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IZMIR KATIP CELEBI UNIVERSITY | DEPARTMENT OF BIOMEDICAL ENGINEERING

MID-TERM EXAM OF BME206 ELECTRONIC CIRCUITS

April 22, 2024

Duration: 75 minutes for 4 questions.

Note: Tere is no extra paper, you should answer your questions on the given question.

Question #1: Draw the circuit defined by the following PSPICE code:

```
* C:\LTspice\examples\Educational\phaseshift.asc
Q1 OUT N004 N005 0 2N2222
R1 N001 OUT 10K
R2 N001 N004 100K
R3 N004 0 10K
R4 N003 0 10K
R5 N002 0 10K
C1 N005 0 1u
C2 N004 N003 .01u
R6 N005 0 1K
C3 N003 N002 .01u
C4 N002 OUT .01u
V1 N001 0 12
.model 2N2222 NPN
.lib C:\LTspice\lib\cmp\standard.bjt
.tran 1u 100m
* This is supplied for educational purposes by LTspice :)
.backanno
.end
```

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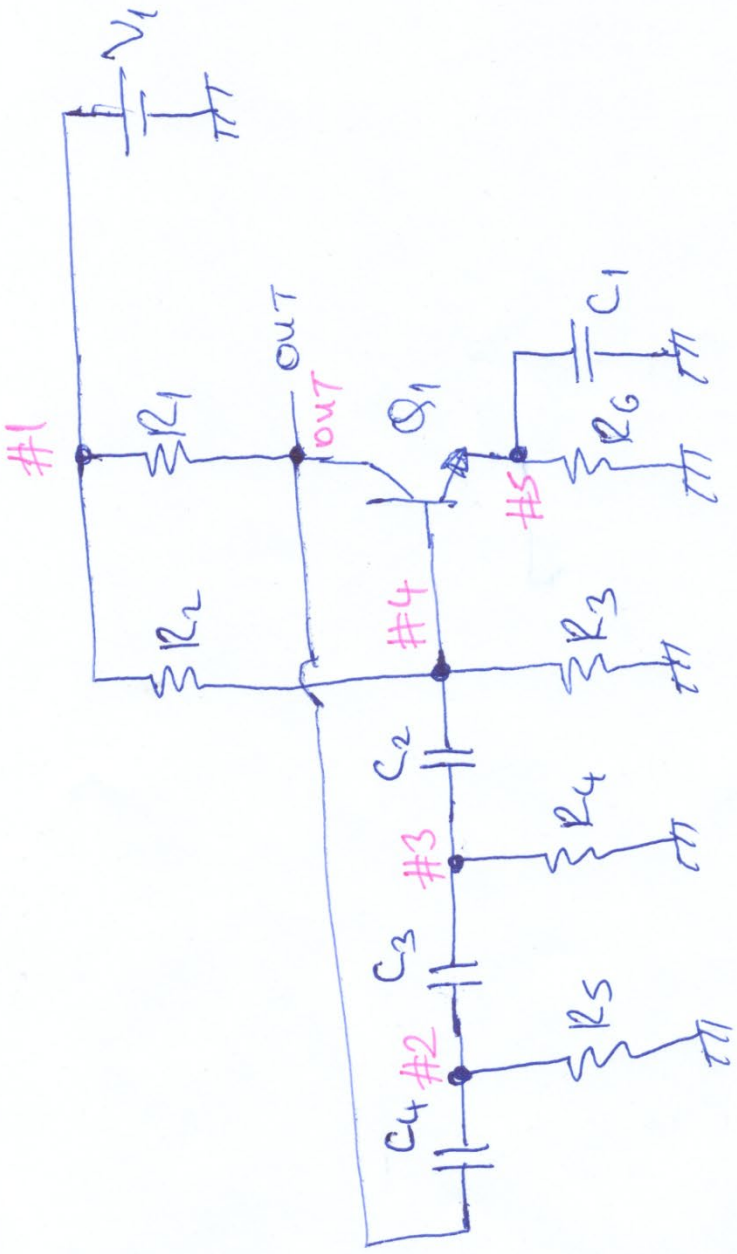

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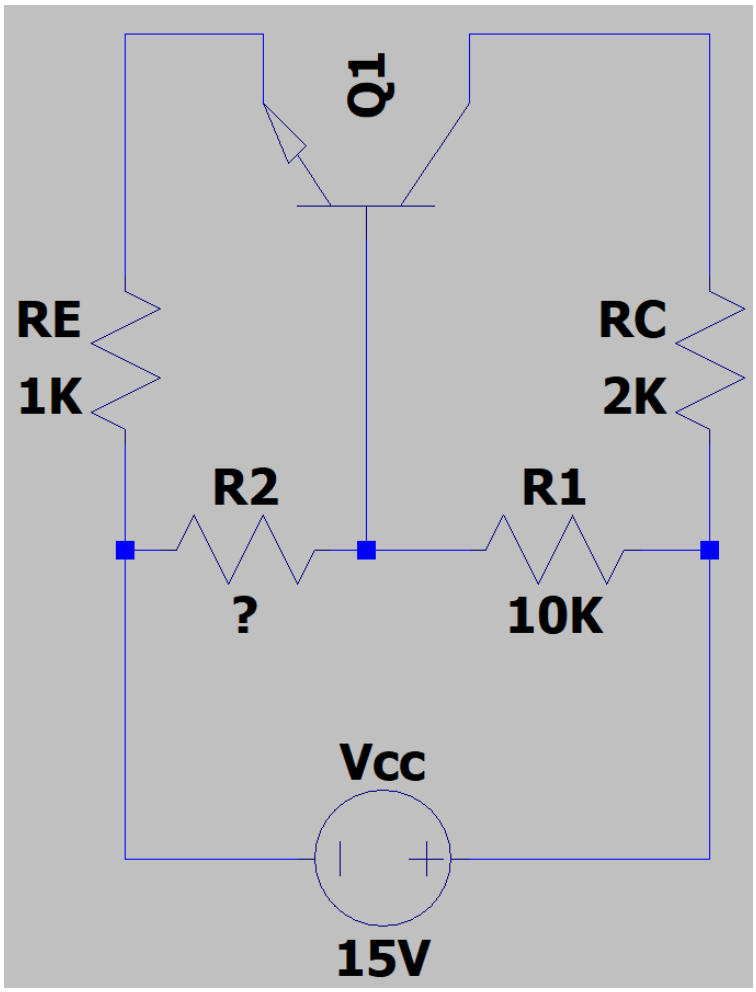
Question #2: For the following BJT circuit, the transistor is a Silicon device (V_{BEQ} = 0.7V). If the β=99 and I_{BQ} = 30 µA, then please calculate the value of R_2.



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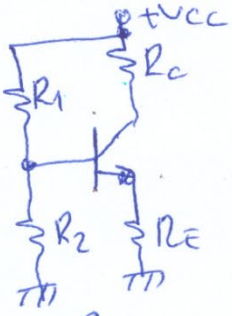
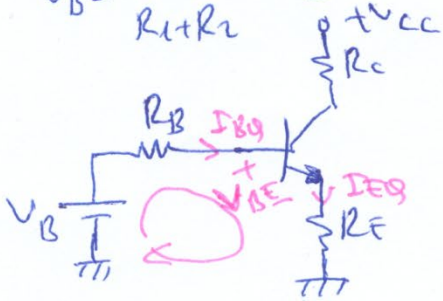
(2) By redrawing the circuit:



$R_B = \frac{R_1 \cdot R_2}{R_1 + R_2}$ and $V_B = \frac{R_2}{R_1 + R_2} \cdot V_{CC}$

So, it becomes



$$-V_B + R_B \cdot I_{BQ} + V_{BE} + R_E \cdot I_{EQ} = 0$$

$$-\frac{R_2}{R_1+R_2} \cdot V_{CC} + \frac{R_1 \cdot R_2}{R_1+R_2} \cdot I_{BQ} + V_{BE} + R_E \cdot (\beta+1) \cdot I_{BQ} = 0$$

$$-\frac{R_2}{10000+R_2} \cdot 15 + \frac{10000 \cdot R_2}{10000+R_2} \cdot 30 \cdot 10^{-6} + 0{,}7 + 1000 \cdot (99+1) \cdot 30 \cdot 10^{-6} = 0$$

$$-15 \cdot \frac{R_2}{10000+R_2} + 0{,}3 \cdot \frac{R_2}{10000+R_2} = -0{,}7 - 3$$

$$-14{,}7 \cdot \frac{R_2}{10000+R_2} = -3{,}7$$

$$\frac{R_2}{10000+R_2} \cong 0{,}25 \Rightarrow R_2 = 0{,}25 \cdot R_2 + 2500$$

$$0{,}75 \cdot R_2 = 2500$$

$$R_2 = 3{,}3K$$

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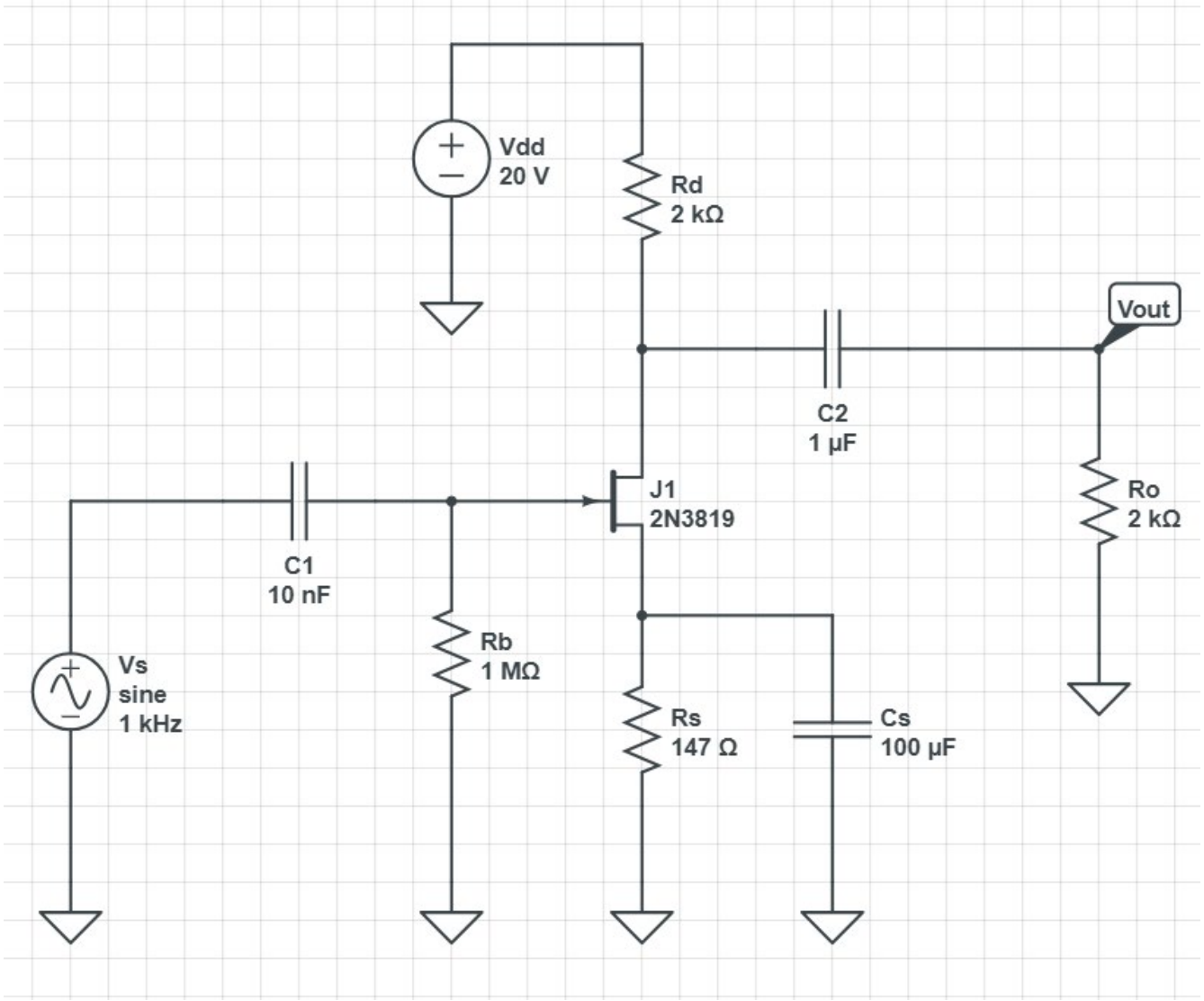
Question #3: For the following JFET circuit, if Vs=1.5 V then please determine the AC voltage gain formula.



$$I_d = I_{dss}\left(1 - \frac{V_{gs}}{V_p}\right)^2$$

$V_p = -2V$ and $I_{dss} = 2mA$ and $g_m = 2mS$ for 2N3819

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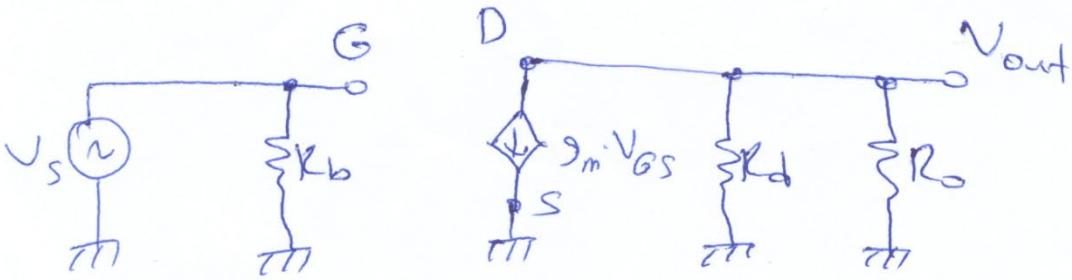
A.C. equivalent circuit,



$$A_v = \frac{V_{out}}{V_s}$$

$$V_{GS} = V_s$$

$$V_{out} = -(R_d // R_o) \cdot g_m \cdot V_{GS}$$

$$V_{out} = -\frac{R_d \cdot R_o}{R_d + R_o} \cdot g_m \cdot V_s$$

$$\frac{V_{out}}{V_s} = A_v = -\frac{2000 \cdot 2000}{2000 + 2000} \cdot 2 \cdot 10^{-3} = -2$$

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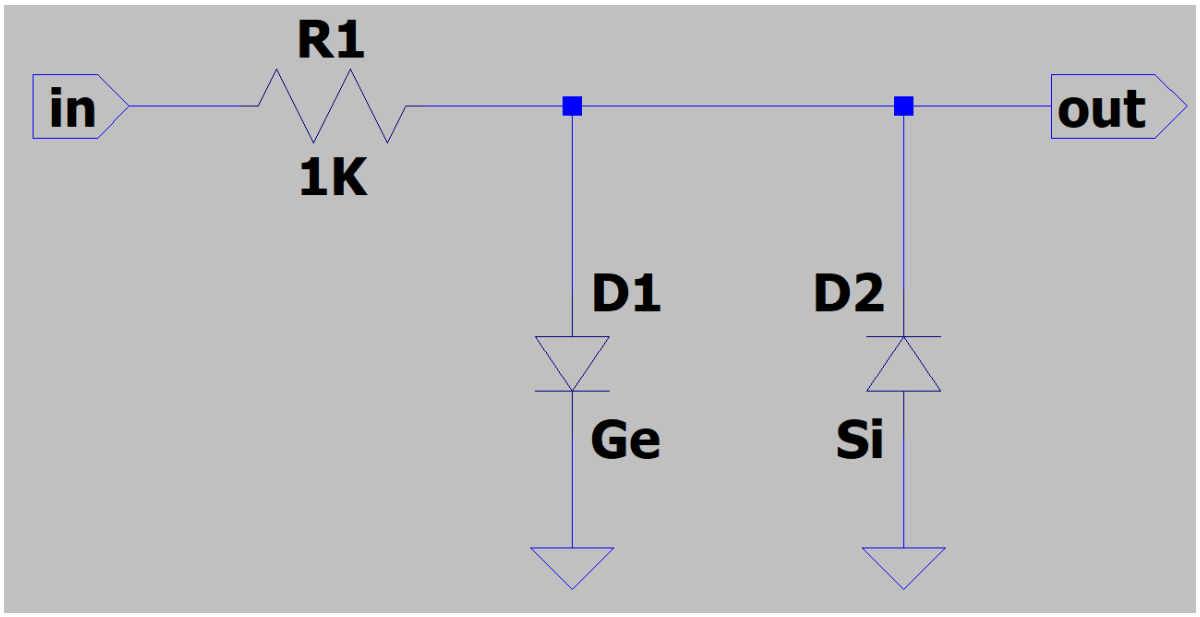
Question #4: For the following circuit, please determine the voltage of the out node if the in node is 3 V sine.



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$V_{Ge} = 0,3\,V$

$V_{Si} = 0,7\,V$

if $V_{in} > V_{Ge}$, $V_{out} = V_{Ge}$, (Ge: ON)

if $V_{in} < -V_{Si}$, $V_{out} = -V_{Si}$, (Si: ON)

otherwise, $V_{out} = V_{in}$, (both Ge and Si: off)