BACHELOR OF POWER ENGINEERING EXAMINATION, 2017

(4th Year, 2nd Semester)

Power Plant Instrumentation and Control

Time : Three hours   Full Marks : 100

Answer any *five* questions.

1. Using PADE's first order approximation derive the controller gains for a PI controller to tune the system $G(s) = \dfrac{5e^{-0.2s}}{10s+1}$ using Z-N closed-loop tuning method. Write the Matlab commands to define the transfer function and to obtain its first order Pade Approximation.

    16+4

2. What is integral wind-up? An error pulse of height 2 units and duration 200ms is applied to the input of a PID controller $1.2 + \dfrac{2.2}{s} + 0.1s$. Calculate the controller output. If the input to the actuator is limited to ±5.2 units , what can be the maximum height of a 200ms error pulse fed to the controller?

    10+10

3. Water flows into a cistern through two pipes with control valves at temperatures T1 and T2 degrees Centigrade and flows out of another pipe fitted with a control valve. Represent a control system to control the level of water in the tank at a set-value of L cms. and at any arbitrary intermediate temperature T degrees Centigrade. Is it possible to control the level if the temperature signal carries a measurement error?

    15+5

4. Represent 3 element drum-level control by a suitable schematic. Deduce an expression for density correction for level measurement in a drum boiler . If the level measurement error is ΔL , the density of steam is ρ_s and the density of water in the drum is ρ_w can you estimate the error in steam quality for the level error?

    4+8+8

5. With a suitable schematic represent the combustion control loop of a coal-fired thermal power plant. What are the requirements of this control mechanism? Why is it necessary to control the temperature of the air-fuel mixture? Define master control signal.

    6+6+6+2

6. What are the problems associated with control of two PA fans with (i)one common controller and (ii) two controllers but with set-points derived from a common source.
    With a neat schematic represent co-ordinated control of a thermal power plant and explain why frequency correction is necessary for load following operation.

    6+6+8

7. Starting from energy balance equation derive the transfer function representing the variation of steam temperature with change in steam flow rate in a super-heater.
    Assuming that the steaming rate equals the boiling rate and the feed-flow is commensurate, deduce a plot of quality vs. length in a once-through boiler. How will this change if the steam flow rate increases?

    10+6+4

    Write short notes on:
    (i)   Swell and shrinkage phenomenon in a drum boiler (ii) sliding mode operation of a power plant.

    10+10