The problem statement for the first round is as follows:

A mechanical engineering student wants to build a robotic arm which can draw the time domain waveform of audio signals on a paper in real time. He decided that he will use a servo motor for this purpose. Servo motor is used for precise position control. It requires input in pulse width modulated form, where the pulse width decides the position. And the motor should get the pulse of same width at regular intervals to hold the position.
Now, the guy has two servo motors, one which operates on 3.3V and another which operates at 5V. Both of them have four modes, which require different refresh rate (100ns, 200ns, 500ns and 1us). The higher the refresh rate, more is the accuracy, but higher is the power consumption. He decided that he will test both the motors in all four modes, and then decide which one to use, based on accuracy and power consumption in the motor.
But as the guy is not so good at circuit building, so he decides to take help from an electronics geek. He asked many people in his college for suggestions on who he should approach, and everyone suggested your name. So, now, help the guy and prove that you are the ONE.

PULSE WIDTH MODULATOR

The task is to design a pulse width modulation circuit. The circuit will get an input VIN, which has to be modulated. VIN is an audio signal (baseband signal with a bandwidth of 22 KHz). Higher VIN should correspond to higher pulse width. The circuit has to give pulse width modulated signal, the frequency of which can be 1/2/5/10 MHz depending on the FREQ_SEL. The output voltage level has to be 0V and 5V or 0V and 3.3V, depending on OUT_LEVEL_SEL.
The expected interface of the circuit is described in the following table:

Port	Direction	Description
VDD	+Supply	+12V supply (with a variation of +-10% and output impedance of 10 Ω)
VDD	-Supply	-12V supply (with a variation of +-10% and output impedance of 10 Ω)
GND	Supply	Ground (0 V)
VREF	Input	Reference voltage of 1.2V (with a variation of +-1% and output impedance can vary from 1K Ω to 1M Ω)
VIN	Input	This is the voltage signal with which output has to be modulated (This can vary from 0V to 5V)
FREQ_SEL<1:0>	Input	2 bits to select output frequency 00 – 1MHz 01 – 2MHz 10 – 5MHz 11 – 10MHz 0 V represents logic 0 and 5V represent logic 1
OUT_LEVEL_SEL	Input	1 bit to select output voltage level 0 – 3.3V 1 – 5V 0 V represents logic 0 and 5V represent logic 1
OUT	Output	Pulse width modulated signal (with output impedance of <100 Ω) Expected 0V for low and 3.3V/5V (depending on OUT_LEVEL_SEL) for high

The components which can be used in the circuit are – Resistor, Capacitor, Inductor, Op-amp, Voltage controlled current source, Current controlled current source, Switch, Diode, Logic gates, Flip-flops.
Further, the guy wishes to draw waveforms of the songs which are being broadcasted on the college radio. The college radio works on AM at a frequency of 1MHz. He was able to get the antenna and the pre-amplifier circuit from the local radio shop, but could not get the demodulator circuit. So, now, again, you are the only hope.

AMPLITUDE DEMODULATOR (BONUS QUESTION)
The amplitude modulated signal can be described by the following equation:
Sig(t) * cos(2*π*1000000*t + Φ), where Sig(t) varies from 0V to 5V and Φ is unknown.
Design a circuit which can demodulate the signal and can be interfaced to the previous circuit.
The expected interface of the circuit is described in the following table:

Port	Direction	Description
VDD+	Supply	+12V supply (with a variation of +-10% and output impedance of 10 Ω)
VDD-	Supply	-12V supply (with a variation of +-10% and output impedance of 10 Ω)
GND	Supply	Ground (0 V)
VREF	Input	Reference voltage of 1.2V (with a variation of +-1% and output impedance can vary from 1K Ω to 1M Ω)
VIN	Input	This is the voltage signal with which output has to be modulated (This can vary from -5V to 5V)
VOUT	Output	Demodulated signal (with output impedance of <100 Ω) Expected voltage level (0V to 5V)

The components which can be used in the circuit are – Resistor, Capacitor, Inductor, Op-amp, Voltage controlled current source, Current controlled current source, Switch, Diode, Logic gates, Flip-flops.

The pspice version which is to be used for the solution can be downloaded from the following link:
http://www.electronics-lab.com/downloads/schematic/013/

The solution should consist of the following:
1. The circuit in pspice format.
2. 1-2 page description about the circuit.

Solutions should be mailed to the following mail id earliest by 28th February
circuitdesignchallenge2010@gmail.com

RULES AND GUIDELINES

1. This is a team event, where each team should not consist of more than three members. Students from different educational institutions can make a team.
2. Only undergraduate and post graduate students of any recognised university can participate.
3. The results for the elimination round will be announced on the website latest by 25february, 2010 following which the selected teams would be informed about the final round.
4. The final round will take place at BITS-Pilani campus during APOGEE-2010.
5. The decision of the judges will be final and binding.