Tutorial-3

1. Two generators rated 200 MW and 400 MW are operating in parallel. The droop characteristics of their governors are 4% and 5%, respectively, from no load to full load. The speed changers are so set that the generators operate at 50 Hz sharing the full load of 600 MW in the ratio of their ratings. If the load reduces to 400 MW, how will it be shared among the generators now and what will the system frequency be? The speed changers of the governors are reset so that the load of 400 MW is shared among the generators at 50 Hz in the ratio of their ratings. What are the no load frequencies of the generators? How can you instruct the microcontroller to perform the task (look-up table method may be used)?

2. An electronic controller is used to balance the power at generator terminal to maintain the frequency and voltage at nominal values in a micro-hydel system. Design the control circuit for varying the duty ratio of chopper circuit in accordance with the load. How can you instruct the microcontroller to perform the task (look-up table method may be used)?
   [The duty ratio (D) of a chopper circuit is the ratio of the ON time (T_{ON}) to the total switching time period ($T = T_{ON} + T_{OFF}$); determines the average DC output voltage ($V_{OUT} = D\ V_{IN}$)]

3. A run-of-river hydro-electric generating station of installed capacity 10 MW operated at a head of 20 meters and is linked to the central grid. The turbine operates at a speed of 500 rpm. The following critical protection systems are to be implemented for emergency shutdown during faulty operations for protection of the turbine from overspeed, vibration, and mechanical damage due to debris impact, and maintaining pressure surges in penstocks. Different sensors are used in the power plant to handle these issues. The following conditions are to be considered:
   1. The overspeed sensor (OS) is activated if the turbine speed is above 115% of the rated speed, else it's in the normal state.
   2. Vibration sensor (VS) on the turbine bearings operates normally at a speed ≤ 3.5 mm/s; otherwise, they are activated.
   3. The penstock is employed with a pressure sensor (PS) for emergency closure of the gates during pressure surges above 3.0 bar, which activates the sensor.
   4. Considering all these conditions, a TRIP command is to be executed whenever there is an abnormal operation in any of the above cases.
   a) Prepare detailed logic conditions, 1 for sensor activation and 0 for normal operating conditions. Write the Boolean equation for TRIP?
   b) Implement the logic using digital logic gates. Draw the circuit implementation and provide the complete truth table for the protection system.
   c) A day in monsoon season, a grid fault occurs, causing the over-speeding of the turbine, and a tree trunk hits the turbine. What could be the status of the system? Extended question- if the pressure also surges, what could be the status of the system?
   d) Provide remarks on each scenario in the truth table.