

MANIPAL INSTITUTE OF TECHNOLOGY MANIPAL

FIRST SEMESTER M.TECH. (CONTROL SYSTEMS) END SEMESTER EXAMINATIONS, NOV/DEC 2016

SUBJECT: PROCESS DYNAMICS AND CONTROL [ICE 5121]

Time: 3 Hours

MAX. MARKS: 50

Instructions to Candidates:

- ✤ Answer ALL the questions.
- ✤ Missing data may be suitably assumed.
- 1A. 5 Obtain the mathematical model of a continuously stirred tank thermal system. Define the term thermal resistance and thermal capacitance. Model a single tank level process when the outlet from the tank is taken through a constant 1**B**. 3 speed motor. How does this system perform when it is subjected to a load change in inflow to the tank? 1C. 2 Distinguish between servo response and regulatory response in process control. 2A. 5 For a proportional controller, the controlled variable is a process temperature with a range of 50 to 130°C and a set point of 73.5°C. Under nominal conditions, the setpoint is maintained with an output of 50%. Find the proportional offset resulting from a load change that requires a 55% output if the proportional gain is 2.0. Also find the percentage controller output if the temperature is i) 61°C ii) 122°C iii) a ramping temperature of (82+5t)°C.
- 2B. Explain different design aspects of a control system.
- **2C.** Define degrees of freedom with an illustration.
- **3A.** For a process plant described by the transfer function $G(s) = \frac{1}{(s+1)^4}$, determine the P, PI and

PID controller gains using ultimate gain method.

- **3B.** Derive the expression for the FOPDT model of a plant obtained through 2 point method.
- **3C.** Write about the performance evaluation using i) ISE ii) ITAE criteria.
- 4A. Explain the proportional-derivative control mode highlighting its advantages and 5 disadvantages. Determine the controller output for the error function with a hypothetical load change shown in Fig. Q(3B) for the same.



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| 4B. | For the general feedforward-feedback system, list the tuning rules to determine the parameters | 3 |
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| | of the feedforward controller $G_{f}(s)$ considered as a lead-lag transfer function. | |
| 4C. | What is the role of ratio control in chemical industry? | 2 |
| 5A. | With relevant sketches explain any two rotating shaft control valves. | 4 |
| 5B. | With a block schematic explain the model predictive control strategy. | 3 |
| 5C. | With analytic expression and plots specify any three control valve characteristics. | 3 |