

NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

APPLIED PHYSICS DEPARTMENT

SPH 4230 – INDUSTRIAL INSTRUMENTATION

EXAMINATION

BSc. HONOURS PART IV: MAY 2005

DURATION: 3 HOURS

ANSWER ALL QUESTIONS FROM SECTION A AND ANY 3 QUESTIONS FROM SECTION B.
SECTION A CARRIES 40 MARKS AND SECTION B CARRIES 60 MARKS.

SECTION A

- 1 (a) Distinguish between control and regulation. [4]
- (b) Give a detailed explanation of three control objectives. [6]
- (c) What are the advantages and disadvantages of feedback control? [4]
- (d) Explain the following:
(i) Hardware of a control system.
(ii) Software of a control system. [4]
- (e) Calculate the output of a proportional integral controller if its gain is 2, $M = 0.1 \text{ s}^{-1}$ for a period of 20 s. The error signal is equal to 0.1 V. [4]
- (f) Explain the following terms:
(i) Transient response
(ii) Steady state response [4]
- (g) What is a digital
(i) encoder
(ii) decoder [4]
- (h) What is a PLC? Draw the architecture of a PLC. [4]
- (i) For a PLC explain the
(i) input systems
(ii) output systems. [6]

SECTION B

- 2 (a) What do understand by proportional only control? [2]
- (b) Draw a block diagram of a proportional only controller. [4]
- (c) Give advantages and disadvantages of proportional only control. [6]
- (d) For a proportional only controller show that
- (i) $PV = \frac{G.SP}{1+G}$
- (ii) $E = \frac{SP}{1+G}$ [8]
- 3 (a) Define the following terms.
- (i) Proportional band.
- (ii) Integral time T_i
- (iii) Derivative time T_d [6]
- (b) Explain the following terms that are used when toggling between manual and automatic control modes.
- (i) Bumpless transfer.
- (ii) Track mode. [4]
- (c) (i) Draw an analogue circuit of a P + I + D controller. [6]
- (ii) What happens to the proportional band and the integral time if R_1 and R_2 are increased respectively? [4]
- 4 (a) (i) Explain using a practical example the term 'integrator windup.' Describe one approach for dealing with windup problem. [6]
- (ii) Write short notes on timed proportional output controller. What are the relative advantages of this type of control strategy over ON/OFF and continuous output types. [6]
- (b) In process control explain the following terms:
- (i) Saturation
- (ii) Velocity limiting
- (iii) Hysteresis
- (iv) Dead Zone [10]
- 5 (a) Draw a diagram that shows a plant used to cast steel into solid billets. Explain the level transducer used. [7]
- (b) In process control what is system modeling? [2]
- (c) For a continuous casting plant, use system modeling and the following data to show that

$$\frac{d^2h}{dt^2} + 0.5 \frac{dh}{dt} + 0.67Kh = 3.94F + 5K.SP - 5V_b$$

[8]

Level transducer output range	0 – 10 V for a 0 – 75 mm height
Motor/drive speed range	0 – 25 rps
Gearbox ratio	550 : 1
Roll diameter	700 mm
Area of mould	(127 x 127) mm ²

[3]

- 6
- (d) Explain the shortcomings of the caster model. [3]
 - (a) What is digital signal processing (DGS)? [2]
 - (b) Give a detailed explanation of four digital signal processing methods. [8]
 - (c) Explain two applications of digital signal processing. [6]
 - (d) In directional reception of waves, calculate the time delay for the wave to travel a distance of 2 m between adjacent sensors given the angle between the distance d and the incident plane wave is 20° . The speed of the wave is 345 ms^{-1} . Find the phase difference corresponding to a delay τ if the period of the sine wave is 30 seconds. [4]

END OF QUESTION PAPER