1. (10 pts) The last Space Shuttle mission to the International Space Station installed a new set of solar panels with the P4 Truss. Calculate the worst case solar pressure force on the newly installed International Space Station solar arrays (Area = 72m²)

2. (12 pts) A spacecraft is initially not spinning. A 2.0 N thruster fires 1.0 m from the spacecraft’s center of mass and perpendicular to the center of mass. If the spacecraft’s mass moment of inertia is 1000 kg·m², what angular acceleration will the spacecraft experience?

3. (25 pts) A zero-momentum spinner has a momentum wheel spinning at 5000 rpm. The angular momentum of the wheel is 100 N·m·s.
   a. What is the spin rate of the spacecraft if its moment of inertia is 500 kg·m²?
   b. What is the moment of inertia of the wheel?
   c. If the wheel suddenly stopped, what would the spin rate of the satellite be?
   d. Assuming the wheel was fixed, how long would it take to get the wheel back up to a speed of 4000 rpm applying a motor torque of 0.1 N·m?
   e. What would the new spin rate of the spacecraft be?

4. (18 pts) A small satellite with the following characteristics is directly above a ground station. The ground station has an antenna with a gain of 20 dB and a system noise temperature of 1000 K.
   - Transmitter Power: 1W
   - Altitude: 10,000 km
   - Carrier Frequency: 0.5 GHz
   - Bandwidth: 20 kHz
   - Antenna Gain: 1 dB
   - Data Rate: 10,000 bits per second

   a. What is the ratio $E_b/N_0$?
   b. What is the signal to noise ratio?
   c. According to the Shannon Limit, what would be the maximum data rate for this system?

5. (9 pts) Determine the minimum $E_b/N_0$ required for the following modulation schemes assuming a BER of $10^{-3}$:
   a. BPSK
   b. FSK
   c. 8PSK
6. (6 pts) You have designed a space-based system to read data from remote weather stations and forward the data to a main ground station at the National Weather Service in Boulder, CO. There are 1000 remote weather stations around the globe that will be monitored. The first part of the telemetry stream down to the ground station is a digital “word” that identifies from which weather station the data was obtained. How many bits are required for the weather station identification word? What would the binary representation (identification word) be for station number 45?

7. (8 pts) A satellite payload is being used to measure the energy of the ambient plasma ions in low-Earth orbit. The payload instrument provides a voltage from 0 to 1 Volt depending on the energy of the ion. Higher ion energies result in larger voltages from the instrument’s micro-channel plate detector. Calibration of the instrument revealed that the resolution of the micro-channel plate detector was 0.001 mV per eV of ion energy. How many bits are required to digitally resolve the ambient ion energy to within 1 eV?

8. (12 pts) The maximum frequency that the human ear can detect is 22 kHz. You decide to start a fully digital sound studio to record your own music (you rock!!). You decide to sample in stereo at 16 bits per channel.
   a. What sampling frequency should you use?
   b. How many quantized levels do you have?
   c. How many bits will you record in a one hour session?
   d. If a CD can hold 760 Mbytes, how much recording time would you have at the sampling frequency and quantization levels used?