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UNIVERSITY OF SWAZILAND

FACULTY OF SCIENCE

**DEPARTMENT OF ELECTRONIC ENGINEERING**

MAIN EXAMINATION 2005

TITLE OF PAPER: **INTRODUCTION TO ANALOG & DIGITAL ELECTRONICS**

COURSE NUMBER: **E212**

TIME ALLOWED : THREE HOURS

INSTRUCTIONS: ANSWER ANY **FOUR QUESTIONS** OUT OF FIVE QUESTIONS.

EACH QUESTION CARRIES 25 MARKS

MARKS FOR DIFFERENT SECTIONS ARE SHOWN IN THE RIGHT HAND MARGIN

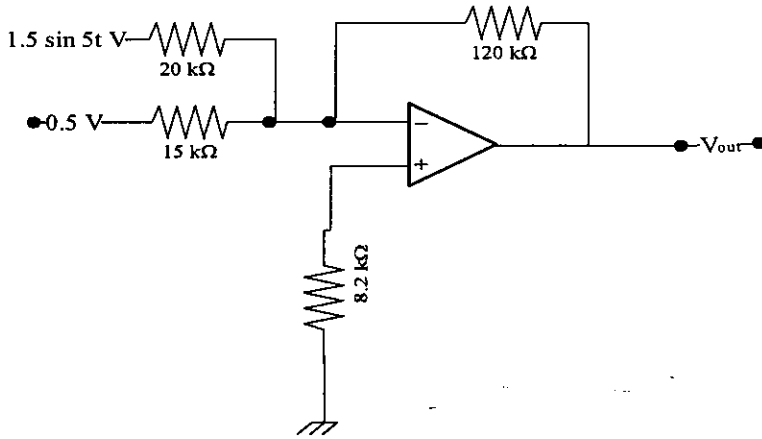
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**Question 1**

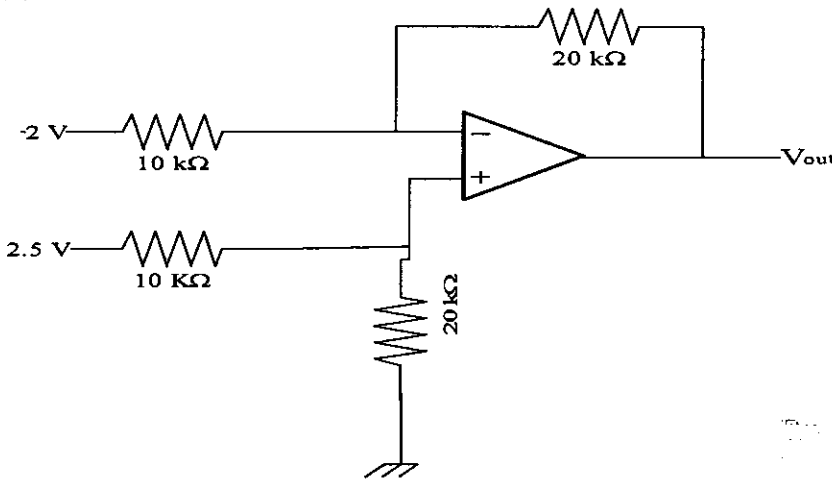
For each of the following op-amp circuits, determine the output  $V_{out}$ .

(a)



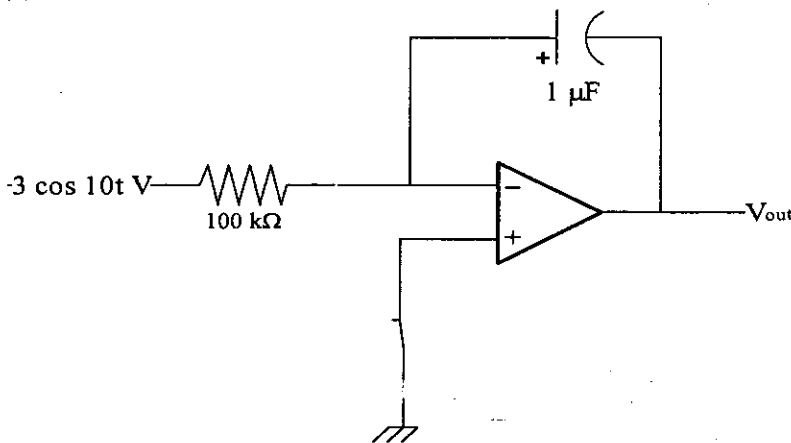
[ 8 marks ]

(b)



[ 8 marks ]

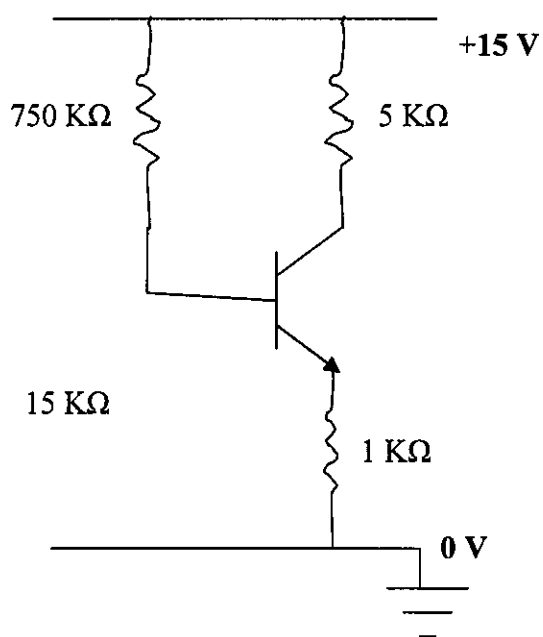
(c)



[ 9 marks ]

**Question 2**

- (a) Using the output characteristics of a common base bipolar junction transistor (BJT) amplifier, indicate the three modes of operation of the BJT. State the conditions of the emitter-base and collector-base junctions in each mode. [11 marks]
- (b) Calculate  $\beta$  for a transistor for which  $\alpha = 0.995$ . For a collector current of 15 mA, find the base current of the transistor. [4 marks]
- (c) For the circuit shown below,  $V_{BE} = 0.7$ ,  $\beta = 100$ . Determine  $I_B$ ,  $I_C$  and  $V_{CE}$ . [10 marks]

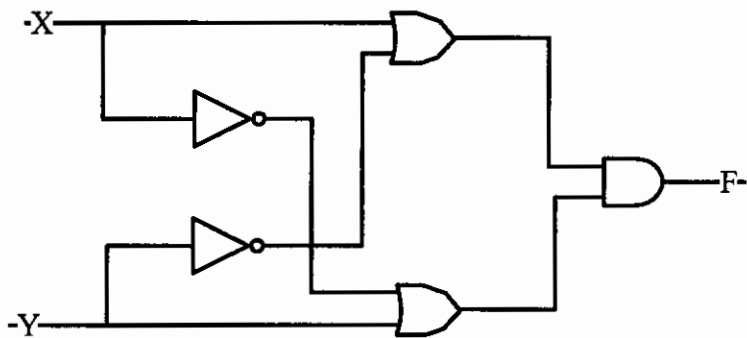


**Question 3**

- (a) What are the differences between JFET, MOSFET and CMOS?  
[ 14 marks ]
- (b) Using the output ( $I_D$ - $V_{DS}$ ) characteristics of a MOSFET, indicate the three regions of operation of a FET. Give the conditions for the FET to be in each of the three regions of operation in terms of  $V_{GS}$ ,  $V_t$ , and  $V_{DS}$ .  
[ 5 marks ]
- (c) You are given a MOSFET with  $V_t = 2$  V. Determine the region of operation in which it will be for the following  $V_{GS}$  and  $V_{DS}$  voltage values:
- (i)  $V_{GS} = 1.8$  V,  $V_{DS} = 5$  V [ 2 marks ]
- (ii)  $V_{GS} = 3.5$  V,  $V_{DS} = 4.5$  V [ 2 marks ]
- (iii)  $V_{GS} = 4.5$  V,  $V_{DS} = 2$  V [ 2 marks ]

Question 4

- (a) Given the logic function  $X = ABC + \overline{BC} + A$
- (i) Simplify the function using de Morgan's theorem. [5 marks]
  - (ii) Implement the simplified function using basic logic gates. [3 marks]
- (b) With reference to the following logical circuit:
- (i) Obtain the Boolean expression for the output F. [3 marks]
  - (ii) Work out the truth table. [3 marks]
  - (iii) Which logic function or gate has the derived truth table? [2 marks]



- (c) Design a circuit to produce an output corresponding to the following truth table. Do any obvious simplifying:

[ 9 marks]

X	Y	Z	F
0	0	0	1
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	0

**Question 5**

- a) Explain what you understand by rectification efficiency. [3 marks]
- b) What are the advantages of using capacitor-input filters in rectifiers? [3 marks]
- c) Sketch the volt-ampere characteristic of a zener diode. [3 marks]
- d) For the circuit shown below, the input voltage  $V_s = 2 \sin(100\pi t)$ , the cut-in voltage of the diode  $V_\gamma = 0.5$  volts, and  $R = 100 \Omega$
- i) find the expression for the voltage across  $R$ , [3 marks]
- ii) find the ignition angle and extinction angle, [10 marks]
- iii) sketch the current through the resistor  $R$  for two cycles [3 marks]

