



MANIPAL INSTITUTE OF TECHNOLOGY MANIPAL

(A constituent institution of MAHE, Manipal)

## VI SEMESTER B.TECH. (BIOTECHNOLOGY) END SEMESTER EXAMINATIONS,

SUBJECT: Bioprocess Control & Instrumentation [BIO 3252]

Time: 2 Hours

MAX. MARKS: 40

## Instructions to Candidates:

- ✤ Answer ANY FOUR full questions.
- Missing data may be suitable assumed.

Figure shows a system of two tanks which are used for the temporary (tank 1) and longerterm (tank 2) storage of a liquid chemical product. The demand is satisfied from the temporary storage tank, while tank 2 is used to accumulate the liquid product in excess of the demand. (a) Identify the external disturbances, control objectives, measurements, and manipulated variables available to you. Is this a SISO or a MIMO system? (b) Develop alternative feedback and/or feedforward control configurations to achieve your control objectives. 5 1A. Supply Demand Tank 2 Tank 1 What is a mathematical model of a physical process, and what do we mean when we talk 5 **1B.** about mathematical modelling? Develop the mathematical model for the system shown if Figure. What are the state variables for this system and what type of balance equations have you used? All the flow rates are volumetric and the cross-sectional areas of the three tanks are  $A_1$ ,  $A_2$ , and  $A_3$  (ft<sup>3</sup>), 5 2A. respectively. The flow rate F<sub>5</sub> is constant and does not depend on h<sub>3</sub>, while all other effluent flow rates are proportional to the corresponding hydro-static liquid pressures that cause the flow.

