ELEC 4170 Midterm
Electric Drives Laboratory

Name:_____

Instructions: Answer **ALL** three tasks in this exam, each task may have multiple questions, all questions are equally weighted. You are allowed to use any reference but each other and be sure to **show your work clearly.** All the key input data are *underlined*, **you need to use those** in schematics or settings. **No credit will be given for final answers without clear documentation of how you arrived at the solution.** Submit as the same format as assignment.

Task 1: Singe-phase full-wave diode rectifier with RL load

Recall Chapter 1

Make a new project. Build a single-phase full-wave diode rectifier with RL load

Use the sinusoidal source in the SOURCE lib set amplitude *60V* and frequency *60Hz*

Use the diode and load parts in the PSpice Component set resistor *100Ω*, inductor *100mH*. Let resistor inductor in series.

Use the time domain simulation set up, set run to time as *40ms* and maximum step size as $1e^{-6}$

a. Show your analysis tab of simulation settings.

b. Show your schematic with all essential parameters.

c. Plot the inductor current

d. Replace the inductor to *200mH*

1) Plot the new inductor current

2) Compare your answer from c. and answer from d.1). Use equations to explain the difference between

Task 2: Three-phase half-wave phase-controlled rectifier with RC load

Recall Chapter 2,

Make a new project. Build a three-phase half-wave phase-controlled rectifier with RC load

Use the sinusoidal source in the SOURCE lib set amplitude *450V* and frequency *20Hz*

Use the pulse voltage source in the PSpice Component and set the rising time *1μs*, falling time *1us*, pulse width *100μs*, low-side output voltage *0V*, and high-side output voltage *20V*

Use the load parts in the PSpice Component set resistor *5Ω*, and capacitor *500μF* in parallel.

Use the thyristor in the ELEC4174_Fall_2024 library.

Use the time domain simulation set up, set run to time as *50ms* and maximum step size as $1e^{-4}$

a. If we have voltage pulse (a phase gate signal) appears at *5ms*,

1) Calculate the firing angle.

2) Show the schematic of all gate signals.

3) Plot the voltage across the capacitor.

b. If we add another *250V* constant voltage load in series with the resistance, other conditions remain the same as in part a.

1) Plot the new voltage across the capacitor.

2) Compare your answers from a.3) with b.1). Briefly explain about what causes the difference.

Task 3: Three-phase bridge converter with RLC load.

Recall Chapter 3

Make a new project. Build a three-phase full bridge converter.

Use the DC source in the PSpice Component, and set amplitude *50V*

Use the IGBT, diode, wave generator, PWM generator in the ELEC4174_Fall_2024 library, set carrier wave peak *5V*, frequency *500Hz* and IGBT gate signal *±20V*

Use the load parts in the PSpice Component set resistor *1Ω*, inductor *5mH* in series and (RL) parallel with capacitor *1μF*.

Use the time domain simulation set up, set run to time as *200ms* and maximum step size as $1e^{-3}$

a. Show your bridge converter schematic with load, no source and reference voltage needed.

b. Assume positive sequence balanced output and the desired output voltage wave given as,

$$v_a(t) = 20\sin(10\pi * t)$$

1) Write down the expression for other two phases.

2) Plot the PWM for phase *c*, and briefly explain about PWM.

3) Plot the inductor current ripple.

4) Now the desired output voltage wave changes to $v_a(t) = 20\sin(1000\pi * t)$, other conditions remain the same.

Can you use the same PWM generator? If not, then design your own and briefly explain about it