**(For Under-Graduate Students)**

**Modern Analog/IC Filter Design (ELEC 441/6081)**

**Mid-Term Test#2 (Winter 2009-2010)**

Electrical and Computer Engineering Department

Concordia University

March 31, 2010

Instructor: Dr. R. Raut **Student id#** **Time: 75 minutes**

Answer **All** questions Return the question paper with your answers

Q.1: Design a second-order low-pass filter using state-variable principle. The filter has *ωp*=1000 rad/sec, *Q*=5 and peak gain of 5. Use equal capacitors of 1µF each.

Q.2: Figure 2 presents a second order filter network built from two OTA devices. Find the voltage transfer function *V2/V1*, at low frequencies, assuming ideal OTA.



Figure 2:

Q.3: Analyze the given switched capacitor filter circuit (Fig.3), and derive the expression for Vo2(1)/Vi(1) in the sampled-data (i.e., z= exp (jΩT))-domain. What will be the response of this filter at DC. The given clock frequency is 64 kHz. The numbers 1 and 2 refer to switching clock signals at phases 1 and 2.



Figure 3:

Q.4: Using FDNR technique design a third-order low-pass Butterworth voltage transfer function. The cut-off frequency should be 5kHz and the prototype source and load resistors should have a value of 500Ω. All the resistors in the FDNR sections should be 5000Ω. You may use the L,C,R structures provided with **Table B.2** . Provide design for the whole system.

