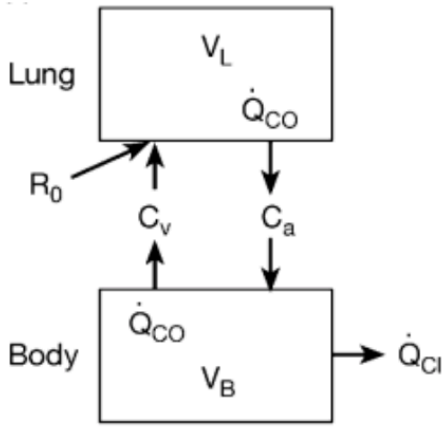
- Acknowledge the honor pledge here: Exam #2 honor pledge. Your exam will not be scored without your acknowledgement of the honor pledge.
- Find general solutions for the system of ordinary differential equations (ODEs) given in the problem statement analytically (by hand) for the homogeneous case (after infusion). You do not need to apply initial conditions. You may use MATLAB to find eigenvalues and vectors. Your written solution must include intermediate steps to show your work and understanding of the solution method. . Upload your solution as a PDF file (may be combined with LiveScript PDF file). (30 pts)
- Create a MATLAB LiveScript (mlx script file).
  - Solve the system of ODEs symbolically and numerically for the nonhomogeneous case (during infusion). Include comments in your script to describe your code. Formatting with the editor tool is optional. (30 pts)
  - Plot the symbolic and numeric solutions on the same graph for $0 \leq t \leq 30$ min. Use solid lines to plot the symbolic solutions and use data markers to plot the numeric solutions. Label axes appropriately including units and add a legend to label the symbolic and numeric solutions. A figure caption is optional. (20 pts)
  - Provide responses to the interpretation question below the problem statement. Formatting with the editor tool is optional. (20 pts)
- Export your LiveScript to a PDF file and upload. Make sure your comments and code are completely visible (not truncated) in the exported PDF file.

Problem statement: A recirculatory pharmacokinetic model[1] of an anesthetic drug delivered intravenously is shown below. The model incorporates physiological processes that are important determinants of intravenous anesthetic disposition including cardiac output, lung kinetics, and injection rate of intravenous bolus administration of the drug. The two compartments represent the lungs and body with respective distribution volumes, V_L and V_B. Q_{CO} is cardiac output, or rate of circulation of blood (L/min) between the two compartments. C_v represents drug concentrations (mg/L) in the venous circulation upstream of the drug infusion site and returning from the body to the lungs. C_a represents drug concentrations (mg/L) in the arterial circulation emerging from the lungs and entering the rest of the body. Q_{Cl} is the clearance rate, or rate of removal of the drug (L/min). R_0 is the drug infusion rate (mg/min). During bolus injection, infusion can be treated as dose (D, mg) given over a time interval equal to the duration of the injection (t_D) and expressed as $R_0 = D / t_D$ (mg/min). After bolus injection, the infusion rate is zero ($R_0 = 0$). The system of differential equations for the model are derived by mass balance of the rates that drug enters and leaves the compartments

Recirculatory Model	Model Equations



$$V_L \cdot \frac{dC_a}{dt} = R_0 - \dot{Q}_{CO} \cdot (C_a - C_v)$$

$$V_B \cdot \frac{dC_v}{dt} = \dot{Q}_{CO} \cdot (C_a - C_v) - \dot{Q}_{Cl} \cdot C_a$$

During Infusion	After Infusion
$D = 100\ mg,\ t_D = 0.5\ min$	
$R_0 = \frac{D}{t_D}\ (mg/min)$	$R_0 = 0\ mg/min$
$C_a\ (0) = 0\ mg/L$	$C_a\ (0) = 24\ mg/L$
$C_v\ (0) = 0\ mg/L$	$C_v\ (0) = 1.8\ mg/L$
$V_L = 2.5\ L$	$V_L = 2.5\ L$
$V_B = 15\ L$	$V_B = 15\ L$
$Q_{CO} = 6\ L/min$	$Q_{CO} = 6\ L/min$
$Q_{Cl} = 2\ L/min$	$Q_{Cl} = 2\ L/min$

Interpretation: Explore the relationship between changes in cardiac output to changes in drug concentration during infusion in the recirculatory model. When a patient is in shock, cardiac output can decrease by 50% (i.e., Q_{CO} = 3 L/min). When a patient is experiencing sepsis or anxiety, cardiac output can increase by 50% (i.e., Q_{CO} = 9 L/min). You may estimate drug concentrations or other parameters based on your graphical results or use other MATLAB functions. Based on your findings, should clinicians administering anesthetic drug consider cardiac output when determining dosage amount for an individual patient? Justify your answer quantitatively.

Rubric Name: Exam 2

Solutions	**Level 4** 30 points	**Level 3** 25 points	**Level 2** 20 points	**Level 1** 15 points	
Analytic solution (by hand)	Correct solution and shows logical, detailed steps	Minor arithmetic or algebraic error	Solution method is not clear and/or is not presented in a logical flow	Attempted solution but not complete	No su
Symbolic and numerical solution (MATLAB)	Symbolic and numeric solution is correct	Minor coding error	Symbolic or numeric solution is correct	Major coding error	No so

Presentation	**Level 4** 20 points	**Level 3** 18 points	**Level 2** 15 points
Symbolic & numerical solution graphs	Both symbolic and numeric solutions are given on same graph, with appropriate axes labels, units, and legend	Missing axes label or units or legend	Missing 2 of 3: axes label or units or legend
Interpretations/Responses	Interpretations/responses are complete, justified, and reasonable	Interpretations/responses are complete but not adequately justified or are not reasonable	Interpretations/responses are incomplete, but justified and reasonable