Programme Code: TU760 (TU651)

Module Code: CHMS H2001
CRN: 26183

TECHNOLOGICAL UNIVERSITY DUBLIN

Tallaght Campus

TU 760 - Bachelor of Science in Bioanalysis

TU 651 Higher Certificate in Science in Applied Biology

Year 2

SEMESTER I EXAMINATIONS 2024/25

Chromatography and Measurement Systems
CHMS H2001

Internal Examiner(s): Dr Eugene Hickey & Dr Sinéad Currivan-Macdonald

External Examiner(s):

Exam Duration: 2 hours

Instructions To Candidates: Answer Question 1 (compulsory) in Section A. Answer any two Questions in Section B. Total marks = 300.

Special Instructions /Handouts/ Materials Required:
Periodic tables should be provided.

Section A:

Question 1 (Compulsory). **(100 marks)**

Answer any eight from twelve parts. Each part is worth 12.5 marks.

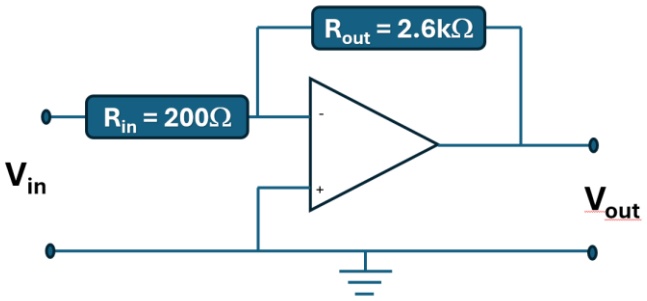
a) Describe the role of RAM in a computer.

b) Within the signal analysis pipeline, what process turns information into knowledge?

c) Explain the source of Shot noise. Describe the frequency spectrum of Shot noise (a rough sketch would be acceptable). What steps can be taken to reduce Johnson noise?

d) What types of filter would be appropriate to reduce the noise in the following signals:
   - White noise where the signal has frequencies from 100hz and 20kz
   - 1/f noise which dominates the signal below 100hz
   - Instrumentation noise with all the noise concentrated in a narrow frequency range around 50hz.

e) Calculate the amplification on the OP-AMP circuit shown below.



f) Give four advantages of digital signals over analogue signals.

g) An analogue signal is being sampled at a sampling rate of 4.2khz. What is the highest frequency in the signal that can be correctly captured without being aliased?

h) What is the resolution limit of an ADC with a range of 5V and 10 bits per sample?

i) What is the raw file size in Bytes when 350s of signal are digitised with a sampling rate of 12kHz and 12 bits per sample?

j) Give four advantages of USB connections over RS232 connections.

k) JPEG is a lossy image compression format.
   - What is the major advantage of lossy image compression?
   - What artifacts can be introduced into images by lossy compression?
   - For what kind of images would the JPEG format be inappropriate?
   - How can we reduce the impact of losses from JPEG images?

l) Describe computer viruses in terms of:
   - What they are
   - The different types
   - What can be done to protect against them

Section B Chromatography

Answer 2 questions.

Question 2: (100 marks) **Answer all parts** (each worth 10 marks).

a) What is the signal to noise ratio, and when is it used?

b) Explain the following terms:

- Efficiency
- Retention

c) What is the main mechanism of operation in normal phase separations?

d) Name **three** separation *mechanisms* encountered in liquid chromatography.

e) Using the information provided below, calculate the efficiency of the column. W_h indicates the peak width at half height.

Peak Number	1	…	17	18
t_R ***(min)***	6.233	…	26.389	27.233
w_h ***(min)***	0.118	…	0.118	0.118

f) Why is ion pairing used in reversed-phase High Performance Liquid Chromatography (HPLC)?

g) Other than non-porous particles, what other particle types/formats are commonly used in HPLC?

h) What is the best approach to overcome the C term in the Van Deemter equation?

i) What types of capillary columns are commonly found in GC analyses?

j) A GC column of 60 m, gave an efficiency value, N, of 750, 000. What is the plate height (H) of the column?

Question 3. (100 marks) **Answer all parts**

a) The phenomenon of band broadening is explained by the Van Deemter equation. Based on the equation, what are the main contributing factors to band broadening? Within your answer sketch a typical van Deemter plot, showing the effect of flow rate (linear velocity) on performance/HETP.

(35 marks)

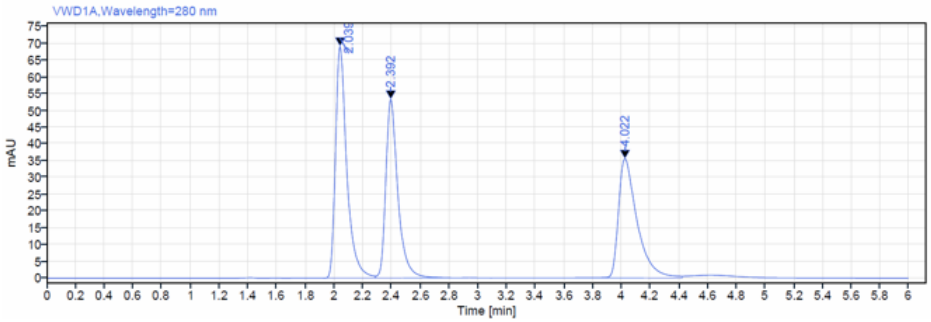
b) Compare and contrast ion exchange chromatography and size exclusion chromatography. Within your answer, specifically discuss:

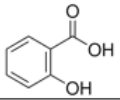
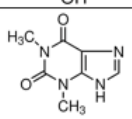
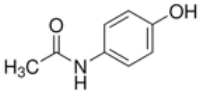
   a. The stationary phase.
   b. The mobile phase.
   c. Retention mechanism.
   d. Typical analytes used.

(35 marks)

c) In RPLC, three analytes are separated on a C18 column, using a mobile phase of 70 % ACN. Based on the following data, which compound will elute first? Within your answer justify your decision in terms of structure, chemistry, and polarity.

(30 marks)



Analyte	Log P	Structure
Salicylic acid	2.26	
Theophylline	-0.02	
Acetaminophen	0.5	

Question 4: Answer **both** parts. (100 marks)

a) What are the main components of a Gas Chromatography (GC) system? In your answer include a diagram, and a description of the components, including their role, and note two detector types commonly found and used with GC. Describe the operation principles of **one** of those detectors.

(50 marks)

b) Name **3 methods** of sample preparation techniques used in sample extraction or clean up, that you may come across in chromatographic separations. **Describe 2 of those methods**, including the operating principles, and any steps required in using that approach to sample preparation. (50 marks)