ID:	Name:

Brac University

Semester: Fall 2024
Course Code: CSE251
Electronic Devices and Circuits
Section: 01-28

Set 02

Assessment: *Final Exam*
Duration: 1 hour 30 minutes
Date: 11 January, 2025
Full Marks: 30

Instructions: **Answer all the questions** and read the questions carefully.

■ Question 1 of 3 *[CO1] [6 marks]*

(a) **[1.5 marks]** Why can we use BJTs as switches? **Explain** briefly with necessary graphs.

(b) **[2 marks]** **Draw** the input and output voltage waveforms of a full-wave rectifier with CVD model when a sinusoidal voltage is applied as input. **Label** the graph properly. **Indicate** the states of the diodes during the positive and negative half cycles of the input voltage.

(c) **[1 mark]** "A resistor is connected to the base of a BJT to build logic gates." - **Explain** the reason briefly.

(d) **[1.5 marks]** Will the output waveform change if you decrease the value of the load resistance of a full-wave rectifier with a capacitor? **Explain** briefly.

■ Question 2 of 3 *[CO2] [16 marks]*

(a) **[6 marks]** **Analyze** the circuit in *Figure-1* and **calculate** the values of I_B, I_C, I_E, and V_O using the method of assuming states. You must **validate** your assumption. Here, $\beta = 100$.

(b) **[6 marks]** **Analyze** the circuit in *Figure-2* and answer the following questions:
(i) **Show** that, if the MOSFET, M2 conducts current, it will operate in the saturation mode. [Hint: You don't need to solve the circuit]
(ii) **Calculate** the values of V_{out}, $I_{R_{D_1}}$, and $I_{R_{D_2}}$ using the method of assuming states. You must **validate** your assumptions.

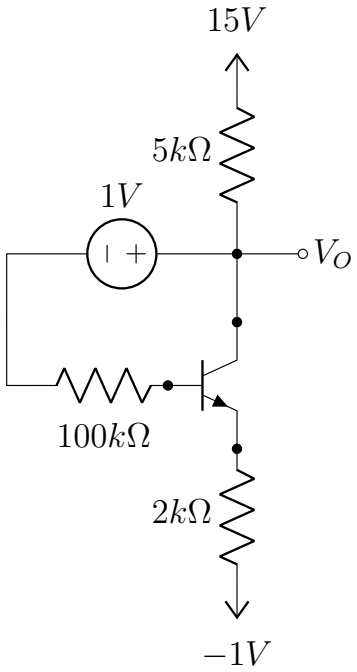
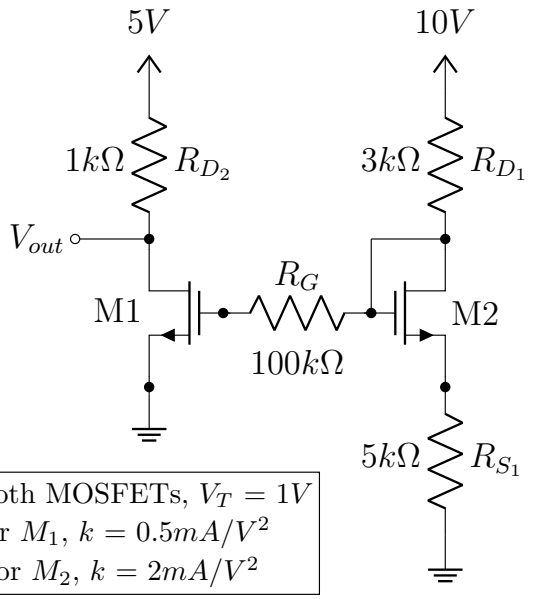


Figure-1



for both MOSFETs, $V_T = 1V$
for M_1, $k = 0.5mA/V^2$
for M_2, $k = 2mA/V^2$

Figure-2

MOSFET Equations

Cut-off Mode: $I_{DS} = 0$
Triode Mode: $I_{DS} = k\left[V_{OV}V_{DS} - \frac{1}{2}V_{DS}^2\right]$
Saturation Mode: $I_{DS} = \frac{1}{2}kV_{OV}^2$

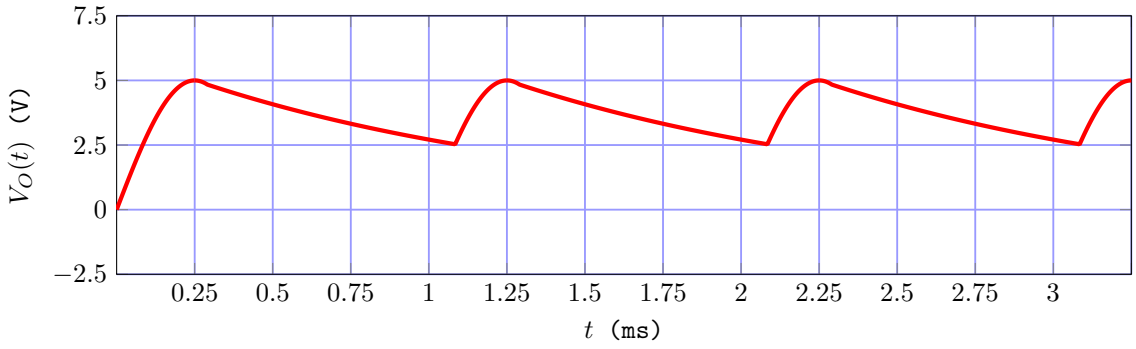


Figure-3

(c) **[2 marks]** In *Figure-3*, you are given the output voltage waveform of an unknown rectifier circuit with an output load resistance, $R = 5k\Omega$, input frequency, $f_{in} = 0.5kHz$, and $V_{D0} = 0.55$V. **Analyze** the waveform in *Figure-3*, and **determine** the output voltage frequency, f_{out} and **draw** the rectifier circuit with proper labels.

(d) **[2 marks]** **Analyze** the circuit in *Figure-4*, and **draw** the output voltage waveform for $V_{in} = 6sin(100\pi t)\ V$.

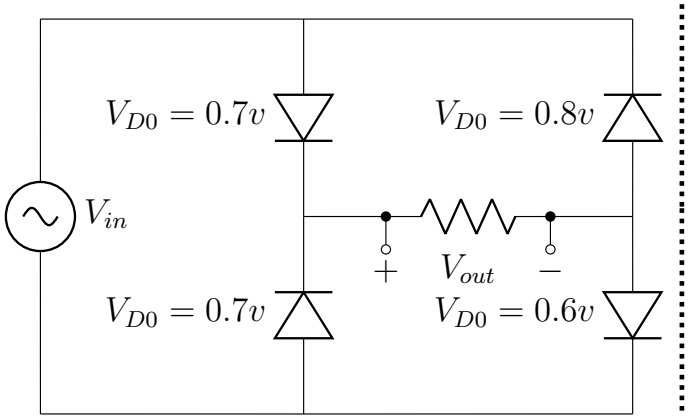


Figure-4

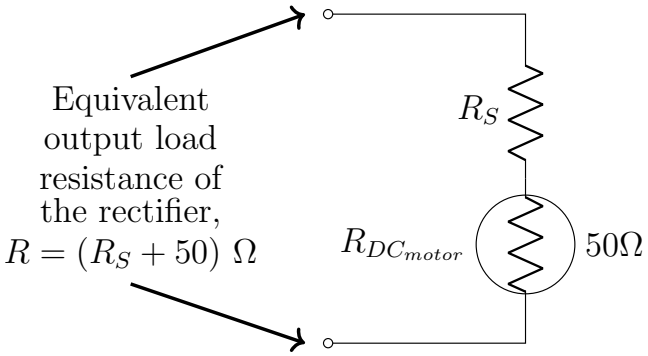


Figure-5

■ Question 3 of 3 *[CO3] [8 marks]*

(a) **[3 marks]** **Design** the circuits with the boolean inputs A, B, C to implement the following boolean logic functions:
(i) $f = \overline{A}.\overline{B} + A.B$ [use MOSFETs] (ii) $g = C.A + B.C + A.B$ [use BJTs]

(b) **[5 marks]** Shadman has access to a sinusoidal voltage source of, $V_{in} = 12sin(500\pi t)\ V$ and he needs a DC voltage source to run a DC motor. The DC motor requires a very good quality DC voltage source to run. But it is difficult for him to get a pure DC voltage source. So, Shadman decided to build a rectifier that will take V_{in} as input and the output of the rectifier will work as the DC voltage source for the DC motor. While building the rectifier Shadman realized that, in order to make the DC motor run smoothly, the ripple voltage of the rectifier should not exceed 3% of the peak input voltage. The DC motor has an internal resistance, $R_{DC_{motor}} = 50\Omega$. It is connected in series with a resistance, R_S to run smoothly, giving a total output load resistance, $R = (R_S + 50)\ \Omega$ for the rectifier circuit as shown in *Figure-5*. Additionally, Shadman is building the rectifier circuit with, $V_{D0} = 0.7$V.

Analyze the diagram in *Figure-5*, and help Shadman to **design** the rectifier circuit that meets the specifications mentioned above and **determine** the appropriate values of the rectifier components. **Assume** any value if necessary. Now, **draw** the designed circuit.