MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Department of Electrical Engineering

6.331 Advanced Circuit Techniques

Laboratory 1   Issued : February 8, 2002
Op-Amp or Oscillator?   Due : Friday, February 22, 2002

Design, build, and test one of the following projects.

1. The 741 operational amplifier can supply an output current of ±20 mA over an output voltage range of ±12 volts. Design a unity-voltage-gain stage that can be added to the output of the op amp to increase the output capability of the combination to at least ±200 mA over a ±10-volt range. Your design should include current limiting to protect it for shorts from the output of the stage to ground and power.

2. Specifications for the LM101A operational amplifier indicate a maximum input bias current of 100 nA and a maximum temperature coefficient of input offset current of 0.2 nA per kelvin. These specifications apply over a temperature range of $-55°$ C to $+125°$ C. Precede this amplifier with a matched pair of 2N5963 transistors connected as emitter followers so that it can be used in applications that require very low input currents. Design the emitter-follower circuit using these transistors and any required bias-circuit components such that the bias current required at the input if the emitter followers is relatively independent of common-mode level over the range of ±10 volts. Also, the drift referred to the input added to the complete circuit by the emitter followers must be less than ±2 μV per kelvin. Measure the input current for the modified amplifier. Estimate the differential input resistance of the modified amplifier.

3. A sinusoidal oscillator can be constructed by connecting the output of a double integrator to its input. Show that amplitude can be controlled by varying the magnitude of the shunt resistor in the feedback network. Design a complete circuit that can produce a 20-V peak-to-peak output signal at 1 kHz. Use a 2N5459 FET for the control element. Analyze your amplitude-control loop to show that it had acceptable stability and a crossover frequency compatible with the 1-kHz frequency of oscillation.