Ajay Kumar Garg Engineering College, Ghaziabad

Department of ECE

Model Solution Sessional Test-2

Course:	B.Tech	Semester:	VII
Session:	2017-18	Section:	EI-1
Subject:	Computerized Process Control	Sub. Code:	NIC-703
Max Marks: 50		Time:	2 hour

JAI SHREE GUPTA

Section-A

Ques(1)- What is real-time operating system (RTOS)?

Ans:- A real-time Operating system (RTOS) is used for the process control computer application. It is capable of managing a real-time resource scheduling and control problems in computer based industrial process control system.

Ques (2)- What is Modem?

Ans:- A modem (modulator-demodulator) is a n/w hardware device that modulates one or more carrier ~~that~~ signal to encode digital information for transmission and demodulates signals to decode the transmitted information.

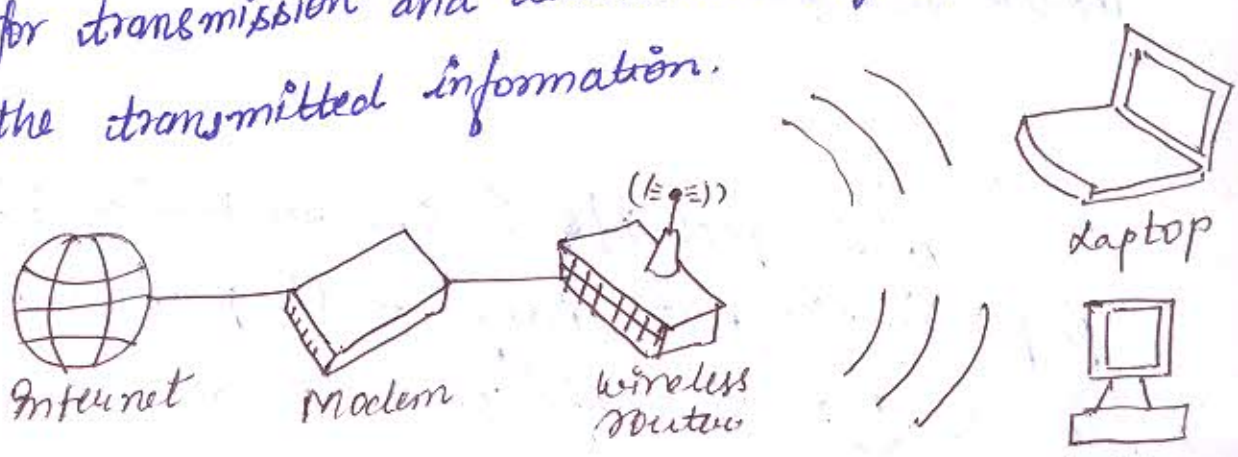


fig- Connection diagram

Ques (3):- List different types of transmission technique used for data transfer b/w two devices.

Ans:- Transmission technique used for data transfer b/w two devices divided into following categories :-

(1) Serial & parallel
(2) Synchronous & Asynchronous
(3) Local Area Network (LAN)

Ques (4):- List general steps of modeling Procedures.

Ans:- General steps of Modelling Procedures:-

(1) Goals definition
(2) Information Preparation
(3) Model formulation
(4) Solution determination
(5) Result Analysis
(6) Model Validation

Ques (5):- What is Lumped System?

Ans:- A dumped s/s is one in which s/s properties do not change with position with in the s/s and the mode involves algebric

and differential equations.
Stirred tank → can dump together various values of the state.

Section-B

Ques⑥:- What is CSMA/CD? for what purpose is this used? Explain with an example.

Ans:- In central bus control, a fixed master assigns the right to one station at a time in data link layer.

→ If master fails, then the entire communication n/w break down.
→ for this reason de-centralized bus control with flying masters has been developed.
→ In this case, the right to transmit can be assigned to several stations.
→ The de-centralized bus control model such as, the CSMA/CD model, ethernet & the token passing model have been used.

CSMA/CD (carrier sense multiple access with collision detection) → All the station on the bus have the right to transmit.

→ Each station continuously listens to (or senses) the bus.

→ If the bus is free, then any of the stations can transmit its data.
→ If several stations want to transmit simultaneously, a collision is detected and all stations withdrawn.

Example:- The CSMA/CD is very popular in office & higher automation systems.
→ It is not suitable for field-buses, since short response time, as required for alarms, cannot be guaranteed.

Buses (7):- What is the use of field buses in industrial ~~purpose~~ process control s/s? What are different types of field buses? Discuss the advantages & disadvantages.

Ans:- Use of field buses in industrial process control s/s:- Field-buses are used to link sensors and actuators at the process level with the s/s intelligence i.e. with DCS s/s, PLCs and controllers, so that the information they supply can flow into the plant information s/s.

Different types of field buses:-

(1) Smart transmitter.
(2) Open manufacturer field-buses such as rack-bus, closed field-buses, MODBUS protocol.

(3) FIP-BUS

(4) PROFI-BUS

(5) MIL-BUS

Advantages of field buses over hand-wired installation such as :-

→ Bidirectional digital transmission
→ Simple cabling and cross-wiring
→ Easy expandability & retrofitting
→ Reduction of planning costs and maintenance
→ Higher safety through self-monitoring
→ Higher resolution of process values.

Disadvantages of field buses :-

→ Field buses s/s are more complex, so users need to be more extensively trained or more highly qualified.
→ The price of field-buses components is higher.
→ Slightly longer reaction times
→ Device manufacturers have to offer different version of their devices (eg. sensors, actuator) due to the number of different field bus standards. This can add to the cost of the devices and to the difficulty of device selection & availability.
→ Investment risk

Ques ⑥:- Why do we need to develop the mathematical model for a process we want to control?

Ans:- A mathematical model of a process is a s/s of equations whose solution, given specific i/p data, is representative of the response of the process to a corresponding set of inputs.

→ Mathematical models are simple or complex, as dedicated by the intended use.

→ A mathematical model is a mathematical expression that describes the important relationships b/w the i/p & o/p of a s/s or component.

→ Applying the many methods of controls to improve command response, stability and disturbance rejection required a thorough understanding of the objects under control.

→ • How does a disturbance couple into the plant?
  • What delay does the feedback device inject?
  • How will the power converter limit the responsiveness of the s/s?

→ To answer these questions, we need an accurate mathematical description (model) of the s/s.

Ques (9):- List and describe all the types of process modelling.

Ans:- Types of process modelling:-

(1) Mathematical models
(2) Dynamic & steady. state models
(3) Dynamic models based on fundamental principles
(4) fundamental & empirical models
(5) dumped & distributed models
(6) Linear & nonlinear models
(7) continuous and discrete time models.

(1) Mathematical models:- A s/s of equations whose solution for particular i/ps will represent the response of process to respective i/p. It is a mathematical that describes the relationship b/w i/p & o/p.

(2) Dynamic & steady state models:-

Dynamic → derivative terms i.e. rate of change of state with time (represented by differential eqn)
Steady state → tells about the only one state of eqn.

(3) Dynamic models based on fundamental principles:-

If the eqn are based on first principles then they must be formulated in terms of fundamental quantities -

Mass, Energy, Momentum

Accumulation = In - Out + (Generation) - (consumption)

(4) fundamental & Empirical models:-

Fundamental → based on fundamental concept (expensive and not feasible)

Empirical → based on experience.

(5) Lumped & distributed models:-

Lumped s/s → in which s/s properties do not change with position with in the s/s & the model involves algebric & differential eqn.

Distributed s/s → properties are dependent on position and model involves partial differential eqn.

(6) Linear & non-linear models:-

Non-linear → are used where accuracy over a wider range of operation is required.

Linear → LTI, time invariant s/s.

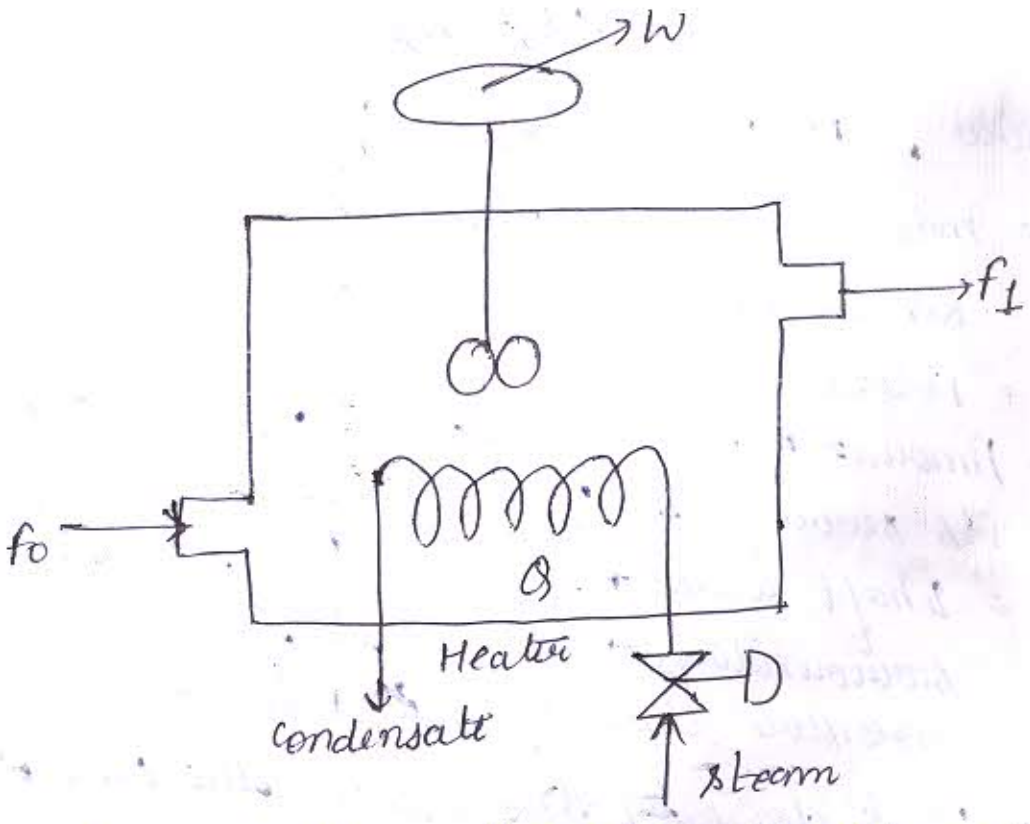
(7) Continuous & discrete time models:-

Continuous value or on-off value

↓ differential eqn ↓ difference eqn (digital s/s)

Ques(10):- Develop a relationship for overall material balance, component material balance & energy balance for model formulation.

Ans:- **Model formulation:-** the third step in modelling procedure is the model formulation in which the important variables, whose behaviour is to be predicted, is selected. Then the eqn is developed based on fundamental principles
- conservation balance (common assumption) → Universals
- Constitutive balance (not universal)



Accumulation = (In) - (out) + (Generation)

Overall material balance = (Accumulation of mass)
= (Mass-in) - (Mass-out)

Component material balance = (Accumulation of component mass)
= (Component mass-in) - (Component mass-out)
+ (Generation of component mass)

Energy balance = (Accumulation of U+PE+KE)
= (H+PE+KE in due to convection)
- (H+PE+KE out due to convection)
+ Q - W_s

where, $H = U + \delta V$ = Enthalpy
U = Internal energy of the s/s
KE = Kinetic energy of the s/s
PE = Potential energy of the s/s
Q = Amount of heat exchanged b/w the s/s and its surrounding per unit time.
W_s = Shaft work exchanged b/w the s/s & its surroundings per unit time.
δV = pressure time specific volume
W = work done by the s/s on the surroundings.

Section - C

Ques:- Draw a communication n/w hierarchy for a process industry showing different process control levels. Explain the func^{n} of each communication level.

Ans:- **Communication n/w hierarchy :-**

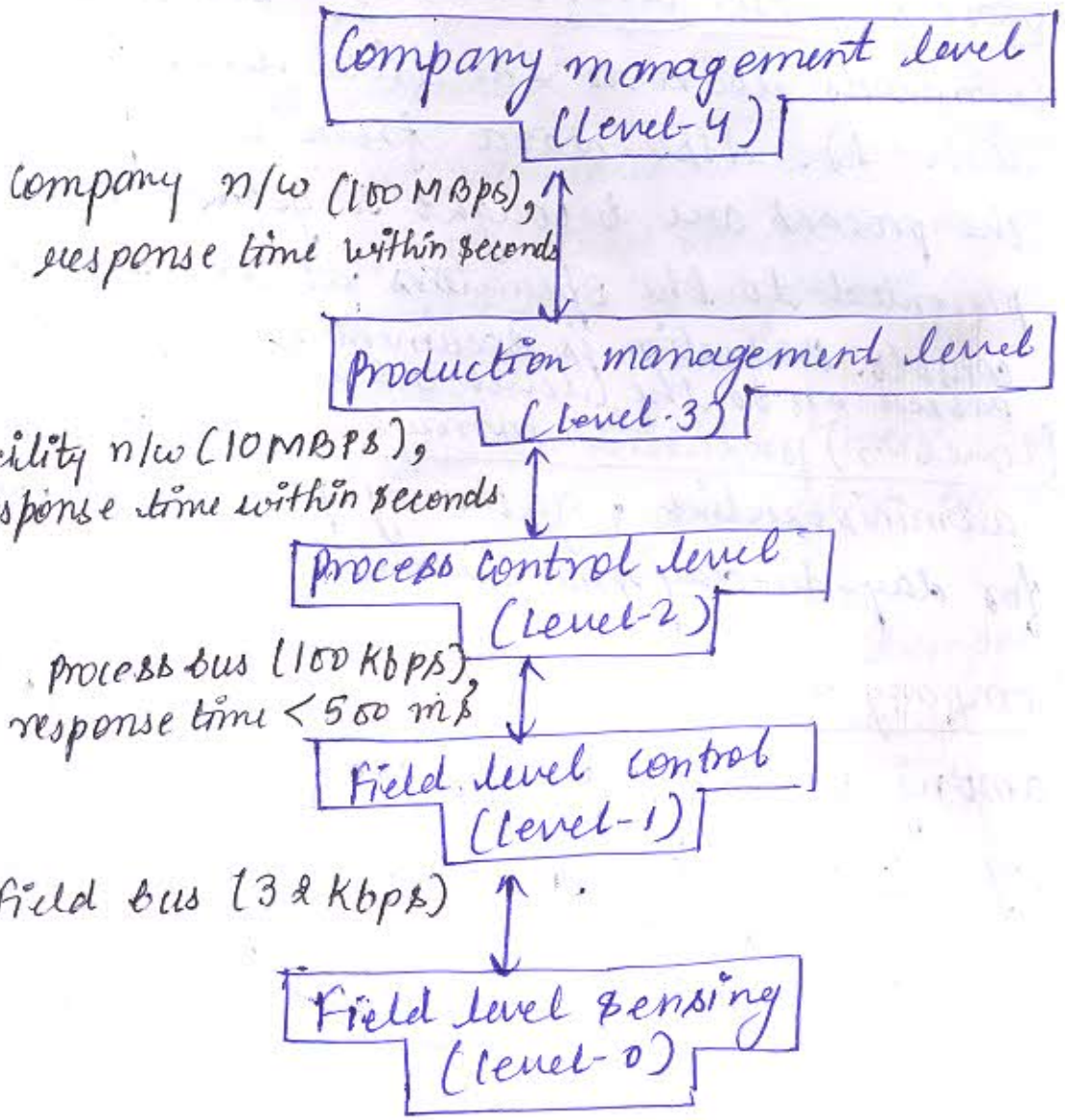


fig:- Communication hierarchy of a production industry

→ Field level (level-0) → Information on process variables is gathered by sensors.

→ Field level control (level-1) → DCS-type process control s/s and PLCs act on this information to control the process by actuating valves, switching on pumps etc.

→ process control level (level-2) → sends the control commands down to the field level (level-0 & level-1). Also data from all parts of the process are brought together and presented to the operators at the engineer's console. Production is documented & selected information passed on to the (level-3 & level-4).

→ (level-3) production management → is purely administrative, gathering production statistics for day-to-day management of the plant.

→ Company management (level-4) → data are exchanged among various departments.

E.g:- acquisition
accounts & sales

Ques (12):- Outline the steps that you should take during the development of a mathematical model for process control purpose.

Ans:- It is important that a framework be used for the development of a process model which is adequate and accurate for the purpose.

→ Steps:

(a) What are the controlled variables? Proper regulation of these variables is the ultimate goal of the control s/s. These variables may not be directly measurable but is inferred from other measurements.

(b) What are the measured variables? These variables are directly measured and thus used by the control algorithm.
They are quantities like, pressure, temperature, and concentration.

(c) Which variable can be manipulated? Control inherently involves variables that can be adjusted in order to affect a change in the measured variables.

(d) What is the expected effectiveness of the control s/s? In order to implement the control properly, the model must determine the following aspects of the process →

- Sign & magnitude changes → When a manipulated variable is increased, does the controlled variable increase or decrease?
- Speed of response → Does the control variable change rapidly or slowly when the given manipulated variable changes?

(e) How sensitive is the s/s to changes in the operating points? Industrial control s/s often experience changes in the operating conditions and equipment performances