

ELECTRONICS

Physics 226 - Spring Quarter, 2009 - University of Chicago

MIDQUARTER EXAM - THURSDAY, MAY 7

There are four problems, each worth 10 points. You may use any book, notes, etc.

1. Design an op-amp circuit which produces $V_{\text{out}} = -V_1 - 3V_2 - 5V_3 + 10V_4$ from inputs V_1, V_2, V_3, V_4 .
2. Suppose a 2N5485 FET has been measured to have a relation between its drain current I_D and its gate-to-source voltage V_{GS} of the form $I_D = k(V_{GS} - V_P)^2$ with pinch-off voltage $V_P = -2.5$ V and $I_{DSS} = 7.5$ mA. Let its gate be grounded, its source connected to ground through a resistance R , and its drain connected to +15 V through a 50 K potentiometer providing a variable load resistance R_L .
 - (a) What is k for this FET?
 - (b) Choose R so that this FET acts as a current source delivering 1/2 mA to R_L .
 - (c) Approximately what is the maximum load resistance R_L for which this functions as a “good” current source? Hint: require the FET to be operating in its saturation region with $V_{DS} \geq V_{GS} - V_P$.
3. Suppose you are given a source with negligible impedance (like the function generator you use in lab). Design a low-pass filter with $f_{3\text{db}} = 20$ kHz using an R-C circuit that attenuates the output for frequencies far below $f_{3\text{db}}$ by no more than a factor of 2 in voltage when driving a load of 6000 Ω .
4.
 - (a) Consider the circuit in the lab manual (Fig. L8.15 on p. 183) for an op-amp amplifier with a push-pull buffer output. What is the gain?
 - (b) For a sine wave input, sketch the output at (i) the output of the op-amp; (ii) the output of the push-pull buffer.
 - (c) Now reconnect the right side of the feedback resistor to the push-pull amplifier output. Sketch the output at (i) the output of the op-amp; (ii) the output of the push-pull buffer.
 - (d) Consider the bridge rectifier circuit in the lab manual (Fig. L3.4 on p. 77). Assume the transformer delivers ± 10 V (peak-to-peak) and that the frequency is 60 Hz. Sketch the output and estimate the duration of the flat segments.