BACHELOR OF POWER ENGINEERING EXAMINATION, 2019

(3rd Year, 2nd Semester)

Power Plant Instrumentation and Control

Time : Three hours | Full Marks : 100

Answer any *five* questions.

1. Deduce the gains of a PID controller for a plant $G(s)=\frac{10e^{-0.2s}}{s(2s+1}$ using Z-N closed-loop method. Is it at all possible to tune this system with Z-N open loop method? Substantiate your answer. 18+2

2. Calculate the steady-state error due to a (i) step input and (ii) a unit ramp input with a controller $G_c(s)=k_p$ for a system $G(s)=\frac{k}{s(Ts+1)}$. Why is a D-only controller never used. 9+9+2

3. The input to the system in question (1) above controlled by a PID controller $G_c(s)=k_p+\frac{k_I}{s}+sk_d$ is varied in the form of a rectangular pulse of height H and duration D. Calculate the controller output and sketch the same. 20

4. An oil-fired boiler uses a combustion control loop with two different flow lines viz. one for oil and one for air. Draw a ratio control loops for an air-fuel ratio of 1:K. Now, if it is necessary to introduce variable delays in each of the loops to accommodate increasing and decreasing load scenarios, how will you modify your scheme with delay addition. 12+8

5. Define Master Control Signal for a Thermal Power Plant. Represent the different modulating control loops in a thermal power plant and show the sequence in which the interacting variables act for (i) Boiler Following Turbine Mode and (ii) Turbine Following Boiler Mode. With a neat schematic represent the Co-ordinated mode of control for a Thermal power Plant. 2+4+8+6

6. Draw the schematic for the combustion control loop of a coal-fired Thermal power Plant. What is the necessity of a temperature control loop? If the fuel-air ratio is 1:K, calculate the slope of the mill load line. 12+4+4

7. 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 gauge 4+6+10

8. For a super heater with a steam flow rate of w_s units and an atemperator flow rate o w_a units, deduce an expression for the transfer function $\frac{\Delta h_o(s)}{\Delta w_a(s)}$ with suitable assumptions where h_o is the output steam enthalpy. From the derived transfer function deduce a relationship between (i) steam temperature at super heater outlet and atemperator flow and (ii) rate of change of steam temperature with atemperator flow and volume of the super heater.

12+4+4