THE AUSTRALIAN NATIONAL UNIVERSITY

First Semester Examinations 2008

ENGN3213
Digital Systems and Microprocessors
Supplementary Exam

Writing Period: 2 hours
Study Period: 15 minutes duration

Permitted Materials: Pens

Total 50 Marks (20% of Subject)

You must attempt all 5 questions
Q1. Fixed point arithmetic (10 marks; 20% Total)
Evaluate the following (1 mark each, except (i)),

(a) \(1304_{10} = X_2, \Rightarrow X = \)
(b) \(12_{16} = Y_5, \Rightarrow Y = \)
(c) \(011001 + 011 = \)
(d) \(0110010 - 101 = \)
(e) \(0101 \times 1011 = \)
(f) \(111001111002 = X_{16} \Rightarrow X = \)
(g) \(1001111002 = Y_8 \Rightarrow Y = \)
(h) Compute \(4_{10} + (-6)_{10}\) using two's complement arithmetic.
(i) Compute the following division in base 2. \(10111 / 101.\) Display the answer to 10 binary places (2 marks)
Q2. Logic Synthesis and Karnaugh Maps (5 marks; 10% Total)

Given the following expression representing a detector for odd prime numbers lower than 16,

\[ F = \Sigma_{A,B,C,D} (1, 3, 5, 7, 11, 13) \]  \hspace{1cm} (1)

(1) Draw the truth table. \textbf{(1 mark)}

(2) Write out the SOP representation of this expression. \textbf{(1 mark)}

(3) Draw the Karnaugh map from the truth table. \textbf{(1 mark)}

(4) On the Karnaugh map loop out the logical adjacencies. \textbf{(1 mark)}

(5) Write down the minimised Boolean logic expression arising from the Karnaugh map. \textbf{(1 mark)}
Q3. State machines and VERILOG  (15 marks; 30% Total)

A spread spectrum radio receiver is based on a synchronous FSM. It has an input X and an output Y where the output will only be '1' when the input sequence of received data bits, $X_k$, is the Barker sequence,

$$X_k = +1, +1, +1, -1, -1, -1, +1, -1, +1, -1.$$  \hspace{1cm} (2)

(1) Design a synchronous state machine, input and output logic to perform this task. Use any convenient flip flop arrangement for its implementation.  \hspace{1cm} (10 marks)

(2) Write VERILOG code that implements this system in HDL.  \hspace{1cm} (5 marks)
Q4. C Programming (10 marks; 20% Total)

Complete the subroutine ftn in the following C program. The subroutine is supposed to fill the elements of the 4 element array passed to it with consecutive integers, starting with the value of the first parameter passed to it. For example, as a result of the subroutine call in the main program, the array arr should be filled with the values 2,3,4,5. Carefully explain each line of code.

```c
void ftn(int a, int *b) {
    [complete the code]
}

int main()
{
    int *arr = malloc(4);
    ftn(2, arr);
    return 0;
}
```

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Q5. General Knowledge  (10 marks; 20% Total)

(a) Describe how a PIC microcontroller executes a branch instruction such as a subroutine call. (2 marks)

(b) Explain using diagrams how a Schmitt Trigger can debounce a switch. (2 marks)

(c) (1) Draw the truth table of a T flip-flop. (2 marks)
(2) Sketch a circuit implementation of the T flip-flop using one D-flip-flop. (2 marks)

(d) The D flip-flop shown in the following figure is applied the input signals shown in the traces.
(1) Define in words the meaning of setup and hold time (1 mark)
(2) Redraw the traces in the figure in your script books and label the setup and hold times of the flip-flop (1 mark).

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\text{[Diagram of D flip-flop and input traces]}
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