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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2014/2015

COURSE NAME	:	PROCESS CONTROL
COURSE CODE	:	BNQ 30703
PROGRAMME	:	3 BNN
EXAMINATION DATE	:	JUNE 2015 / JULY 2015
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

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Q1 (a) Discuss briefly the differences of the following basic control modes in a feedback control system.

(i) proportional control

(ii) integral control (4 marks)

(b) By plotting graphs, illustrate the qualitative effects (or effects on the process response) of

(i) increasing controller gain for a case of a proportional control and

(ii) increasing integral time for a case of a proportional integral control (6 marks)

(c) Figure Q1(c) shows a standard block diagram of a feedback control system. A proportional controller is used and D=0.

(i) Determine the open loop and close loop transfer function of Y/Y_{sp}. Consider $Y_{sp}(s)=2/s$. (10 marks)

(ii) Determine the stability of the closed loop system. Consider $K_c=5$ (5 marks)

Q2 (a) Discuss briefly the ideal performance criteria for closed loop system (6 marks)

(b) Determine the equivalent controller G_c of the following transfer function by using internal model control method for each of the cases below.

$\check{G}(s) = 0.05e^{-2s}/(7s+1)$

(i) A controller without a filter. Suggest the algorithm of this controller. (6 marks)

(ii) A filter is placed before the controller. (7 marks)

(c) Very slow disturbance responses are associated with the Internal Model Control and Direct Synthesis methods due to a large τ_I value. Propose how this problem can be solved. (6 marks)

Q3 (a) Ratio control is a special type of feedforward control.

(i) Discuss briefly the objective of ratio control (4 marks)

(ii) Give **TWO (2)** examples of typical applications of ratio control (2 marks)

(b) (i) Compare the basic concepts of feedforward and feedback control. (3 marks)

(iii) Propose a configuration of feedforward-feedback control where the feedforward controller can affect the stability of the feedback control system. (2 marks)

(c) The close loop transfer function for disturbance changes in a feedforward-feedback control system is defined as

$$\frac{Y(s)}{D(s)} = \frac{G_d + G_t G_f G_v G_p}{1 + G_c G_v G_p G_m}$$

where

$G_d = K_d/(\tau s+1)$, $G_t = 15e^{-s}$, $G_v = K_v/(\tau_v s+1)$, $G_{IP} = K_{IP}$, $G_p = K_p/(\tau s+1)$

$K_d = 1$, $K_t = 20$, $K_v = 15$, $K_{IP} = 1$, $K_p = 4$, $\tau = 1$, $\tau_v = 0.1$, $\theta = 1$

(i) Determine the ideal feedforward controller, G_f (4 marks)

(ii) Determine the ideal feedforward controller, G_f, for the case where the disturbance transmitters and control valve have negligible dynamics. From the result, what you can conclude about G_f? (6 marks)

(d) Consider a feedforward-feedback control system where

$$\frac{U(s)}{D(s)} = G_v G_f G_t$$

Given

$$G_v = \frac{20}{0.5s+1} \qquad G_f = -\frac{0.5\,(s+1)}{(2s+1)} \qquad G_t = 10e^{-s}$$

Determine the steady state gain for $\frac{U(s)}{D(s)}$ (4 marks)

Q4 (a) Design a cascade control for ONLY **ONE (1)** of the systems below.
(i) an exothermal chemical reactor **OR**
(ii) a heat exhanger.

(7 marks)

(b) Figure Q4(b) shows the block diagram of a cascade control system. The transfer functions are

$G_{p1}= 2/(2s+1)^2$
$G_{p2}= 1$
$G_v= 3/(s+1)$
$G_{d1}=1/(2s+1)$
$G_{d2}=1$
$G_{m1}=0.1$
$G_{m2}=0.5$
$G_{c2}=5$
$G_{c1}=2$

(i) Compare the cascade control system shown in Figure Q4(b) with the conventional feedback control system. The comparison has to be carried out by analyzing TWO (2) performance criterias. (13 marks)

(ii) Conclude why one system is superior than the other.

(5 marks)

- END OF QUESTION -

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Formula

$Z/Z_i = \Pi_f/(1+\Pi_e)$

$K = \lim_{s \to 0} G_v G_f G_t$

$G_c = f/\check{G}\text{-}$

$f = 1/(\tau_c s+1)$

$\lim_{t \to 0} y(t) = \lim_{s \to \infty} sY(s)$

$\lim_{t \to \infty} y(t) = \lim_{s \to 0} sY(s)$

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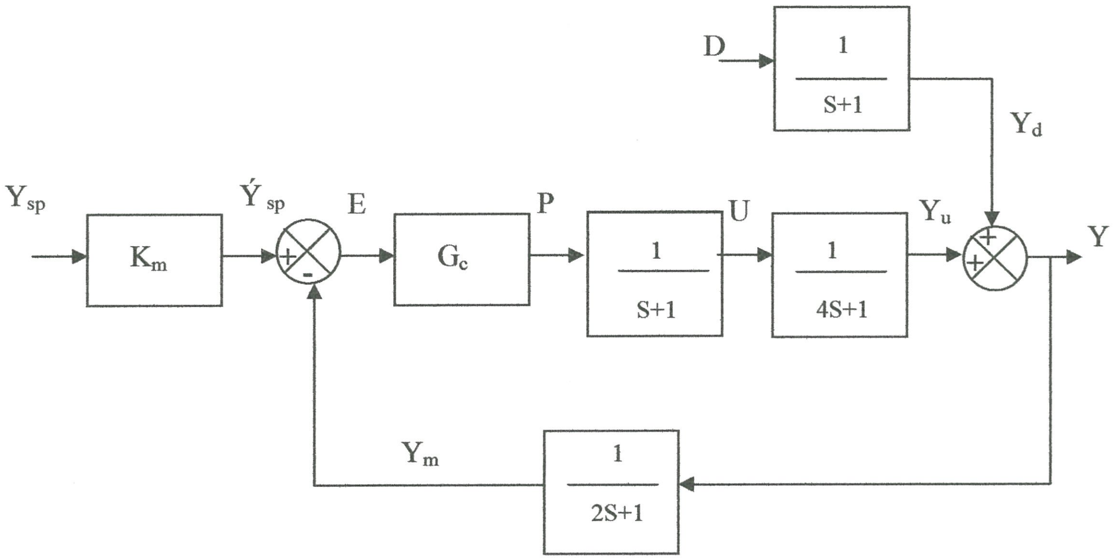

FIGURE Q1(c)

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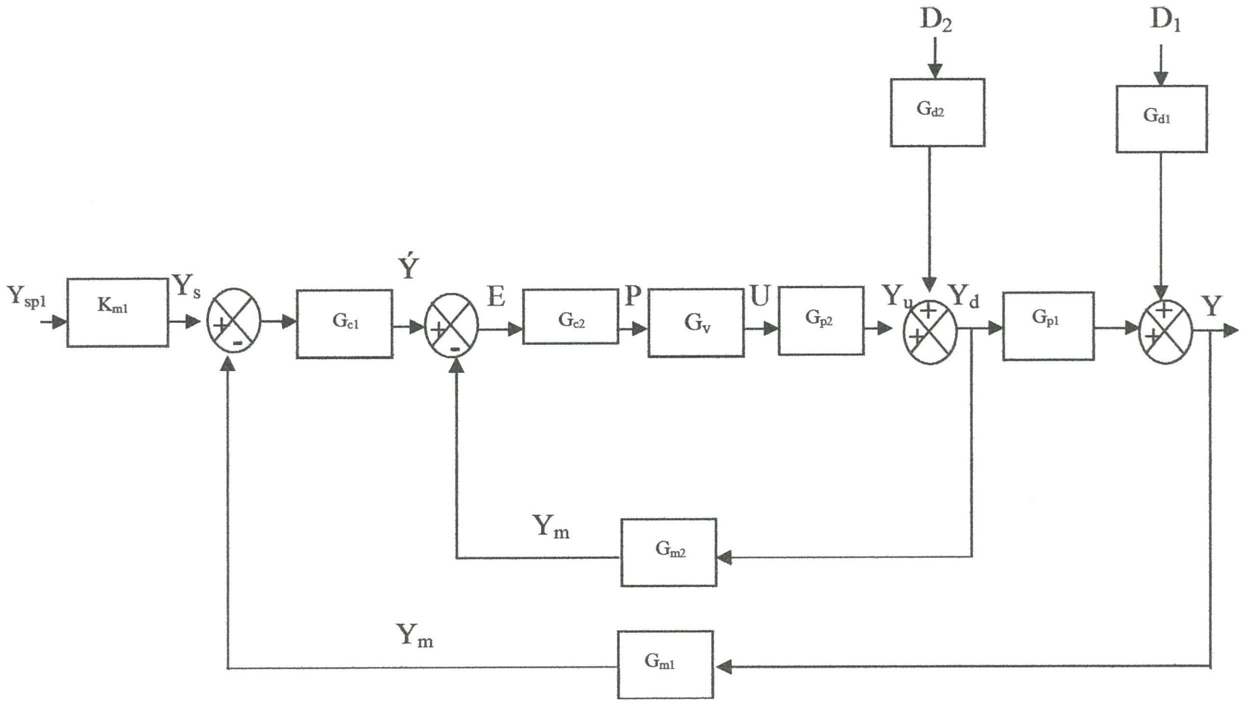

FIGURE Q4(b)