BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE (BITS) PILANI – Pilani Campus

SECOND SEMESTER, 2022 – 2023 | CHE G552 Advanced Transport Phenomena | Mid-Semester Test

Time: 11.00 to 12.30 PM | Maximum Marks: 60 (30 %) | Date: 17. 03. 2023 (Friday) | **CLOSE + OPEN BOOK**

INSTRUCTIONS

1. **This question paper consists of two parts. Part A is close book and Part B is open (only text) book.**
2. **Part-B answer book will be supplied after you return Part-A answer book.**
3. **Make and state suitable, logical and scientifically justifiable assumptions if necessary.**

- **Give just 2 iterations for iterative procedure(s).**
- **Be to the point. Show all steps systematically.**

PART A (CLOSE BOOK

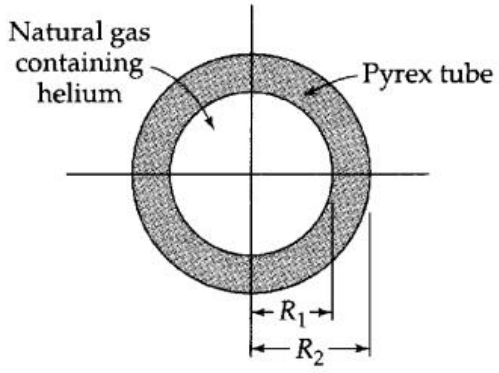
Tensors | Vectors | Scalars: distinguish among them, very clearly, while evolving the formulations.

Q1. [23 Marks] (a) Interpret T_{ij} and π_{ij} with 2 perspectives: Force & Flux; **(b)** Does molecular stress tensor differ from molecular momentum-flux tensor? Justify your analysis. In a systematic manner, give all of its/their components; **(c)** Formulate convective momentum transport and summarize all its components; **(d)** How do you find the convective momentum flux through a plane of arbitrary orientation; **(e)** How to get combined momentum flux, represent it in tensor notation and give all its 9 components very systematically; **(f)** Illustrate the meaning of Φ_{ij} ; (**g**) Contrast convective, viscous, molecular and combined momentum-flux tensors.

Q2. [17 Marks] (a) Formulate **(*i*)** convective transport of energy and ***(ii)*** work associated with molecular motions; **(b)** Define combined energy flux vector, give the physical significance of each of its terms; **(c)** Show systematically: how enthalpy factors in and how to evaluate it? **(d)** Summarize the following flux vectors: convective energy, molecular heat, molecular work and combined energy.

PART B (ONLY OPEN TEXT BOOK)

Q3. [20 Marks] A method for separating helium from natural gas could be based on the relative diffusion rates through pyrex. Suppose a natural gas mixture is contained in a pyrex tube (of length *L*) with dimensions shown in the figure below. Obtain an expression for the rate at which helium will *leak* out of the tube, in terms of diffusivity of helium through pyrex, interfacial concentrations of the helium in the pyrex, and dimensions of the tube. Use shell-balance method.



END