FEDERAL UNIVERSITY OF TECHNOLOGY OWERRI
SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY
DEPARTMENT OF ELECTRICAL /ELECTRONIC ENGINEERING
2018/2019 RAIN SEMESTER EXAMINATION
ECE 316: Applied Electronics 24th October 2019

Instruction: Attempt Any Five questions of your choice Unit: 3; Time: 3 hours

FOR OPERATIONAL AMPLIFIERS (All questions carry 20 marks)

1a. In a tabular form, compare an ideal operational amplifier (op-amp) and a real op-amp with respect to their input resistance ***Ri***, output resistance ***Ro*** and open loop gain ***A***. Give the **two** primary equations that define an ideal op-amp completely. **(5 marks)**

1b. Draw the equivalent circuit of a real op-amp and its characteristic curve showing the output voltage *vo* as a function of the differential input voltage *vd* (Indicate all regions). **(5 marks)**

1c. An instrumentation amplifier shown in Fig.1 is an amplifier of low-level signals used in process control or measurement applications and commercially available in single-package units. Given that amplifier A3 is a difference amplifier, show that (complete derivation) **(10 marks)**

$$v_o = \frac{R_2}{R_1}\left(1 + \frac{2R_3}{R_4}\right)(v_2 - v_1)$$

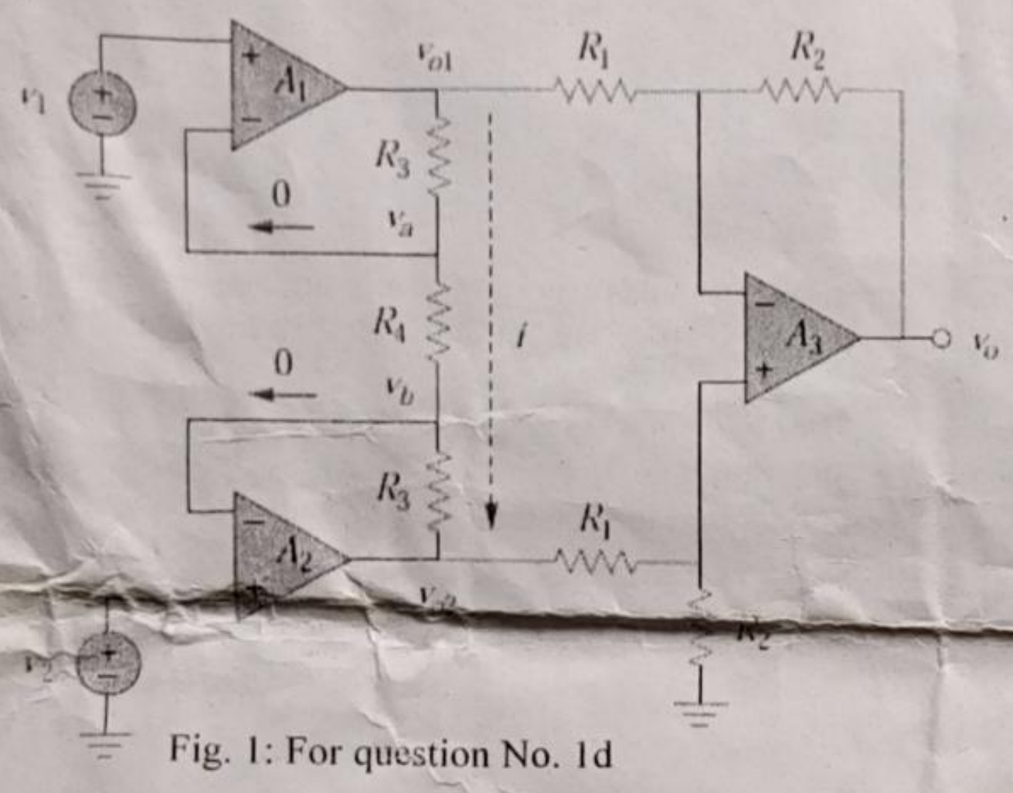

Fig. 1: For question No. 1d

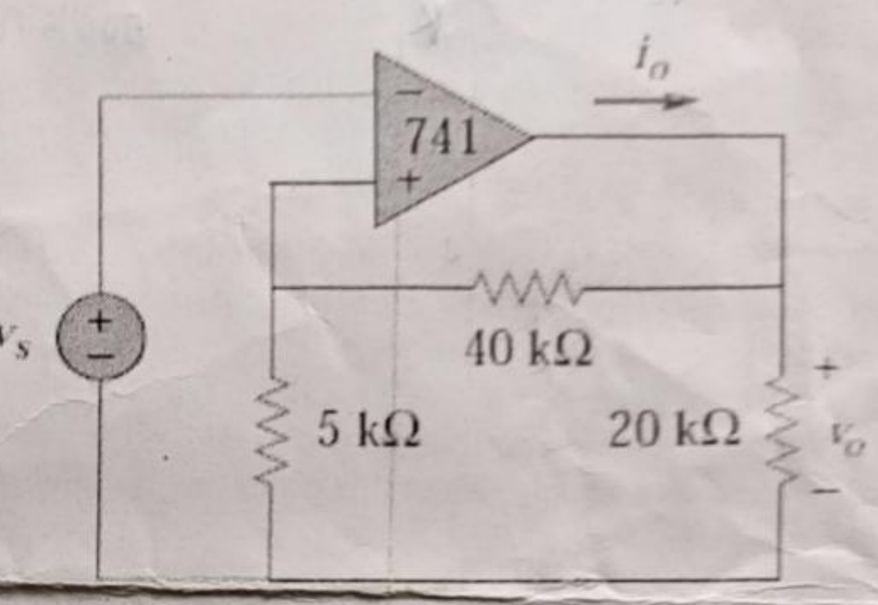

Fig. 2: For question No. 2a

2a. A 741 op-amp has an open-loop voltage gain of 2 x 105, input resistance of 2MΩ and output resistance of 50 Ω. The op amp is used in the circuit of Fig2. Find the closed-loop gain vo/vs and determine current io when vs = 1 V. (10 marks)

2b. Confirm the **two solutions** obtained in question **2a** by considering the op-amp as an ideal op-amp. **(5 marks)**

2c. List **only five** applications of an op-amp in electrical, electronic or control circuitries. **(5 marks)**

FOR BREAKDOWN DEVICES (All questions carry **20 marks**)

3a. The phase control circuit of Fig. 3 is connected to an ac supply $v = 60 \sin \Theta$ and load RL = 50Ω. Gate current is 100μA and gate voltage 0.5V. Determine the range of adjustment of *R* for the silicon-controlled rectifier (SCR) to be triggered between 30° and 60°. Take the diode barrier voltage to be 0.7V. **(5 marks)**

3b. List **three** methods of turning on and **two** methods of turning off an SCR. **(5 marks)**

3c. List **five** applications of a silicon-controlled rectifier. **(5 marks)**

3d. The two-transistor analogy of an SCR has the following data: PNP transistor gain = 0.4; NPN transistor gain = 0.5; gate current IG = 50mA. Calculate the anode current IA of the device. **(5 marks)**

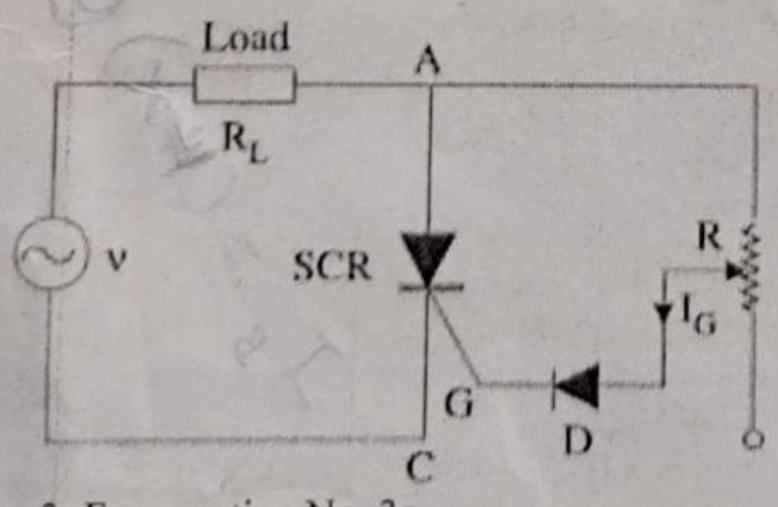

Fig. 3: For question No. 3a

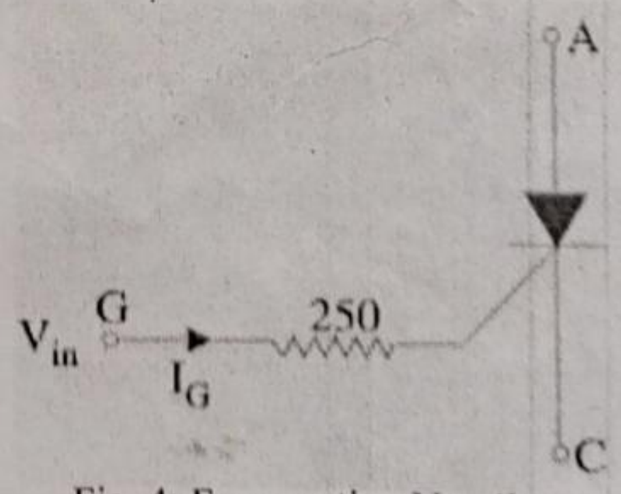

Fig. 4: For question No. 4b

4a. Describe the following thyristors using only their detailed electronic symbol, PN structure and IV characteristic.

i) Silicon controlled rectifier **(3 marks)**

ii) Triode ac **(3 marks)**

iii) Diode ac **(3 marks)**

iv) Unijunction Transistor **(3 marks)**

4b. A 250 Ω resistor is connected in series with the gate of an SCR as shown in Fig 4. The gate current required for firing the SCR is 8mA. Calculate the value of the input voltage Vin required for causing the SCR to breakdown. **(4 marks)**

4c. Thyristors are otherwise known as breakdown devices due to a phenomenon called avalanche breakdown. Thus, differentiate between avalanche breakdown and Zener breakdown. **(4 marks)**

5a. Outline seven major considerations (parameters) while using a Bipolar Junction Transistor (BJT) for electronic circuit design. Explain three of them (6 marks)

5b. In a Transistor configuration, V_{CC} = +35v, biasing resistors connected in voltage-divider pattern with R_1=2550Ω, R_e=900Ω and R_2=11450Ω. Calculate the bias voltage (3 marks)

(c) Sketch the symbol of complementary metal oxide semiconductor <CMOS>, label all the terminals and state 2 applications of this component (4 marks)

(d) A BJT circuit shown in figure 5 has a current gain (ß) of 50 and Emitter-Base voltage V_{BE} of 600mV. Determine the Emitter-Collector Voltage V_{EC} in volts (7 marks)

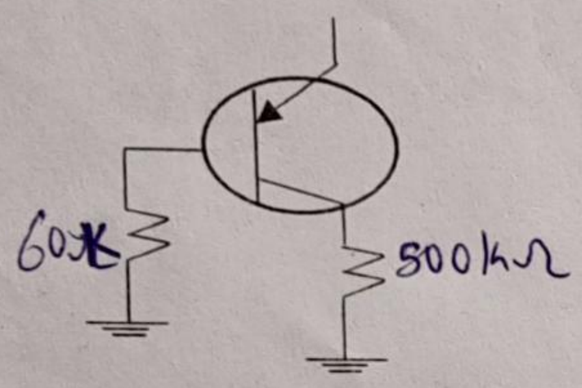

Fig 5: A PNP transistor

6a. With the aid of circuit diagram, explain the 3 types of BJT configuration and their respective main applications (5 marks)

6b. Sketch the input and output characteristics of a common Emitter BJT configuration. From there, determine the Q-point and internal resistance (r) respectively (6 marks)

6c. Compare MOSFET types with JFET types by sketching their symbols only (4 marks)

6d. A common based current gains of a BJT is 0.92 and its collector base junction reverse bias saturation current I_{CO}=0.45μA. Determine the collector current I_C, when this transistor is connected in CE mode and operated in the active region with base current I_B of 160μA (5 marks)