Instructions:
This is a closed-book/closed-notes exam module, four hours in duration. There are ten (10) problems in this exam, and you will have a choice of answering only eight (8). The 4 questions from EE 234 and EE310 are required. The other 4 questions can be selected from other topics. The selected eight (8) questions must be clearly marked in the selection boxes below.

<table>
<thead>
<tr>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
<th>Q5</th>
<th>Q6</th>
<th>Q7</th>
<th>Q8</th>
<th>Q9</th>
<th>Q10</th>
</tr>
</thead>
</table>

Write your name and student ID below.

Full Name: ____________________________________________

Student ID: ____________________________________________

Please write your student ID Number of EVERY PAGE, but DO NOT write your name on any other pages of the exam.

Blank paper is provided if you need additional space to show your work. PLEASE INDICATE THE PROBLEM NUMBER ON EACH ADDITIONAL PAGE YOU USE.

Good Luck!
Consider the following matrix:

\[
\begin{bmatrix}
2 & 0 & 3 \\
0 & 5 & 0 \\
3 & 0 & 2
\end{bmatrix}
\]

a) Find its characteristic equation. (16 points)

b) Find all eigenvalues, their algebraic multiplicities and the spectral radius of the matrix. (24 points)

c) Find all eigenvectors and the geometric multiplicity of each eigen value. (60 points)
Question 2, ElecEng 234

a) Consider the following nonhomogeneous ODEs, find their homogeneous solution, and give the form (no need to determine coefficients) of nonhomogeneous solution. (48 points)
   i) $4y''+9y = 3e^{-x}\sin(1.5x) + \cos(1.5x)$
   ii) $y'' - 9y = 2\sinh(3x) + x^2$

b) Find the general solution of $y'' + 2y' + y = e^{-x}$ with following steps i) Determine homogeneous solution, ii) Find nonhomogeneous solution with coefficients determined using method of undetermined coefficients and iii) Arrive at the general solution. (52 points)
Question 3, ElecEng 310

Find the total response of a system specified by the equation

\[ y[n + 1] + 2y[n] = x[n + 1] \]

if \( y[-1] = 10 \), and the input \( x[n] = e^{-n}u[n] \). (10 points)
Question 4, ElecEng 310

(a) Find the zero-state response of an LTID system with transfer function and the input $[ \cdot ] = + [ \cdot ]$. (8 points)

$$H[z] = \frac{z}{(z + 0.2)(z - 0.8)}$$

(b) Write the difference equation relating the output $y[n]$ to input $x[n]$. (2 points)
Question 5, ElecEng 301

For the circuit of shown below, $v_s(t) = 30 \cos (200t - 5^\circ)$ and $I_s(t) = 10 \cos (400t + 25^\circ)$ (note that the two sources have different frequencies). Solve for the time-domain voltage across the 100 ohm resistor, $v_R(t)$. 

![Circuit Diagram]
Question 6, ElecEng 305

In the circuit shown below, find the impedance seen by the source and the current $I_1$. 

\[ 24^\circ V \pm \]

\[ I_1 \quad \text{Ideal transformer} \quad \text{Ideal transformer} \]
Question 7, ElecEng 354

Let \( F = [(AB)C + (A'B')C'] + [B'(AC') + B(AC')] \)

a) Simplify \( F \) using Boolean Algebra and obtain minimal sum of products.

b) Draw a logic circuit that implements simplified \( F \) using AND, OR, and NOT gates.

c) Implement \( F \) using NAND gates only.

d) Implement \( F \) using a decoder and an OR gate.

e) Implement \( F \) using only a multiplexer and NOT gates.
Question 8, ElecEng 367

Consider the following 10 bit signed number \( X \) (given in 2’s compliment notation) shown below:

\[ X = 1011001111_2 \]

(3 points) Determine the decimal (base 10) equivalent of \( X \)

(2 points) In general, what range of numbers (give your answer in decimal) can be represented by a 10 bit, 2’s compliment number?

(3 points) In a few words, explain the concept of “bus contention” as it relates to microprocessor design. What causes this condition, and how can it be avoided?

(2 points) Given a small microprocessor with limited Random Access Memory (RAM), would you choose to store a temporary variable in a ‘general purpose’ static RAM location, or in the memory area normally referred to as the ‘stack’. Explain your choice for full credit.
Question 9, ElecEng 362

1. A three phase induction motor runs at 246 \( r/min \) at no load and 238 \( r/min \) at full load when supplied from a three-phase 50Hz source.
   a. How many poles does the machine have?
   b. What is the synchronous speed in \( r/min \)?
   c. What is percent slip at no load?
   d. What is percent slip at full load?
   e. What is the slip speed in \( r/min \) at no load and full load?
   f. What is the rotor winding electrical frequency in Hz at no load and full load?
Question 10, ElecEng 362

2. Consider a DC motor with a shunt connected field circuit with the following parameters:
   \[ f = 160 \Omega, \quad a = \quad \Omega, \quad N_f = 2500 \text{ turns} \]
   a. If externally rotated at \( n = 1909 \text{ RPM} \) with a resultant open circuit voltage of 200V,
      find the constant in the back EMF that contains the information on motor geometry and
      the armature winding

   b. Using the result from (a), find the stalled torque when \( V_t = 200V \) is applied and the
      machine is operated as a motor, with the rotor position locked.

   c. Using the result from (a), find the applied mechanical torque and power to the shaft
      when the motor speed is at \( n = 1900 \text{ RPM} \)