

BACHELOR OF POWER ENGINEERING EXAMINATION, 2017

(3rd Year, 2nd Semester)

Power Plant Instrumentation and Control

Time : Three hours

Full Marks : 100

Answer any *five* questions.

1. Define sensitivity and complimentary sensitivity. For a system $G(s)$ controlled with a controller $H(s)$ deduce how these should depend upon frequency to achieve good (i) disturbance rejection and (ii) immunity to measurement noise. 10

Write the MATLAB commands for defining the transfer function $G(s) = \frac{10e^{-0.1s}}{(0.5s+1)(5s+1)}$.

Sketch the approximate Root Locus for $G(s)$ and deduce the controller you would recommend for a slightly under-damped closed-loop response. 4+6

2. For the system $G(s) = \frac{10e^{-0.4s}}{(2s+1)(0.1s+1)}$ deduce the ultimate gain and the ultimate period and hence deduce parameters of a PID controller. Is it possible to tune this using the Z-N open loop method?. If so how will you proceed? 15+5

3. For the system $G(s) = \frac{10}{s(0.6s+1)}$ calculate the steady-state error with a P-I controller for a (i) step input and (ii) for a ramp input. What are the requirements of a good controller? 8+8+4

4. Ammonia is produced in a chemical reactor by mixing two steams of Hydrogen and Nitrogen each controlled by a control valve according to the reaction $N_2 + 3H_2 = 2NH_3$. Devise a suitable control scheme to control the production of Ammonia. 20

5. Define master control signal for a thermal power plant. With a proper schematic represent the turbine-follow-reactor scheme with frequency correction applied. What are the advantages and disadvantages of this mode? Explain the basis of selection of the proper air-fuel ratio in a thermal power plant. 2+8+4+6

6. With the help of a neat schematic represent the cross-linked combustion control mechanism for an increasing load scenario. If the ratio of air:fuel is 1:K deduce the mill-load line for a coal fired boiler. 15+5

7. From first principles deduce an expression for incremental transfer function relating change in specific enthalpy of steam to change in atemperaton flow for a superheater. Represent the temperature control for main-steam temperature using a suitable control schematic. What constraint does atemperatation impose on feed pressure?

8. A drum boiler is controlled by a 3 element drum level controller. The steam flow rate increases by an amount ΔW kg/s at time $t=0$ which causes a change in level given by $\Delta L(t) = x(1 - e^{-\frac{t}{2}})e^{-\frac{t}{10}}$ without a controller. Devise a suitable control scheme to control the drum level at the desired set-point. Sketch a possible variation of the drum level with your controller