國立臺灣科技大學 109 學年度碩士班招生試題

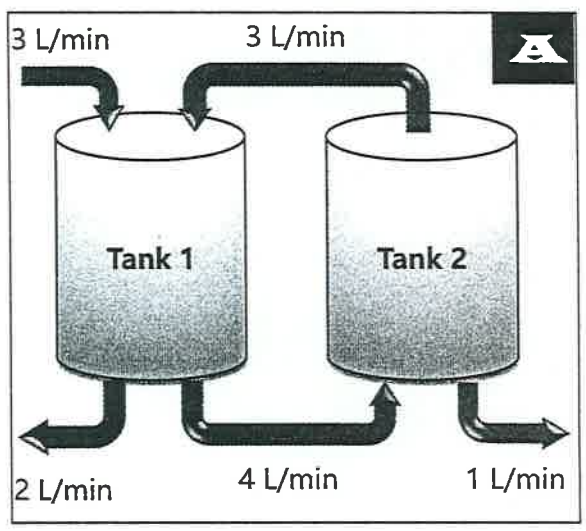
系所組別：化學工程系碩士班

科　　目：工程數學與輸送現象

(總分為 100 分)

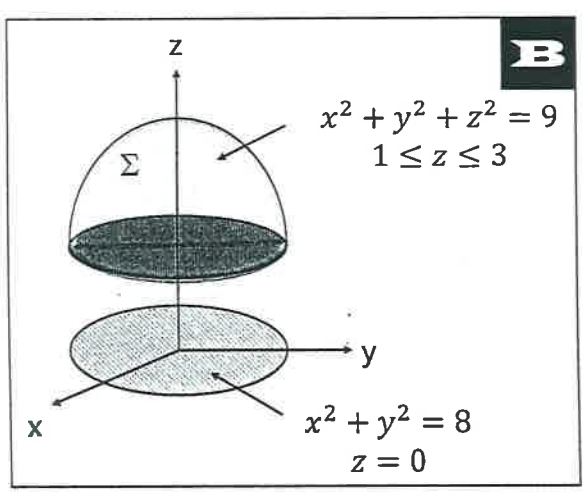
1. (*10 points*) Solve the equation $x^2y'' - xy' + y = ln\, x$

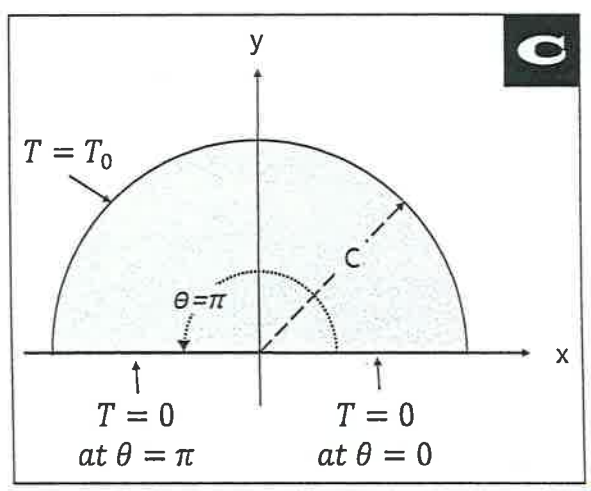
2. (*15 points*) Two tanks are connected by pipes as shown in **Figure A**. Tank 1 initially contains 200 liters of syrup in which 10 kilograms of sugar are dissolved. Tank 2 initially contains 5 kilograms of sugar dissolved in 100 liters of water. Beginning at time zero, pure water is pumped into tank 1 at the rate of 3 liters per minute, while syrup solutions are interchanged between the tanks at the rates shown. Three minutes after time zero, 5 kilograms of sugar are poured into tank 2. Determine the amount of sugar in each tank for any time *t*.



3. (*10 points*) Calculate the flux of $\vec{F} = x\vec{\imath} + y\vec{\jmath} + z\vec{k}$ across the part Σ of the sphere $x^2 + y^2 + z^2 = 9$ between the planes $z = 1$ and $z = 3$ (as **Figure B**).

4. (*15 points*) Find the steady-state temperature $T(r, \theta)$ in the semicircular plate shown in **Figure C**.





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5. (*20 points*) Answer the following questions about heat transfer. Please carefully indicate the meaning of each symbol you used.

(a) (5 points) What's the driving force for heat transfer?

(b) (5 points) What are the three modes of heat transfer?

(c) (5 points) What is the "physical meaning" of the dimensionless group, Nusselt number?

(d) (5 points) In a force convection system, what dimensionless groups can affect Nusselt number, i.e. Nusselt number is a function of what?

6. (*10 points*) A waste stream of volatile organic compound (VOC) vapor in air from a process was adsorbed by activated carbon particles in a packed bed having a diameter of 4 cm and length of 14 cm containing 80 g of carbon. The inlet gas stream having a concentration C_0 of 600 ppm and a density of 0.0012 g/cm^3 entered the bed at a flow rate of 700 cm^3/s. The break-point concentration is set at C/C_0=0.01. After calculation, it is known that total capacity of the bed is 5.5 hr while the usable capacity of the bed up to the break-point time is 3.8 hr, corresponding to the 4 cm of the unused bed. Please calculate that if the break-point time required for a new column is 10 hr, what is the new total length of the column required?

7. (*20 points*) Answer the following questions. Please carefully indicate the meaning of each symbol you used.

(a) (5 points) What are the assumption for a Langmuir isotherm?

(b) (5 points) What is the definition of a q (in q-line) in terms of the enthalpy related equation?

(c) (10 points) Ammonia gas is absorbed by water solution, based on two film theory, which side of the mass transfer rate dominates the whole process and why?