CS/M.Tech (CI)/SEM-2/CI-2.2/09

PROCESS CONTROL AND INSTRUMENTATION (SEMESTER - 2)

1. ....
Signature of Invigilator

2. ....
Signature of the Officer-in-Charge

Reg. No. | | | | | | | | | | | | | | | |

Roll No. of the Candidate | | | | | | | | | | | | | | | |

CS/M.Tech (CI)/SEM-2/CI-2.2/09

ENGINEERING & MANAGEMENT EXAMINATIONS, JULY – 2009

PROCESS CONTROL AND INSTRUMENTATION (SEMESTER - 2)

Time : 3 Hours] [Full Marks : 70

INSTRUCTIONS TO THE CANDIDATES :

1. This Booklet is a Question-cum-Answer Booklet. The Booklet consists of **32 pages**. The questions of this concerned subject commence from Page No. 3.
2. You have to answer the questions in the space provided marked 'Answer Sheet'. Write on both sides of the paper.
3. **Fill in your Roll No. in the box** provided as in your Admit Card before answering the questions.
4. Read the instructions given inside carefully before answering.
5. You should not forget to write the corresponding question numbers while answering.
6. Do not write your name or put any special mark in the booklet that may disclose your identity, which will render you liable to disqualification. Any candidate found copying will be subject to Disciplinary Action under the relevant rules.
7. **Use of Mobile Phone and Programmable Calculator is totally prohibited in the examination hall.**
8. You should return the booklet to the invigilator at the end of the examination and should not take any page of this booklet with you outside the examination hall, **which will lead to disqualification**.
9. Rough work, if necessary is to be done in this booklet only and cross it through.

No additional sheets are to be used and no loose paper will be provided

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Marks Obtained

Question Number											***Total Marks***	***Examiner's Signature***
Marks Obtained												

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Head-Examiner/Co-Ordinator/Scrutineer

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PROCESS CONTROL AND INSTRUMENTATION
SEMESTER - 2

Time : 3 Hours] [Full Marks : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Question No. 1 is compulsory. Answer another *four* questions from the rest.

5 ∞ 14 = 70

1. Choose the correct answer giving justification : 7 ∞ 2

i) A 25% proportional band means a proportional gain of

a) 0·25 b) 4

c) 25 d) 75.

ii) Controller tuning based on parameters of the S-curve of the process

a) is essentially an offlines method

b) reduces ultimate period of oscillation of the process

c) results in a quarter decay ratio in the process response

d) is applicable to analague controllers only.

iii) Which of the following is NOT true ?

Valve co-efficient C_v for a flow control system depends on

a) flow rate

b) fluid viscosity

c) type of fluid

d) type of plug.

iv) Which of the following actuators is the most powerful ?

a) Armature controlled *d.c.* motor

b) Spool valve controlled hydraulic motor

c) Variable reluctance step motor

d) Torque motor.

v) Half-life t_{half} of a nucleonic radiation is

a) $\frac{0{\cdot}639}{\lambda}$

b) $\frac{\lambda}{2}$

c) $\frac{2}{\lambda}$

d) $\frac{\lambda}{0{\cdot}639}$, where λ is the decay constant.

vi) Stirred tank reactor is controlled using

a) heat balance b) material balance

c) both of these d) none of these.

vii) Process control signal for current transmission is the range of

a) 0 – 16 mA b) 4 – 16 mA

c) 4 – 20 mA d) 0 – 20 mA.

2. The philosophy of the controller fabrication is to select a suitable network *H* to be placed in the feedback path of a loop with a high gain amplifier in the forward path.

a) Justify the philosophy. Hence show what should be the transfer function *H* for a *PD* controller. 3

b) What are the components and high gain amplifiers used in electronic controllers and pneumatic controllers ? Discuss with reference to their characteristics. 3

c) What is 'live zero' and 'dead zero' in a process controller ? State their values when the output of the controller is electrical or pneumatic signal. 2

d) What is the function of a pilot relay or air relay in a pneumatic controller ? Explain its principle of operation with a neat sketch when used along with a *P*-controller. 3

e) Specify a process controller and explain significance of each specification. 3

3. Give simulation diagrams of the following process controllers and derive the transfer functions or mathematical expressions :

   a) Three term stack controller 5

   b) Electronic PI controller 4

   c) Digital P-I-D controller. 5

4. a) What is a feed forward control ? Show how in a feed forward control, the control loop can be made insensitive to a load disturbance. What are the limitations of their method ? 5

   b) What is a cascade control system ? How would you determine the type of process that would require a cascade control ? 5

   c) Explain the principle of operation of an override controller and its application. 4

5. a) Explain with neat sketches, principle of operation of the following : 3 + 2 + 3

      i) Lifting gate valve

      ii) Parabolic type plug used in valve

      iii) Butterfly valve.

   b) What is C_v factor of a control valve ? How is it useful in valve selection and sizing ? Find the proper valve size for pumping a liquid flow rate of 600 gpm with a maximum pressure difference of 55 psi. The liquid specific gravity is 1·3. 6

Valve in inches	$\frac{1}{4}$	$\frac{1}{2}$	1	$1\frac{1}{2}$	2	3	4	6	8
C_v	0·3	3	14	35	55	108	174	400	725

6. a) What are different tuning schemes for PID controllers adapted in process industries ? Discuss methods and compare them. 5

   b) What are different types of step motors ? Explain switching sequence, the principle of operation of a permanent magnet type step motor. 5

c) What is a valve positioner ? Explain with a neat sketch the principle of operation of a pneumatic type valve positioner. 4

7. a) Describe the principle of operation of nucleonic sensing. 3

b) Describe the measuring circuit, sensor and intensity modulation of a nucleonic sensor. 7

c) Describe the level measuring techniques and their characteristics using nucleonic sensor. 4

8. a) What is unit operation of a process control system ? 2

b) Derive the transfer functions of a mixing process involving thermal balance when one of the inputs is controllable. 6

c) How is a distillation column modelled for use in the process control analysis ? 6

END