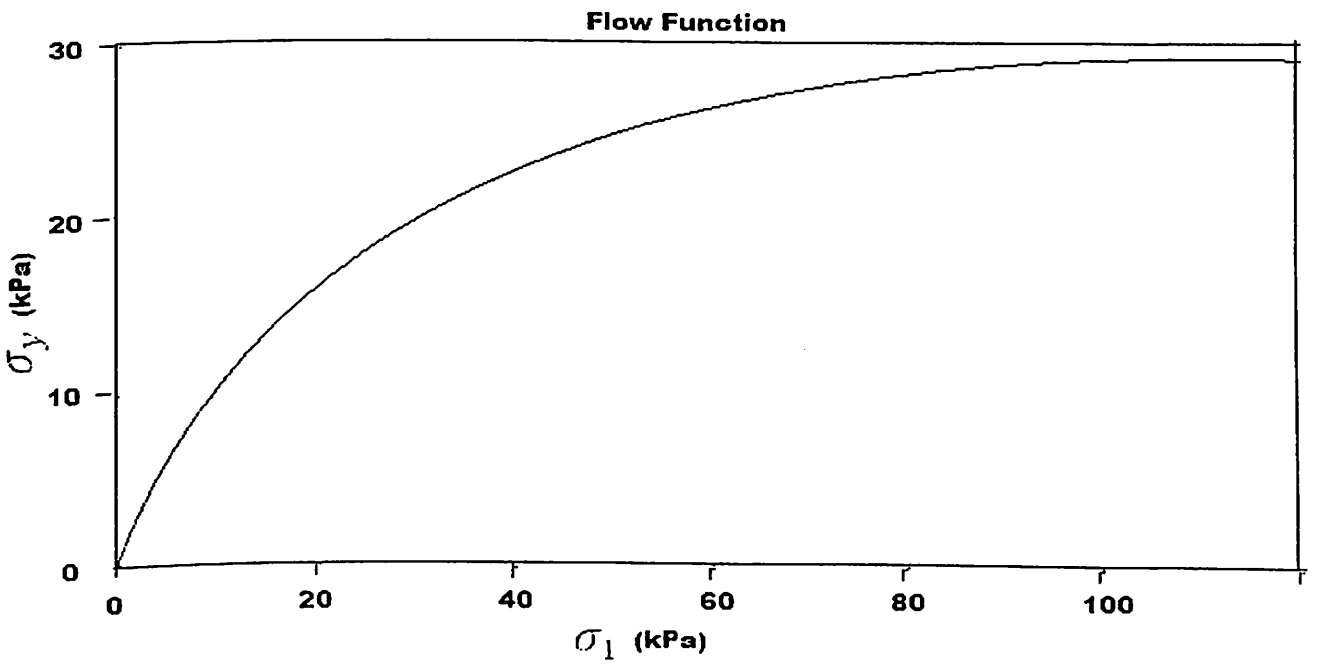

Figure 1 – Flow function

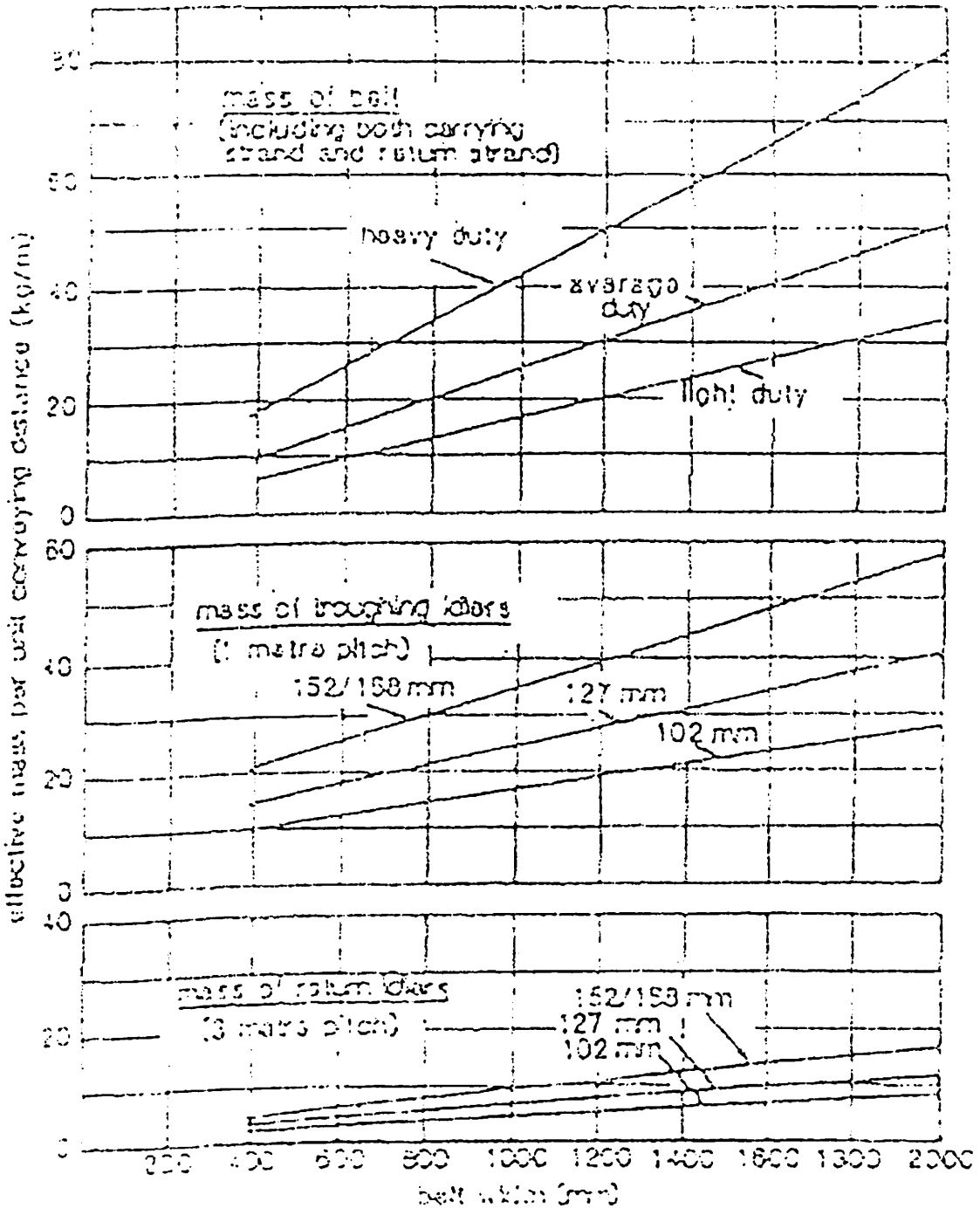

Figure 2: Mass of belt conveyor moving parts approximation

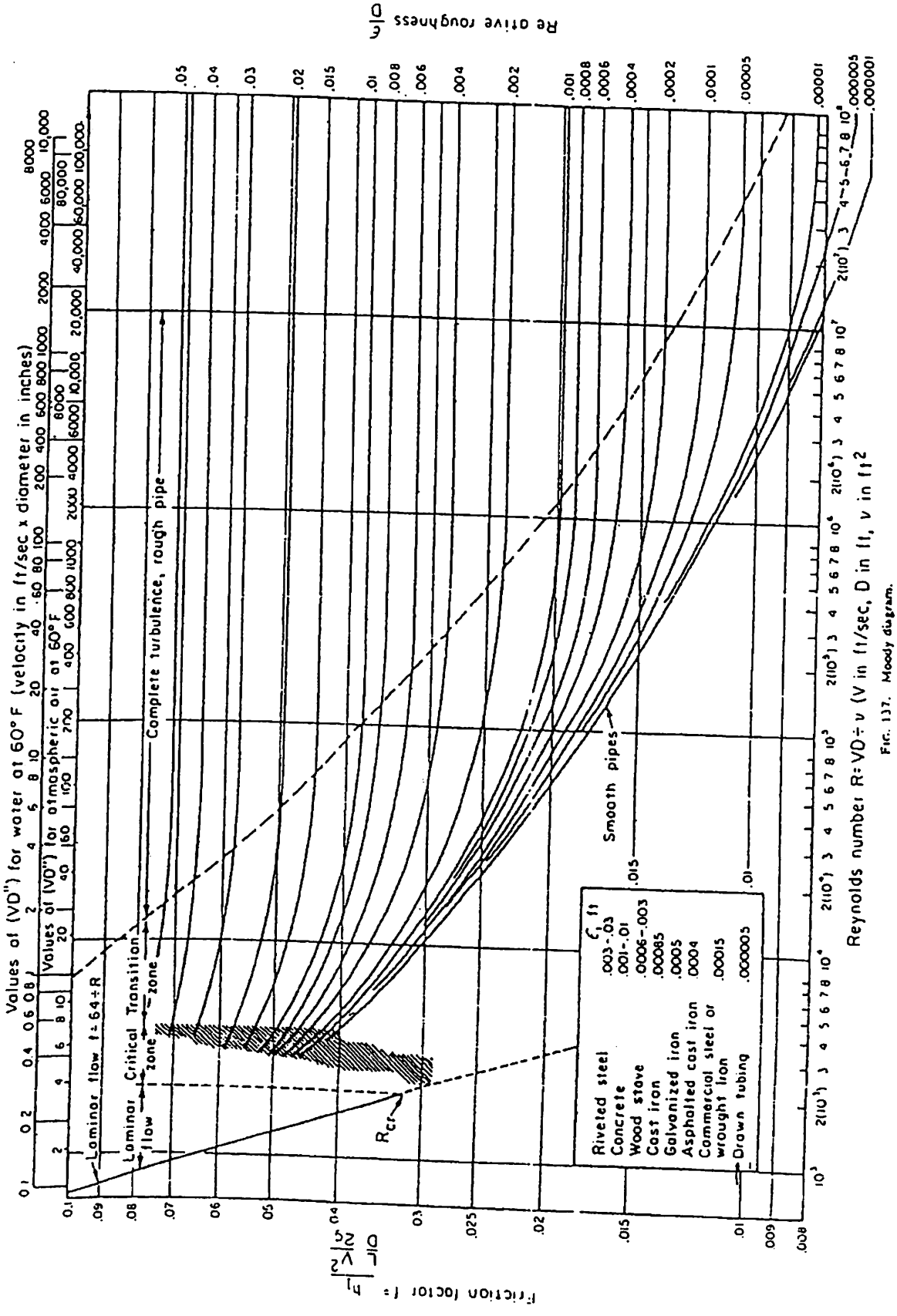

Figure 3: Friction factor estimation chart