FIJI NATIONAL UNIVERSITY

COLLEGE OF ENGINEERING, SCIENCE AND TECHNOLOGY

School of Electrical & Electronics Engineering

Bachelor of Engineering (Electrical & Electronics/ Mechanical/ Building & Civil)

BEN506 – Introduction to Electrical & Electronics Engineering

FINAL EXAMINATION

Semester 2, 2015

Date: As per Exam Time Table

Time: As per Exam Time Table (3 hours)

Venue: As per Exam Timetable

Instructions to Students

1. You are allowed an extra ten (10) minutes of reading time during which you are NOT allowed to write.
2. Attempt ALL questions in this examination booklet
3. Write your answers in the answer booklet provided.
4. Write your Student ID number on each page used.
5. Begin each Section on a fresh page and use both sides of the answer sheet.
6. You may use calculators provided they are non-programmable.
7. Clearly number the questions in your answer paper in their correct sequence and write legibly. Show all working.
8. Attach any extra sheets used to your answer booklet securely with the string provided.

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Section A: Multiple Choices [12 marks]
Choose the letter of the BEST choice.

1. The largest decimal number that can be produced when using 8 bits is:
   a) 63
   b) 64
   c) 255
   d) 256

2. An asynchronous counter differs from a synchronous counter in:
   a) the number of states in its sequence
   b) the method of clocking
   c) the types of flip-flops used
   d) the value of the modulus

3. A 6-bit DAC has a resolution of:
   a) 0.015625%
   b) 0.015873%
   c) 1.562500%
   d) 1.587300%

4. An inverter
   a) performs the NOT operation
   b) changes a HIGH to a LOW
   c) changes a LOW to a HIGH
   d) does all the above

5. The output of an AND gate is HIGH when
   a) any input is HIGH
   b) all inputs are HIGH
   c) no inputs are HIGH
   d) both answers (a) and (b)

6. The output of an OR gate is HIGH when
   a) any input is HIGH
   b) all inputs are HIGH
   c) no inputs are HIGH
   d) both answers (a) and (b)

Please Turn Over

7. Proper handling of CMOS device is necessary because of its:

   a) fragile construction
   b) high-noise immunity
   c) susceptibility to electrostatic discharge
   d) smaller power dissipation

8. In a pnp transistor, the p regions are:

   a) base and emitter
   b) base and collector
   c) collector and emitter
   d) only base

9. BJT is a _____ controlled device.

   a) voltage
   b) current
   c) power
   d) none of the above

10. Sampling of an analog signal produces

    a) a series of impulses that are proportional to the amplitude of the signal
    b) a series of impulses that are proportional to the frequency of the signal
    c) digital codes that represent the analog signal amplitude
    d) digital codes that represent the time of each sample

11. The unit of electrical charge is:

    a) volt
    b) coulomb
    c) ohm
    d) joule

12. A current of 1.2A flows for 5 hours through a 125 Ω resistor. The energy consumed by the resistor is:

    a) 0.18 kWh
    b) 0.75 kWh
    c) 0.90 kWh
    d) 0.15 kWh

Please Turn Over

Section B: Short Answers [19 marks]

a) State ohm's law. [2 marks]

b) Draw the symbol of a 2 input XOR gate. [2 marks]

c) With the aid of diagram, show how you will connect an ammeter to measure the current through and the voltage across a resistor in an electronic circuit. [2 marks]

d) With the aid of diagrams, explain the terms digital and analog electronics. [2 marks]

e) State two disadvantages of using analog system over digital system. [2 marks]

f) Draw a fully labeled symbol for a p-channel JFET. [2 marks]

g) List two characteristics that made TTL superior compared to CMOS in the past. [2 marks]

h) Show the truth table of a 3 input X-NOR gate. [3 marks]

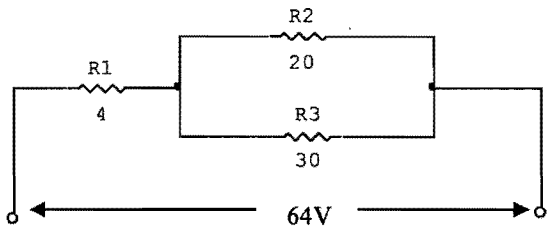
i) State two characteristics of an ideal op-amp. [2 marks]

Please Turn Over

Section C: Concepts and Calculations [68 marks]

Question 1: Circuit Analysis [28 marks]

a) Refer to the circuit shown below to answer the following questions (all resistances are given in ohms)

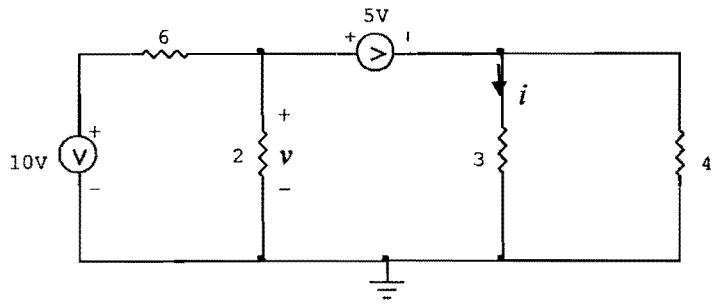


Calculate:

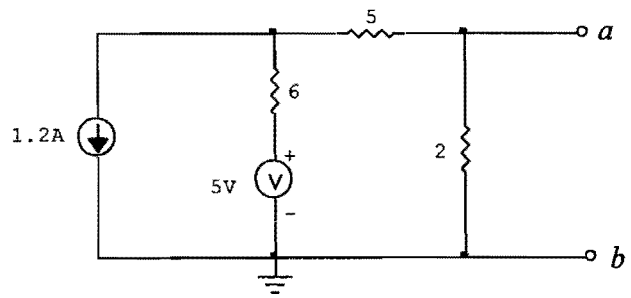
i) the total resistance of the circuit [2 marks]

ii) the power dissipated by R3 [3 marks]

b) Find the voltage *v* and current *i* in the circuit shown below using nodal analysis. [8 marks]



c) Find the Norton's equivalent circuit at terminals a-b for the circuit given below. [8 marks]

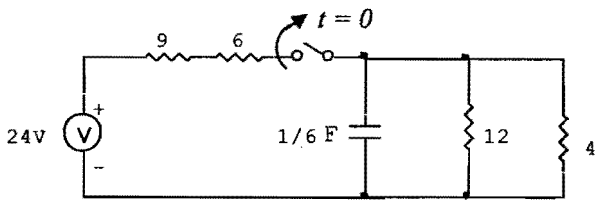


Please Turn Over

d) The switch in the circuit below has been closed for a long time, and it is opened at t = 0.

i) Calculate the initial energy stored in the capacitor. [3 marks]

ii) Find the voltage across the capacitor at $t = 0.53s$. [4 marks]



Question 2: Digital Electronics [30 marks]

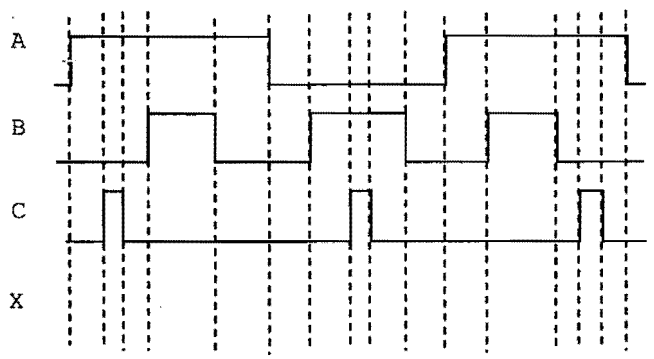
a) Represent the decimal number 38.375 in:

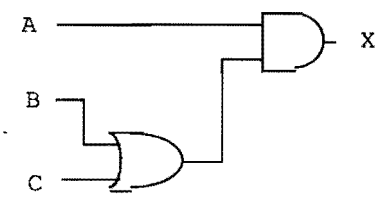
i) Binary [2 marks]

ii) Hexadecimal [2 marks]

b) Using Boolean algebra techniques and DeMorgan's theorems, simplify the expression $\overline{AB + AC} + \overline{A}\overline{B}C$ [3 marks]

c) Show the output waveform for the three input circuit shown below with its proper time relationship to the inputs. [4 marks]





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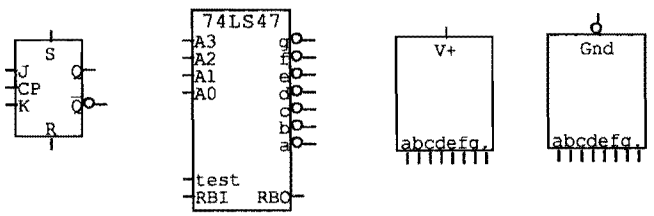
d) In a certain chemical processing plant, a liquid chemical is used in the manufacturing process. The chemical is stored in three different tanks. A level sensor in each tank produces a HIGH voltage when the level of the chemical in the tank drops below a specified point. Design a circuit that monitors the chemical level in each tank and indicates when the level in any two tanks drops below the specified point. Formulate the solution as follows:

i) Show the truth table for the problem solution. [3 marks]

ii) Determine the minimum SOP expression using Karnaugh map. [3 marks]

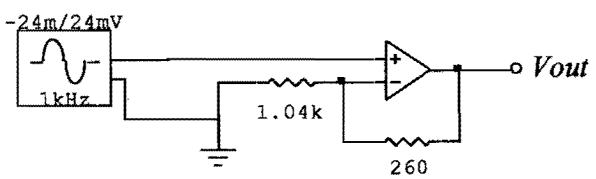
iii) Implement/draw the circuit. [2 marks]

e) Given the following components, design a synchronous counter that will count in the sequence 3, 5, 0, 7, 1 (after 1, the count should restart at 3) using JK flip-flops. The counter is to be self-starting and restart counting at 3 after 1. The final prototype must be a completely functional circuit which utilizes the 74LS47 BCD to 7 Segment Decoder/Driver. Select the correct 7 segment display to be used from the two given. [11 marks]



Question 3: Analog Electronics [11 marks]

a) Determine and draw the output waveform of the operational amplifier (w.r.t the input waveform) circuit shown below. [3 marks]



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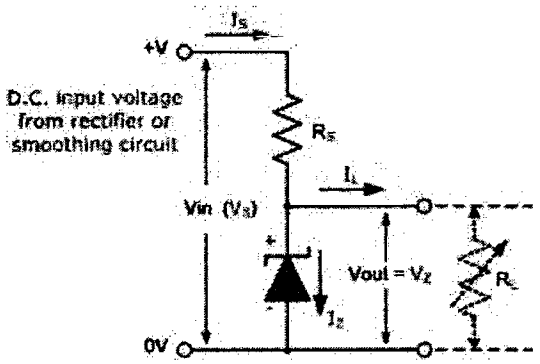
b) Show with the aid of a circuit diagram how an NPN transistor can be used as a switch for controlling a load. Briefly explain the circuit operation. [4 marks]

c) A 5 V stabilized power supply is required from a 12 V dc input source. The maximum power rating of the Zener diode is 2.2 W. Using the circuit given below, calculate:

i) the maximum current flowing in the Zener diode [1 mark]

ii) the value of the series resistor, R_s. [1 mark]

iii) the total supply current, I_s when connected to a load of 1 kΩ. [2 marks]



THE END

Please find attached the solution sheet for Section C; Q2(c) on the next page. Attach this to your answer booklet.

ALL THE BEST FOR THE EXAMINATION

SOLUTION SHEET (Please attach this sheet to your Answer Booklet)

Section C: Question 2 (c)