BACHELOR OF POWER ENGINEERING EXAMINATION, 2018

(3rd Year, 2nd Semester)

Power Plant Instrumentation and Control

Time : Three hours Full Marks : 100

Answer any ***five*** questions.

1. For a system $G(s)$ with a dynamic controller $H(s)$, write expressions for sensitivity and complementary sensitivity and state their physical significance. Enumerate the desirable characteristics of a controller and hence deduce the advantages of placing the controller $H(s)$ in the forward path. 6+4+10

2. Deduce the gains of a PID controller for a plant $G(s)=\frac{10e^{-0.1s}}{0.5s+1}$ using Z-N open-loop method. 20

3. A chemical reactor is used to produce Ammonia gas from Hydrogen and Nitrogen. Devise a control system to control the amount of Ammonia produced by varying the amounts of Nitrogen and Hydrogen and derive the set-point(s) of the controller(s). What kind of control scheme is this? How are the dynamics of the two loops related? 14+2+4

4. Consider a system $G(s)=\frac{10}{(0.1s+1)(10s+1)}$ Deduce the dominant root for the system. Hence suggest a suitable control scheme to control the system stating the condition that needs to be satisfied for this and sketch the schematic. How will you tune such a system? 14+6

5. Represent the different modulating control loops in a thermal power plant and show the interacting variables. With the Rankine Cycle in a T-S plane, explain how Boiler following Turbine mode of control works in a thermal power plant. 8+12

6. With a neat schematic represent the cross-linked combustion control mechanism in a thermal power plant for a decreasing load. With a schematic represent how the air-flow demand is calculated for a mix fuel (coal and oil) fired plant. 14+6

7. The total air requirement for a thermal power plant is $x\ kg/hr.$ and at most 70% of this is hot air. The temperature of the fuel air mixture is to be maintained at $T\ C$ where $T_2 < T < T_1$ and T_1, T_2 being the temperatures of the hot and the tempering air respectively. Now if T_2 is $0.7T_1$ calculate the maximum tempering air requirement if T varies between $0.8T_1$ and $0.9T_1$. Now, if these PA fans are controlled by a single controller and have the capacity to supply the 70% of full air requirement individually, what is the maximum input that a fan can see in the worst case? Explain the answer. 12+8

8. Define swell and Shrinkage in a drum boiler. With a schematic represent the 3-element drum level controller and hence deduce the expression for the modulating input to the controller. With suitable assumptions deduce the expression for error in level measurement in a drum boiler with a water level gage. 4+6+10