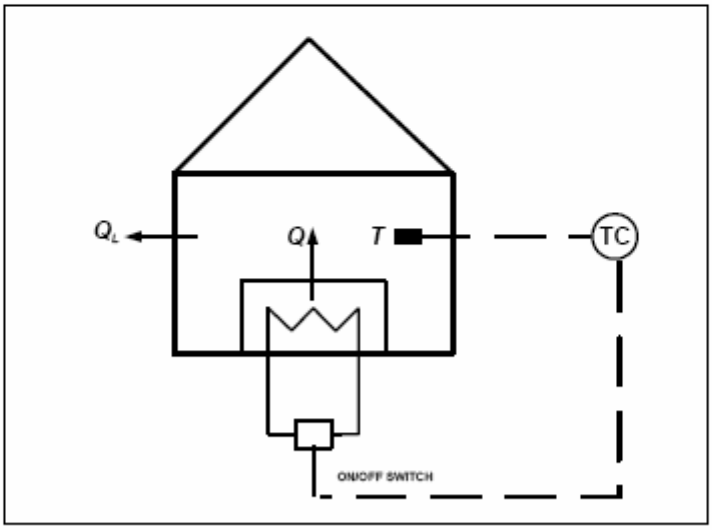
Home Work # 1

Chapter 1

1.1

a) True
b) True
c) True
d) False
e) True

1.2



Controlled variable- T (house interior temperature)

Manipulated variable- Q (heat from the furnace)

Disturbance variable- Q_L (heat lost to surroundings); other possible sources of disturbances are the loss of gas pressure and the outside door opening.

Specific disturbances include change in outside temperature, change in outside wind velocity (external heat transfer coefficient), the opening of doors or windows into the house, the number of people inside (each one generating and transmitting energy into the surrounding air), and what other electric lights and appliances of any nature are being used.

1.3

The ordinary kitchen oven (either electric or gas), the water heater, and the furnace (Ex. 1.2) all work similarly, generally using a feedback control mechanism and an electronic on-off controller. For example, the oven uses a thermal element similar to a thermocouple to sense temperature; the sensor's output is compared to the desired cooking temperature (input via dial or electronic set-point/display unit); and the gas or electric current is then turned on or off depending on whether the temperature is below or above the desired value. Disturbances include the introduction or removal of food from the oven, etc. A non-electronic household appliance that utilizes built-in feedback control is the water tank in a toilet. Here, a float (ball) on a lever arm closes or opens a valve as the water level rises and falls above the desired maximum level. The float height represents the sensor; the lever arm acting on the valve stem provides actuation; and the on-off controller and its set point are built into the mechanical assembly.

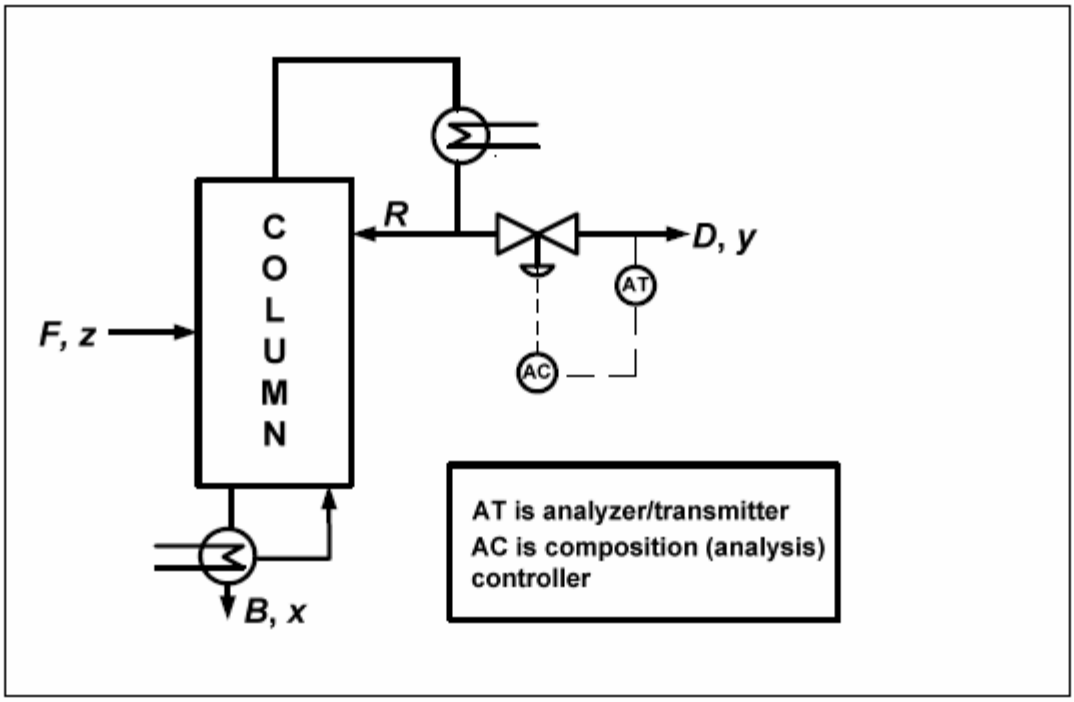
1.5

a) In steering a car, the driver's eyes are the sensor; the drivers hands and the steering system of the car serve as the actuator; and the driver's brain constitutes the controller (formulates the control action i.e., turning the steering wheel to the right when the observed position of the car within its desired path is too far to the left and vice versa). Turns in the road, obstructions in the road that must be steered around, etc. represent disturbances.

b) In braking and accelerating, a driver has to estimate mentally (on a practically continuous basis) the distance separating his/her car from the one just ahead and then apply brakes, coast, or accelerate to keep that distance close to the desired one. This process represents true feedback control where the measured variable (distance of separation) is used to formulate an appropriate control response and then to actuate the brakes/accelerator according to the driver's best judgment. Feedforward control comes into the picture when the driver uses information other than the controlled variable (separation distance) that represents any measure of disturbance to the ongoing process; included would be observations that brake lights on preceding vehicle(s) are illuminating, that cars are arriving at a narrowing of the road, etc. Most good drivers also pay close attention to the rate of change of separation distance, which should remain close to zero. Later we will see that use of this variable, the time derivative of the controlled variable, is just another element in feedback control because a function of the controlled variable is involved.

1.6

a) Feedback Control : Measured variable: y
Manipulated variable: D,R, or B(schematic shows D)



1.7

Both flow control loops are feedback control systems. In both cases, the controlled variable (flow) is measured and the controller responds to that measurement.