1. Water is being heated inside a copper tube by condensing steam outside. The inside area is 0.045 m^2/m of tube, and the outside is 0.050 m^2/m. The steam side heat transfer coefficient is 17030 W/m^2 outside area-°K, and the overall coefficient is 1950 W/m^2 outside area-°K. What is the inside heat transfer coefficient, in W/m^2 inside area-°K, if the metal resistance is negligible? What is the heat transfer rate if the tube is 10 m long and the log mean temperature difference for the tube is 18 °K. (20%)

2. A gas containing 0.03 mole fraction acetone in air is fed to the bottom of a packed absorption tower, and the gas from the top of the tower is to contain only 0,002 mole fraction acetone. Pure water is fed to the top of the tower at a rate that water leaving the bottom of the tower contains 0.01 mole fraction acetone. What is the overall gas phase number of transfer unit (N_{Oy}) for this system? The equilibrium constant is 2.5, ($y_e=2.5x_e$). (15%)

3. The McCabe-Thiele diagram for binary distillation is shown below. Answer the following questions: (15%)

    (1) Where is the ideal feed plate?

    (2) What kind of state (liquid, vapor, etc.) is the feed?

   (3) How many theoretical plates does this distillation job need?
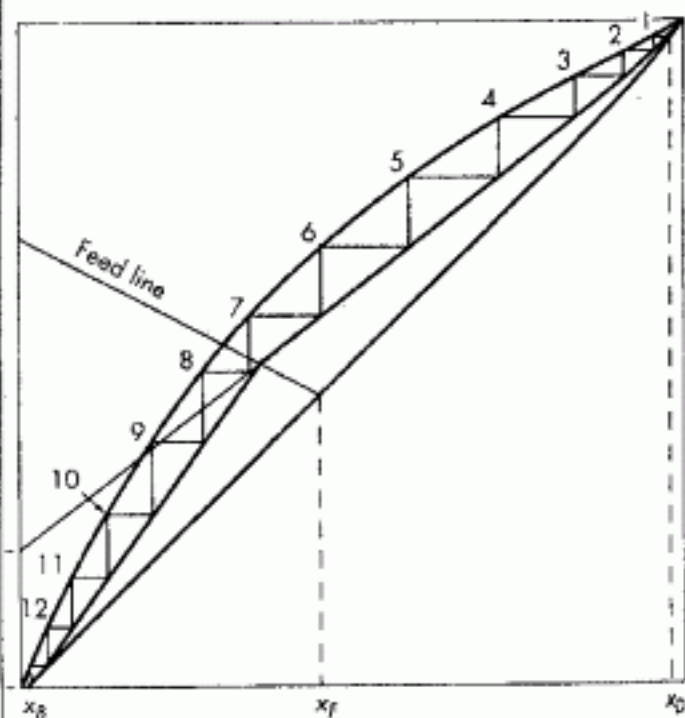
4. Derive an expression for the temperature distribution $T(x)$ in a viscous fluid in steady laminar flow between large flat parallel plates (distance = 2B). Both plates are maintained at constant temperature To. Take into account explicitly the heat generated by viscous dissipation. Neglect the temperature dependence of μ and k. (20%)

5. The model of enzyme pathway mechanisms occurred for the periplasmic translocation is as the following figures. The reactions are catalyzed by the translocase that comprises both peripheral and membrane protein complexes; for example, Sec-mediated translocation in Escherichia coli.
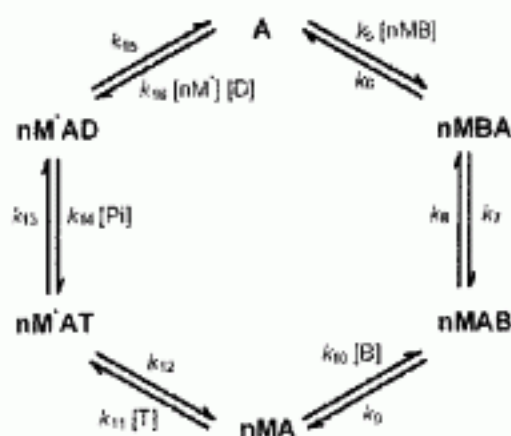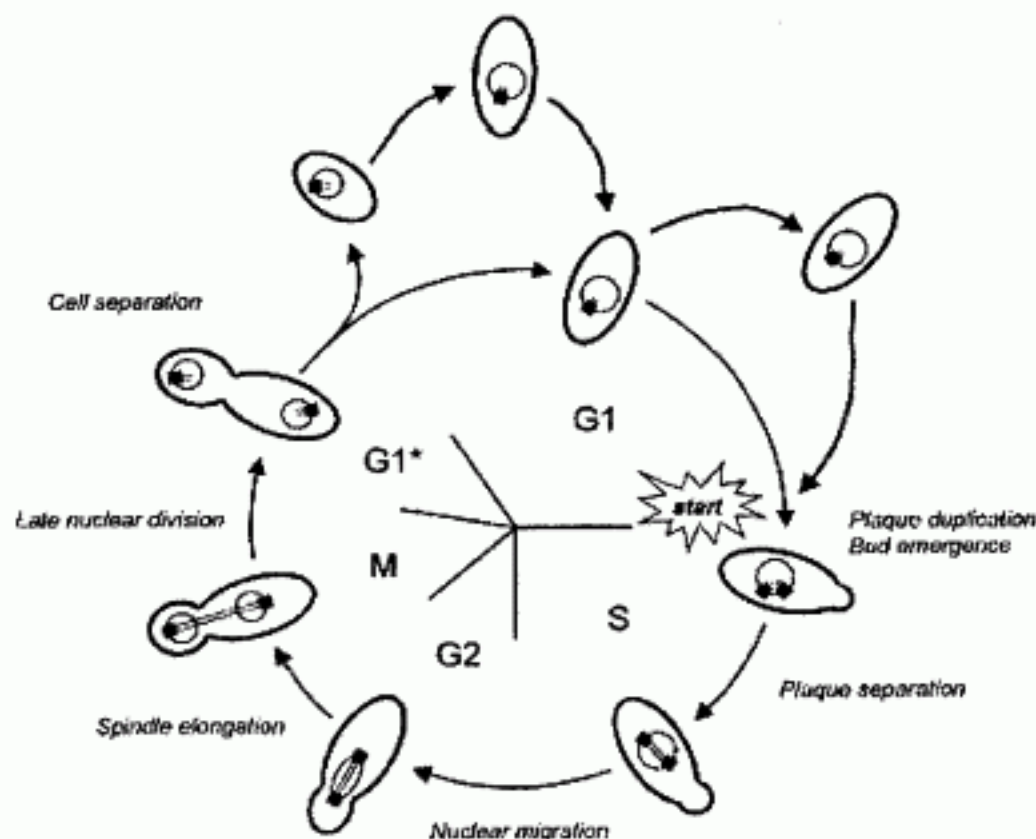

By assuming the reaction is complete in a single step, different enzyme species can be arranged into a regular geometric figure with each species in one corner. So the above translocation reactions can be simplified into six different enzyme species that represent the unimolecular or bimolecular step by which the two species are interconverted.
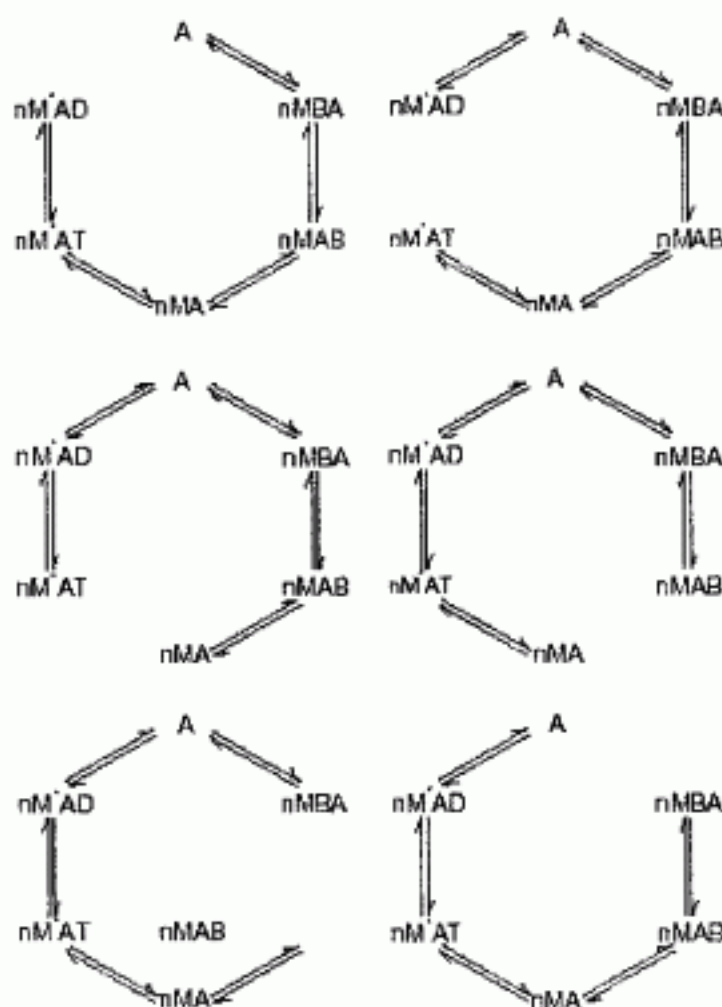
Please derive the kinetic reactions to show why the simplified patterns (i.e. network reduction technique) offer the advantages in modeling the translocation enzyme reactions. (15%)

6.

a) Give one cell type having the cell-cycle characteristics below? (5%)

Cell separation

Late nuclear division

G1*

G1

M

G2

S

start

Plaque duplication
Bud emergence

Plaque separation

Spindle elongation

Nuclear migration

b) The cell cycle can be considered as the succession of discrete events subjected to complex genetic regulations.　The first phase of the cell cycle is the S phase and consists of the plaque duplication and separation, and the bud starts to emerge as a protuberance.　The S phase is followed by the G2 phase and the M phase.　There is no separation of the cytoplasm until the beginning of the G1 phase, called G1* phase. Expansion of new born cells takes place mainly during the G2, M, and G1 phases.　At the end of the G1 phase, the new cell becomes an adult cell ready for division.　Please write down the cell growth kinetic models to describe the cell growth cycle.　(10%)