Name: Enrolment No:	UPES

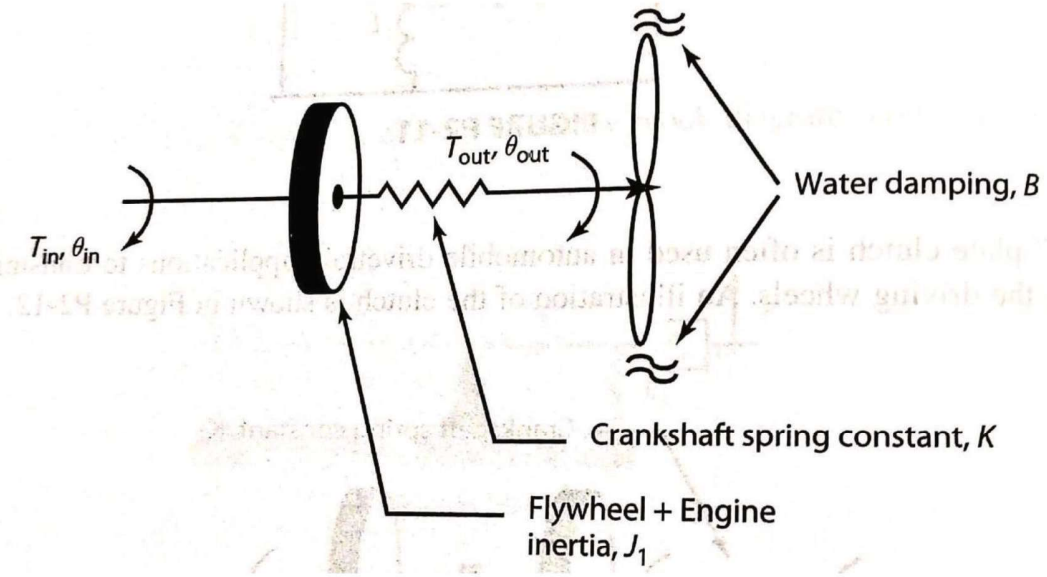
UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

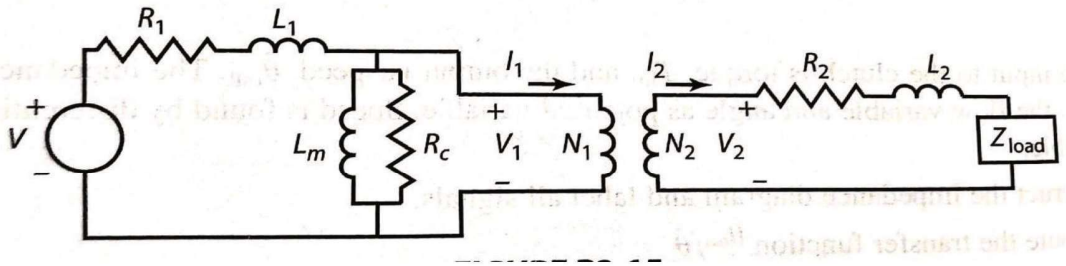
End Semester Examination, December 2019

Programme Name: B.Tech Mechatronics **Semester** : VII
Course Name : Mechatronics System Design **Time** : 03 hrs
Course Code : MEEL404 **Max. Marks** : 100
Instructions:

SECTION A

S. No.		Marks	CO
Q 1	List the key elements of mechatronics system design.	5	CO1
Q 2	Explain the function of a sensor and a actuator in a mechatronics system. List different types of actuator and sensor.	5	CO1
Q 3	The automatic control system for the temperature of a bath of liquid consists of a reference voltage fed into a differential amplifier. This is connected to a relay , which then switches on or off the electrical power to a heater in the liquid. Negative feedback is provided by a measurement system , which feeds a voltage into the differential amplifier . sketch a block diagram of the system and explain how the error signal is produced	5	CO2
Q 4	A steel mill has production set up where metal sheets are rolled for desired thickness as they emerge from the production sequence. It is a continuous , real time production and measurement have to be made on line. Suggest a sensor that can do the job. The final output should be electrical.	5	CO2
	SECTION B		
Q 5	A machine table driven by a closed loop positioning system consists of a servo motor, lead screw, and optical encoder . The lead screw has a pitch of 0.500 cm and is coupled to the motor shaft with a gear ratio of 4:1(4 turns of motor for 1 turn of lead screw). The optical encoder generates 150 pulses/rev of the lead screw. The table has been programmed to move a distance of 15 cm at a feed rate of 45 cm/min. determine (a) How many pulses are received by the control system to verify that table has moved exactly 15 cm? (b) What is the pulse rate? (c) What is the motor speed that corresponds to the specified feed rate?	10	CO3
Q 6	A computer numerically controlled PCB drilling machine uses a stepper motor for the positioning purposes. The lead screw which drives the table of the machine tool has a pitch of 10 mm. the work table traverse 40 mm at a linear speed of 400 mm per minute. If the stepper motor has 180 step angles , calculate the speed of the stepper and the number of pulses needed to move the machine table to a desired location.	10	CO4

Q 7	In a machining operation using horizontal boring machine , assume that the sensors have been installed to measure cutter vibration (v), product surface roughness(s), product dimensional accuracy (a) , and cutter temperature (t). Assume that the sensors send the following digital signals: v=1 for excessive vibration t=1 for high temperature s= 1 for poor product surface a=1 for poor quality otherwise these signals are zeros. Design a logic circuit which has two outputs code; yellow(Y) and red(R). Code yellow is a 1 if any one of the sensor signals is a 1. Code red is 1 if more than one of the sensor signals is 1, otherwise both the outputs are zero.	**10**	**CO3**
Q 8	Consider a chemical tank for which there are three variables to be mounted are, (a)level(b)pressure(c)temperature. The alarm will sound if the liquid level is high and the temperature is high. Another condition for alarm is a condition of high liquid level with low temperature and high pressure. Design the circuit such that an alarm is sounded when certain combinations of conditions occur the variables. OR A motor to be driven by a digital signal has a speed of 200 rev/m.in per volt with minimum rpm at 5V and maximum at 10V. Calculate the minimum speed word, maximum speed word and speed change for change of 1bit. Use a 5-bit ,15V reference, DA converter	**10**	**CO3**
	SECTION C		
Q 9	An illustration of a simple propeller system in water is shown in figure 1.  Figure 1 The input to the propeller system is torque, T_{in},and the output is the propeller speed, $\dot{\theta_{out}}$, . The impedances are based on torque, as the flow variable and angle as potential variable (a) Construct the impedances diagram and label all signals (b) Compute the transfer function.	**20**	**CO4**

Q 10	A transformer circuit which accounts for magnetization and core losses is presented in figure2.  Figure 2 Voltage , V_{in}, is applied to the transformer primary side coil, which consists of a series resistance and inductance, $R_1$and L_1. the secondary side coil of the transformer is also modeled as a series resistance and inductance, $R_2$and L_2. The magnetization and core losses in the core of the transformer is created by replacing each element of the circuit with it's associated impedance. The impedance of each resistance, R_i,is denoted as Z_R , and the impedance of each inductance , $L_i$and Z_{Li}. (a) Draw the impedance diagram for the transformer (b) Draw the block diagram from the impedance diagram (c) From the block diagram compute the system equation relating the input and the output. OR The suspension system of a car can be modeled on a per-wheel basis as a two -mass system ;the car mass and the wheel mass. The tire behaves as a spring , and the connection between the tire and the car is a spring-shock absorber. The road roughness provides the input to the system as a displacement. The outputs are the axle displacement and the vehicle displacement. Develop the block diagram model for the tank system using analogy approach.	**20**	**CO4**