



SCHOOL OF ELECTRICAL & ELECTRONICS
ENGINEERING.

CERTIFICATE IV IN ELECTRONICS ENGINEERING

STAGE 3

EEE 413 – ANALOG ELECTRONICS 1A.

FINAL EXAMINATION – PENSTER 2 - 2016.

DAY/DATE: As per Timetable TIME: As per Timetable ROOM: As per timetable.

INSTRUCTIONS TO STUDENTS'

1. *You are allowed 10 minutes Extra reading time during which you are NOT to write.*
2. *Begin each answer on a fresh page and use both sides of the sheet.*
3. *Write your candidate-number at the top of each attached sheet*
4. *Insert all written foolscaps, graph paper, drawing paper, etc. in their correct sequence and secure with string*
5. *For all sheets of paper on which rough/draft work has been done, cross it though and you MUST ATTACH to your answer scripts.*
6. *Write clearly the number(s) of the question(s) attempted on the top of each sheet.*
7. **ANSWER ALL QUESTIONS.**
8. *You **MUST attach multiple questions sheet** together with the Answer script.*
9. *Do not use programmable calculators*
10. **ALWAYS CHECK YOUR WORK BEFORE YOU LEAVE THE ROOM!**

Section A

Multiple Choice

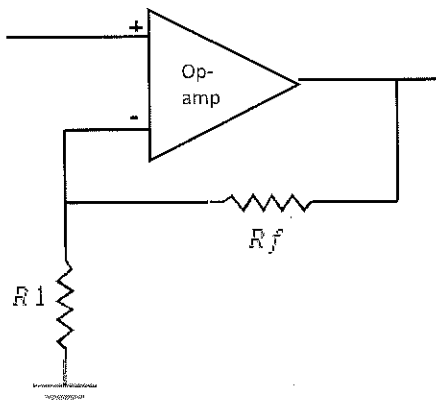
[20 Marks]

Write the **Alphabet** of the **best choice** in the Answer Sheet.

1. How many junction does a BJT have?
A) 1
B) 2
C) 3
D) 4

2. In common mode operation,
A) Both inputs are grounded
B) The outputs are connected together
C) An identical signal appears on both inputs
D) The output signals are in phase

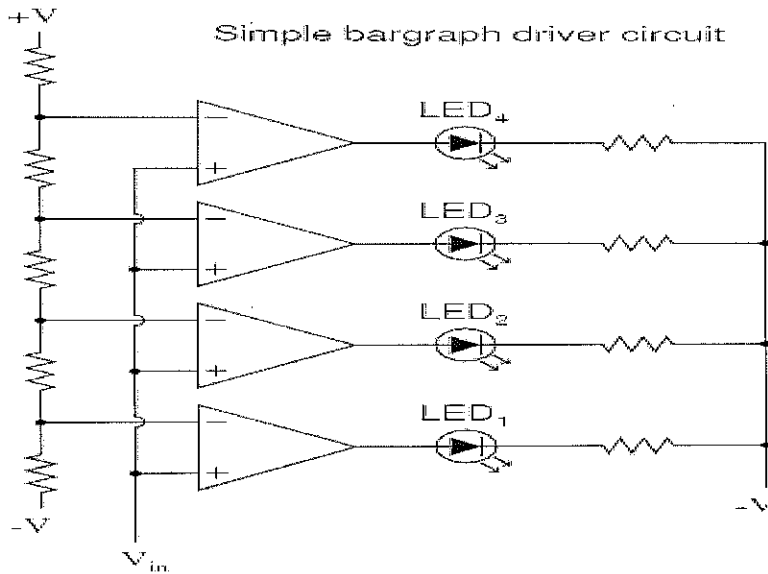
- 3) Calculate the overall voltage gain of the circuit if $R_1 = 5K\Omega$ and $R_F = 150K\Omega$



- A) -31
 - B) 31
 - C) -30
 - D) 750
-
- 4) What is the slew rate of an op-amp if the output voltages change from 3 V to 6 V in 0.3ms?
A) 10 V/ms
B) 3 V/ms
C) 5 V/ms
D) 1 V/ms

- 5) If $A_v(d) = 250$ and $A_{cm} = 0.025$, the CMRR is
- A) 625
 - B) 10,000
 - C) 80dm
 - D) Answer B and C
- 6) Which power amplifier has the least efficiency?
- A) Class A
 - B) Class B
 - C) Class C
 - D) Class D
- 7) Which of the following pin numbers represent the output terminal of LM741 operational amplifier?
- A) 2
 - B) 3
 - C) 4
 - D) 6
- 8) In NPN transistor, the N-Region are
- A) Base and emitter
 - B) Base and collector
 - C) Emitter and collector
 - D) Only base
- 9) If I_c is 100 times larger than I_B , then β is
- A) 0.02
 - B) 100
 - C) 50
 - D) 500
- 10) The approximate voltage across the forward-biased base-emitter junction of a silicon BJT is
- A) 0V
 - B) 0.7V
 - C) 0.3V
 - D) V_{BB}
- 11) The FET is
- A) A Unipolar device
 - B) A voltage- controlled device
 - C) A current-controlled device
 - D) Answers A and B

12) Which **LED** will be the *last* one to light up in the circuit?



- A) LED 1
- B) LED 2
- C) LED 3
- D) LED 4

13) BJT is a _____ controlled device. The JFET is a _____ controlled device

- A) Voltage, voltage
- B) Voltage, Current
- C) Current, Voltage
- D) Current, Current

14) Which of the characteristics does not necessarily apply to an op-amp?

- A) High Gain
- B) Low Power
- C) High Input impedance
- D) Low output impedance

15) If β_{DC} is hundred and I_B is $200 \mu A$, then the I_C is

- A) 20mA
- B) 20,000mA
- C) 20,000 μA
- D) Both A and C

- 16) For a certain JFET, $I_{GSS} = 10\text{nA}$ at $V_{GS} = 10\text{V}$. The input resistance is
- A) $100\text{M}\Omega$
 - B) $1\text{M}\Omega$
 - C) $1000\text{M}\Omega$
 - D) $1000\text{m}\Omega$
- 17) A JFET always operates with
- A) The gate-to-source *pn* junction reversed-biased
 - B) The gate-to-source *pn* junction forward-biased
 - C) The drain connected to ground
 - D) The gate connected to source
- 18) For a properly biased PNP transistor, let $I_C = 10\text{mA}$ and $I_E = 10.2\text{mA}$. What is the level of I_B ?
- A) 0.2A
 - B) 200mA
 - C) $200\mu\text{A}$
 - D) 20.2mA
- 19) When operated in active region, the transistor acts like
- A) A linear amplifier
 - B) A switch
 - C) A variable capacitor
 - D) A variable resistor
- 20) What is the ratio of I_D/I_{DSS} for $V_{GS} = 0.5V_P$?
- A) 0.25
 - B) 0.5
 - C) 1
 - D) 0

SECTION B

QUESTION 1

Operational Amplifier (OP-AMPS)

[20 Marks]

- A) List three characteristics of a practical **OP-AMP**. (3 marks)

- B) A certain amplifier has a differential gain voltage of 2000 and a common mode gain of 0.2. Determine the CMRR and express it in dB. (2 marks)

C) Match Column A to Column B

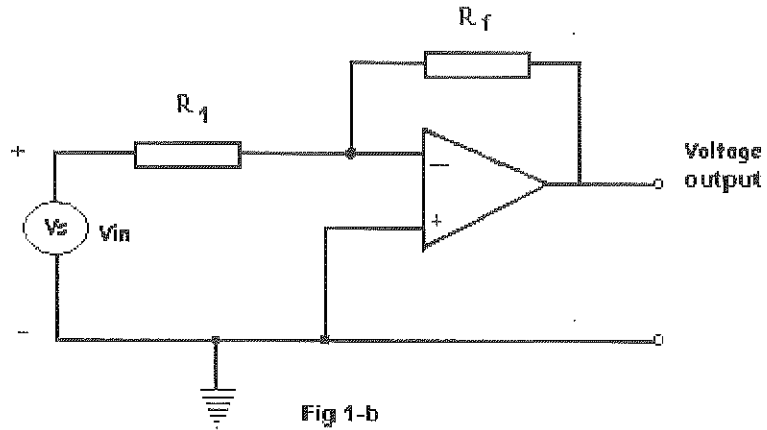
Column A

Column B

| | |
|-----------------------------------|---|
| 1. Slew Rate | i. Is the voltage that must be applied between the two input terminals of an op-amp to null the output. |
| 2. Input offset voltage, V_{IO} | ii. Is the maximum rate of change of output voltage per unit of time. |
| 3. Input offset current, I_{IO} | iii. Is the measure of an amplifier's ability to reject common mode signals. |
| 4. CMRR | iv. Is the algebraic difference between the currents into the inverting and non-inverting terminals. |

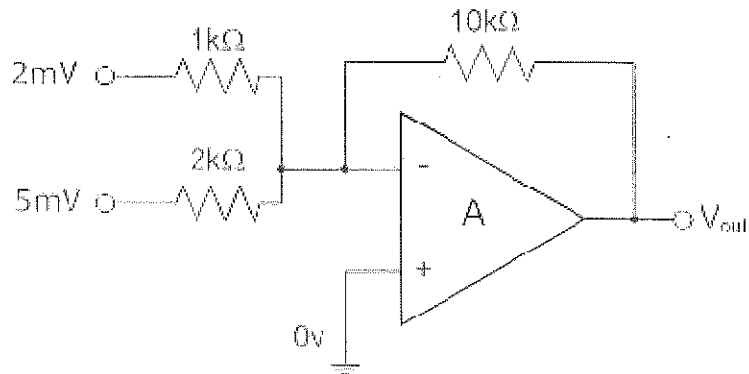
(4 marks)

- D) i) State the Expression for the voltage gain of the **OP-AMP** circuit given below in **Figure 1-b** (1 mark)
- ii) Calculate the gain of the amplifier if R_f has a resistance of $20K\Omega$ and R_1 , a resistance of $5K\Omega$. (2 marks)
- iii) Calculate the output voltage, if $V_{IN} = 10V_{P-P}$ (2 marks)
- iv) Explain the purpose of the feedback resistor R_f in the circuit. (2 marks)



E) Fig 1-F below shows a circuit diagram of an Op-Amp circuit.

- i) Identify the circuit. (1 mark)
- ii) Calculate the **output Voltage (V_o)**. (3 marks)



QUESTION 2**BIPOLAR JUNCTION TRANSISTORS****[20 Marks]**

- A) Draw the Physical and Symbolic Representation of the two types of **BJT**. (2 marks)
- B) State the three regions of operation of a bipolar transistor. (3 marks)
- C) List any three biasing methods. (3 marks)
- D) Use the **BJT Data Sheet** provided to answer the questions asked.

| TYPE | CASE | POL MAT | V _{CE} | V _{CB} | I _C mA | V _{CES} @I _C mA | H _{fe} @ I _C mA | P(TOT) mW | USE | EQUIVALENT |
|----------|-------------|---------|-----------------|-----------------|-------------------|-------------------------------------|-------------------------------------|-----------|--------------|---------------------|
| BD140 | TO-126 | PS | 80 | 100 | 1.5A | 0.5@500 | 40@250 | 8W | G.P. o/p | 40410 |
| BC107 | TO-18 | NS | 45 | 50 | 100 | 0.25@10 | 110@450 | 300 | G.P.S.S. amp | BC207, BC147, BC182 |
| BC559 | TO-92 VAR 1 | PS | 30 | 30 | 100 | 0.65@100 | 125@800 | 500 | G.P.S.S. amp | BC159 |
| 2N3055 | TO-3 | NS | 60 | 70 | 15 A | 1.1@4A | 20@70 4A | 115W | G.P. power | BDY 20 |
| TIP 3055 | TOP-3 | NS | 70 | 100 | 15 A | 1.1@4A | 20@ 4A | 90W | Power output | MJE 3055 |

- i. Current gain of MJE 3055 and what current can this transistor operate from? (2 marks)
- ii. Material used in all transistors? (1 mark)
- iii. Abbreviation of G.P.S.S. from the table. (1 mark)
- iv. Power dissipation of TIP3055? (1 mark)
- v. Package of BC207? (1 mark)
- vi. Polarity of the BD140 transistor? (1 mark)

E) Refer to the circuit in **Fig 2-D** below

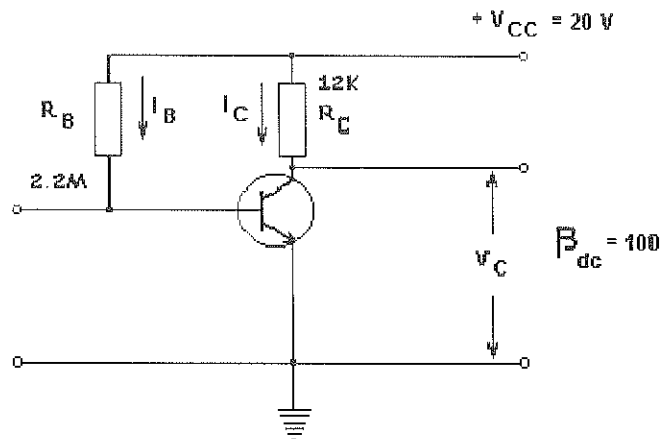


Fig 2-D

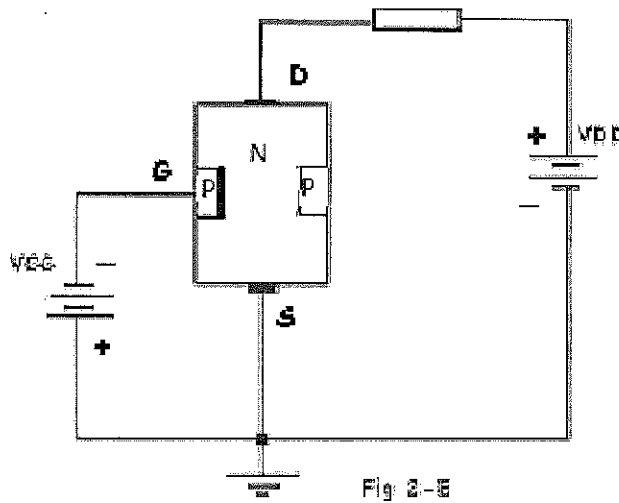
- Calculate the values of:
- i) Base current (I_B) (2 marks)
 - ii) Collector current (I_C) (1 mark)
 - iii) Collector voltage (V_C) (2 marks)

QUESTION 3

FIELD EFFECT TRANSISTORS

[20 Marks]

- A) There are two main types of Field Effect Transistor (FET). The JFET and MOSFET. For each type of FET, draw the following standard symbol:
- i) N – Channel JFET
 - ii) P – Channel D – MOSFET
 - iii) N – Channel E - MOSFET (3 marks)
- B) **Fig 2-E** shows a circuit of a **Junction Field Effect Transistor (JFET)**. It shows biased voltages applied to an N – Channel device.
Clearly explain the JFET Operation from the circuit below.

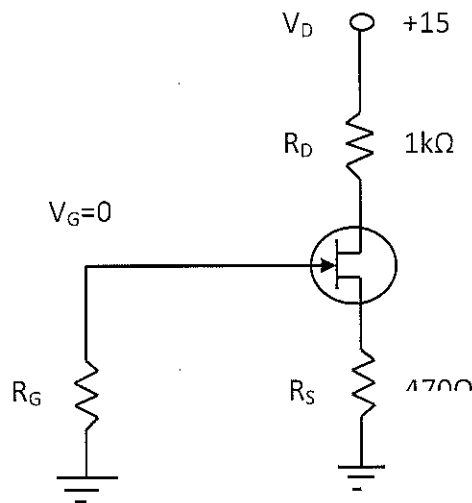


(4 marks)

C) A certain JFET has an I_{GSS} of 2nA for $V_{GS} = -20\text{V}$.
Determine the input resistance?

(3 marks)

D) Find V_{DS} and V_{GS} in the figure below, given that $I_D = 5\text{mA}$.



(4 marks)

E) For a certain D-MOSFET, $I_{DSS} = 18\text{mA}$ and $V_{GS(off)} = -8\text{V}$.

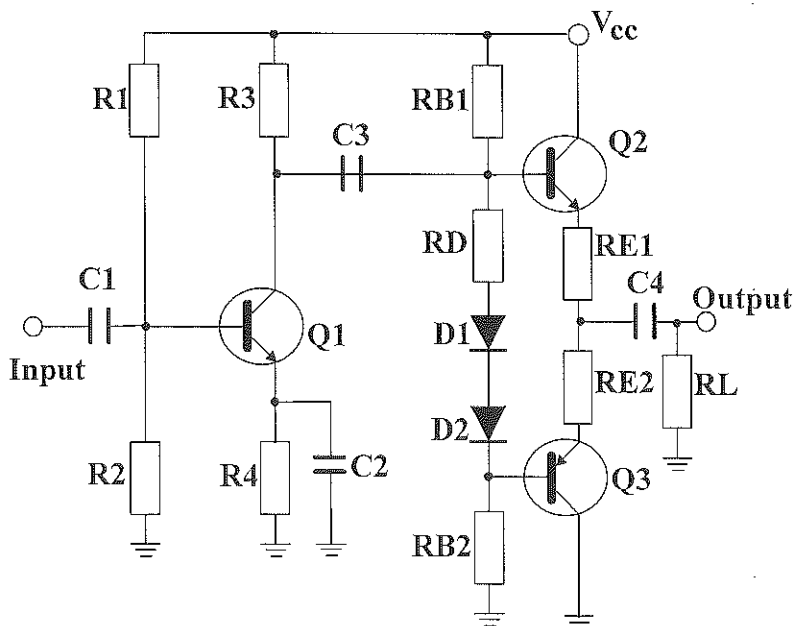
- i. Calculate I_D at $V_{GS} = -3\text{V}$.
- ii. Calculate I_D at $V_{GS} = +3\text{V}$.

(3 marks)

(3 marks)

QUESTION 4**POWER AMPLIFIERS****[20 Marks]**

- A) i) Which type of Power amplifier has the highest efficiency? (1 mark)
 ii) Give the application of the above power amplifier? (1 mark)
- B) A class C amplifier is driven by a 200kHz signal. The transistor is on for $1\mu\text{s}$, and the amplifier is operating over 100% of its load line.
 If $I_{C(\text{SAT})} = 100\text{mA}$ and $V_{CE(\text{Sat})} = 0.2\text{V}$, what is the average power dissipation? (2 marks)
- C)
 i. What is heat sink made of? (1 mark)
 ii. What is the function of heat sink? (1.5 marks)
 iii. Why are the heat sinks mostly fin shaped? (1.5 marks)
- D) Refer to diagram below and answer the following questions:
 a. Identify the circuit below. (1 mark)
 b. State the function of the following components.
 i) C_3 . (2 marks)
 ii) D_1 and D_2 (2 marks)
 iii) RB_1 and RB_2 (2 marks)
 iv) RD (2 marks)



- E)
 i. A class A amplifier has a current gain of 85 and voltage gain of 60.
 Calculate the power gain? (1 mark)

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- ii. A class A amplifier is biased with a centred Q-point at $V_{CEQ} = 9V$ and $I_{CEQ} = 15mA$. Calculate maximum output power? (2 marks)

*****THE END*****