Name: _____ **Section:** _____

Signature: _____ **EEE 313 Fall 2013**

Bilkent University
Department of Electrical and Electronics Engineering
EEE 313 Electronic Circuit Design
Midterm 1
1 November 2013, 18:00
(4 questions, 120 minutes)

- This is a **closed book**, closed notes exam. No cheat sheet allowed.
- All cell-phones should be completely **turned off**.
- Use a calculator for numerical computations. Carry at least **4 significant digits** during calculations. Your final answer should be at least **3 significant digits**.
- Be sure to write the **units** of all numerical results.
- **Show** all work clearly.
- Please put your **final answer** for each part inside a box for easy identification. Do not give multiple answers, they will not be graded.
- Do not remove the **staple** from the exam sheets or separate pages of the exam. All extra pages must be stamped to your exam.
- You may leave the exam room when you are done. However, please do not leave during the **last five minutes** of the exam.
- At the end of the exam, please stay seated unitl **all** exam papers are collected.

FET equations:

n-channel MOSFET

$i_D = K_n(v_{GS} - V_{Tn})^2$ SAT

$i_D = K_n\left[2(v_{GS} - V_{Tn})v_{DS} - v_{DS}^2\right]$ NON-SAT

p-channel MOSFET

$i_D = K_p(v_{SG} + V_{Tp})^2$ SAT

$i_D = K_p\left[2(v_{SG} + V_{Tp})v_{SD} - v_{SD}^2\right]$ NON-SAT

n-channel JFET

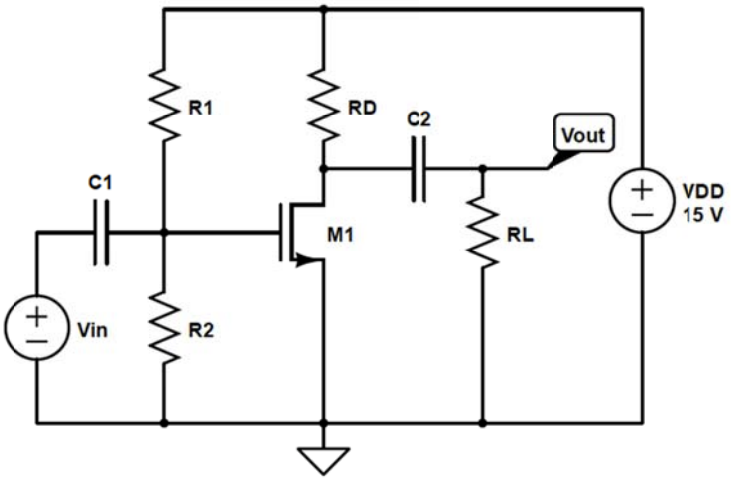
$i_D = \frac{I_{DSS}}{V_p^2}(v_{GS} - V_P)^2$ SAT

$i_D = \frac{I_{DSS}}{V_p^2}\left[2(v_{GS} - V_P)v_{DS} - v_{DS}^2\right]$ NON-SAT

Please do not write below this line

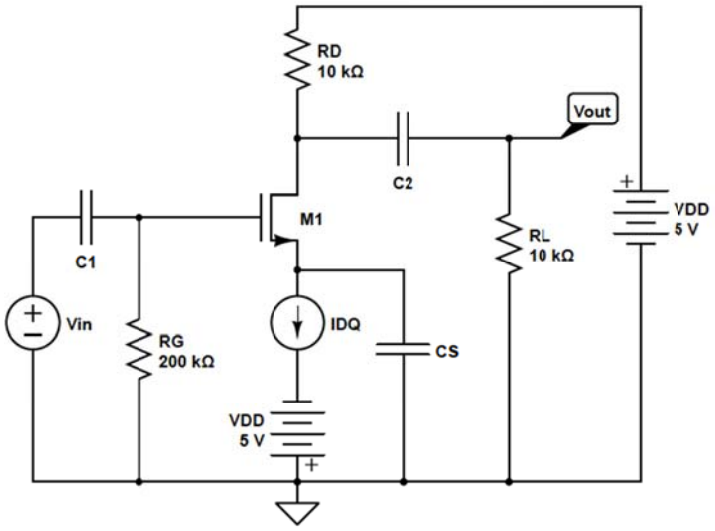
1. 25 pts.	
2. 30 pts.	
3. 25 pts.	
4. 20 pts.	
Total 100 pts.	

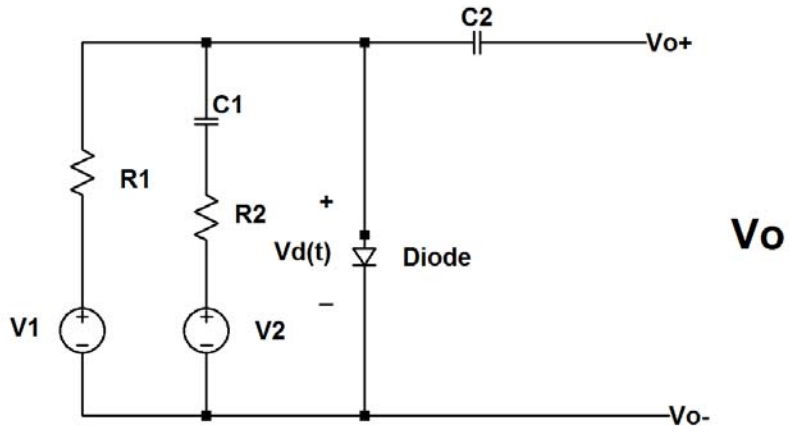
1) (25 points) Design the common source circuit below using an n-channel MOSFET. The quiescent values are to be I_{DQ}= 25 mA and V_{GSQ}= 7 V. The transconductance is g_m= 10 mA/V. Let R_L= 1 kΩ, R_1= 1 kΩ $A_v = v_{out}/v_{in} = -5$, and R_{in}= 56 kΩ. Find:
   a) (6 points) R_1 and R_2
   b) (6 points)R_D
   c) (7 points)K_n
   d) (6 points) V_{tn}



2. (30 points) The transistor in the common-source amplifier has parameters threshold voltage, $V_{TN} = 1V$, conductance parameter, $K_n = 0.5mA/V^2$ and Early voltage, V_A=100V. Be careful about the polarities of voltage sources.

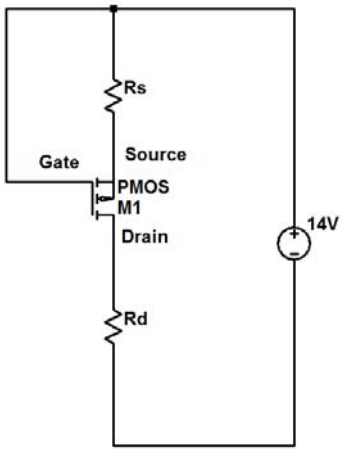
a. (20 points) Determine I_{DQ} to achieve the maximum undistorted peak-to-peak output swing in the output voltage.
b. (10 points) Find the small-signal voltage gain.





3. (25 points) At the circuit given above, the diode Vγ=0.6Volts. The value of the resistor R_2 is 15Ω. V_1=10Volts, R_1=2kΩ and C_2 is very large. $V_2(t)$ is equal to 0.02cos(1000t) Volts. The diode is at room temperature and the ideality factor n=1. Answer the following:

a) (6points) Find the DC current, I_{DQ}, through the diode,
b) (6 points) Draw the AC equivalent circuit,
c) (7 points) Calculate and plot $v_o(t)$ including the right timing of the waveform.
d) (6 points) Do we expect to see an undistorted or distorted sinusoidal wave over the diode? Please state the reason behind your answer.



4. (20 points) At the depletion-mode p-channel MOSFET circuit given above, V_{TP}=3 Volts and $K_P=5x10^{-3}A/V^2$. $R_d=6k\Omega$ and $R_S=3k\Omega$

a) (15 points) Find the bias of the transistor,
b) (5 points) Verify the solution.