Name: _____

Problem	Points	Score
1	10	
2	10	
3a	10	
3b	10	
4	10	
5	10	
6a	10	
6b	10	
6c	10	
6d	10	
Total	**100**	

Notes:

1. The exam is closed book / closed notes. You are allowed a copy sheet — only **one** side of **one** standard US-size (8.5" x 11") sheet of paper — on which you can write relevant information such as equations.

2. Please show **all** work. Incorrect answers with no supporting explanations or work will be given no partial credit.

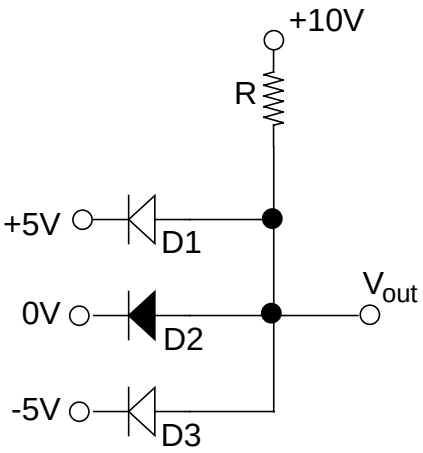
3. If I cannot read or follow your solution, it is wrong; and no partial credit will be given — **PLEASE BE NEAT**!

4. Please indicate clearly your answer to every problem.

5. There is sufficient space after each problem to write your solution. In case you need extra paper please see the instructor.

6. Assume an offset diode model with $V_\gamma = 0.7\text{V}$ unless specified otherwise. Assume $V_{BE} = 0.7\text{V}$ for a transistor in active region unless specified otherwise.

Problem No. 1:

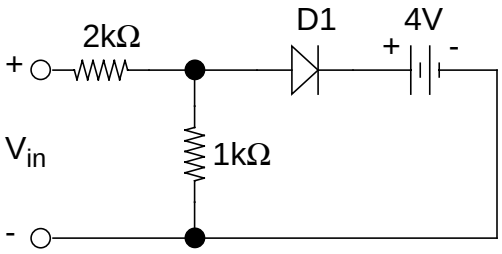


Determine which diodes are forward biased and which are reverse biased in the adjacent circuit, and find the output voltage V_{out}.

Note that D2 is an ideal diode, while D1 and D3 are offset diodes.

If the current through the resistor cannot exceed 10 mA, what is the smallest possible value of the resistor R?

Problem No. 2:



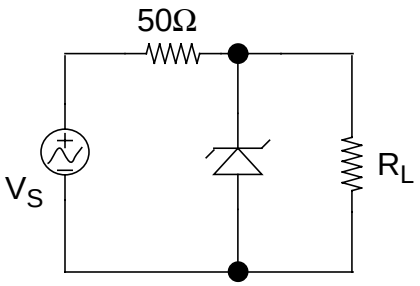
In the adjacent circuit find the range of V_{in} for which the diode D1 is forward biased.

Problem No. 3:

An electric drill machine requires a constant 9V DC power supply. Design an adapter circuit to convert the 110V AC supply voltage into DC.

a) Draw a circuit diagram for the adapter with all its component devices (no need to calculate any values here) such as a full wave bridge rectifier, ripple elimination filter and Zener regulator. What should be the Zener breakdown voltage V_Z of the Zener diode in the regulator?

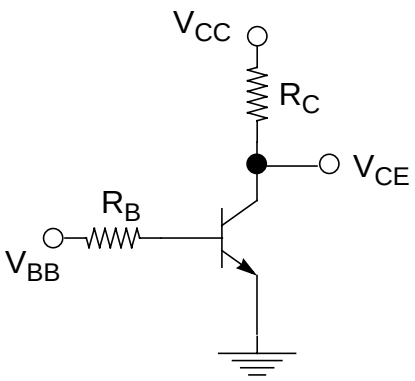
b)



If the adjacent circuit is used for Zener regulation for the above power supply, where V_S is the rectified and filtered voltage, find the maximum acceptable load resistance R_L for the drill machine.

Assume a power rating of 4.5W on the Zener diode and V_S = 64V.

Problem No. 4:



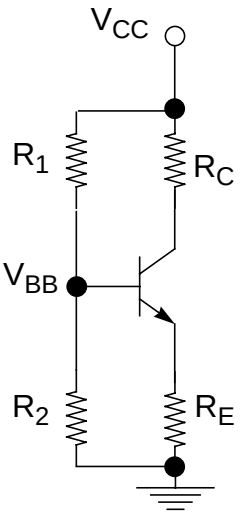
The transistor in the adjacent circuit is considered to be in saturation if V_{CE} < 0.4V. Find the smallest possible value of R_B for which the transistor stays biased in the active (linear) region.

Assume that

$$V_{CC} = +15\text{V} \qquad R_C = 250\Omega$$

$$V_{BB} = +10\text{V} \qquad \beta = 100$$

Problem No. 5:



Your electronics consultant — Back & Ward Solutions Inc. — has devised the adjacent DC self-bias circuit to measure the internal gain β of the transistor. The following values are used —

$$R_1 = 100k\Omega \qquad R_2 = 50k\Omega$$
$$R_C = 5k\Omega \qquad R_E = 3k\Omega$$
$$V_{CC} = 15V \qquad V_{BE} = 0.7V$$

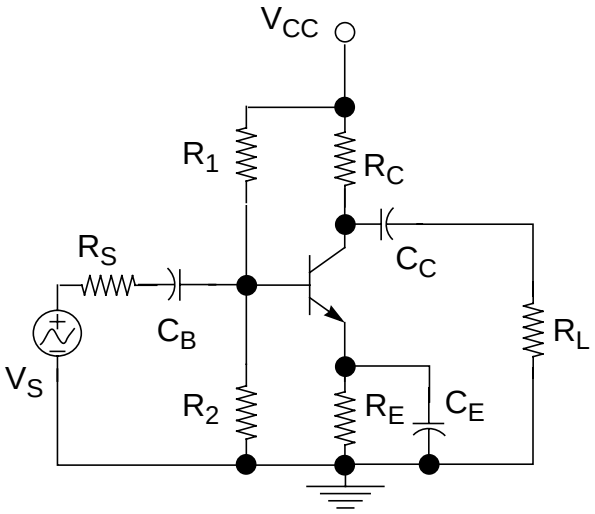
The operating point of the transistor is measured to be at

$$I_{BQ} = 12.8\mu A \qquad V_{CEQ} = 4.72V$$

Find I_{CQ} and therefore calculate β for the transistor.

Problem No. 6:

Auto Amplifiers Inc. is planning to introduce a new amplifier in the car stereo market for the year 2000 models. They have hired you as a design expert to analyze their latest common emitter amplifier. The circuit for this amplifier is shown below. The biasing values and the transistor hybrid parameters are as follows —



$V_{CC} = 15V$ $\quad R_S = 100\Omega$

$R_1 = 40k\Omega$ $\quad R_2 = 10k\Omega$

$R_C = 5k\Omega$ $\quad R_E = 2k\Omega$

$\beta = 100$ $\quad h_{fe} = \beta$

$h_{ie} = 1k\Omega$ $\quad h_{oe} = 10^{-8}S$

a) In DC analysis of this circuit, what is the effective voltage V_{BB} at the base? What is the equivalent base resistance R_B? Draw the DC equivalent circuit.

b) Draw the amplifier circuit for AC analysis with the appropriate small-signal transistor model. Calculate the transconductance g_m and the effective input resistance of the circuit r_i.

c) Calculate the output resistance r_o and the AC open circuit voltage gain μ of the amplifier. State explicitly any assumptions you make.

d) For a load resistance of $R_L = 1k\Omega$, calculate the voltage gain A_V of the amplifier.