UNIT-V

INDUSTRIAL ROBOTICS

PART- A

1. **What are the benefits of industrial robots?**

    - Increased Productivity
    - Significant Savings
    - Improved Quality
    - Better Safety
    - Competitive Edge

2. **What is work volume?**

    The volume of the space swept by the robot arm is called work volume.

3. **What are the four basic robot configurations available commercially?**

    - Cartesian coordinate system
    - Cylindrical coordinate system
    - Polar or spherical coordinate system
    - Revolute coordinate system.

4. **What are the types of Mechanical Grippers?**

    - Linkage actuation gripper
    - Gear and rack actuation gripper
    - Cam actuated gripper
    - Screw actuated gripper

5. **Give some examples of tool as robot End effector.**

    - Spot Welding Tools
    - Arc welding Torch
    - Spray painting nozzle
    - Water jet cutting tool

6. **What are the basic classifications of sensors?**

    - Tactile Sensors,
    - Proximity Sensors,

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- Range sensors,

- Voice sensors etc.,

7. Classify the position sensors.

- Incremental encoders

- Absolute encoders

- Resistive position sensors

- Linear variable differential transformer.

- Encoders

- Potentiometer

8. What are the methods of robot programming?

- Lead through methods

- Textual robot languages

- Mechanical Programming

9. Define servo controlled robots.

Servo controlled robots, which are programmed by lead through an textual language methods tend to actuate all axes simultaneously.

10. What is manual lead through programming?

In manual lead through programming the programmer moves the manipulated wrist to teach spray-painting or arc welding. The movements consist of combination of smooth motion segments.

11. Define pitch, yaw and roll. (Nov/Dec 2016).

The robot's wrist is used to establish the orientation of the end effector. Robot wrists usually consist of two or three degrees-of-freedom. The Figure illustrates one possible configuration for a three-degree-of-freedom wrist assembly. The three joints are defined as: (1) roll, using a T joint to accomplish rotation about the robot's arm axis: (2) pitch, which involves up-and-down rotation, typically using a R joint; and (3) yaw,

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which involves right-and-left rotation, also accomplished by means of an R joint. A two d.o.f wrist typically includes only roll and pitch joints (T and R joints).
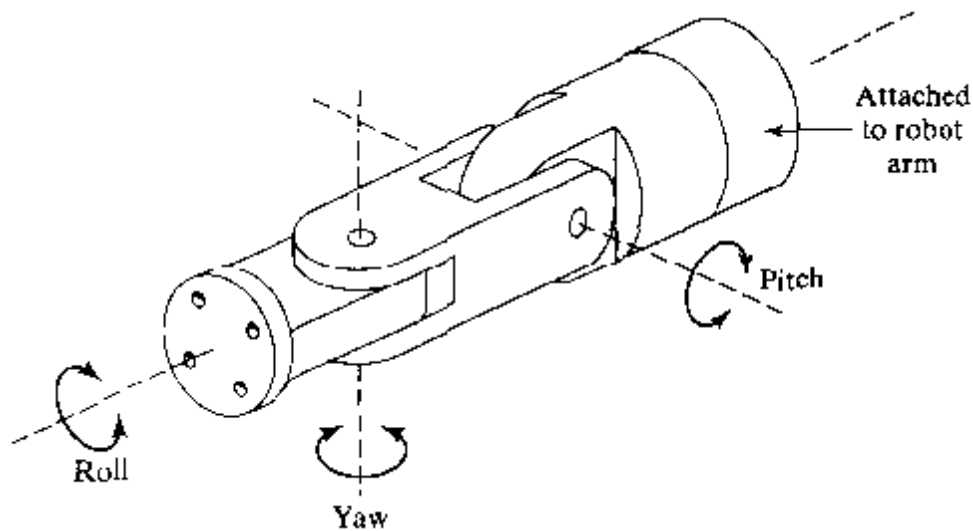
12. What is accuracy and repeatability in industrial robots? (Nov/Dec 2016).

Industrial robots are used in applications that require high levels of accuracy and repeatability. Repeatability is a measure of the ability of the robot to consistently reach a specified point. Accuracy is a measure of the distance error associated with the desired point and achieved point.

13. Classify the robot control systems. (Apr/May 2017)

The robotic systems are classified mainly into three main types on the basis of application. They are:
- Manipulation Robotic system
- Mobile robotic system
- Data acquisition and control robotic system

14. Differentiate between world and tool coordinate system in robotics with simple sketch. (Apr/May 2017).

Based on a mechanical interface coordinates system, you may define tool coordinates system, which is Cartesian coordinates, by offsetting the origin of the mechanical interface coordinates system to a different point, along with the size and direction of a

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tool, and then rotating the origin around the Z-axis of the mechanical interface coordinates system.

World coordinate system is a coordinate system whose origin is specified by a user. This system enables multiple robots to use a common coordinate system for position designation. By setting the origin of the facilities to that of the world coordinate system, you can set positions of different robots on the same coordinate system.

Coordinate Systems

World coordinate system   Tool coordinate system

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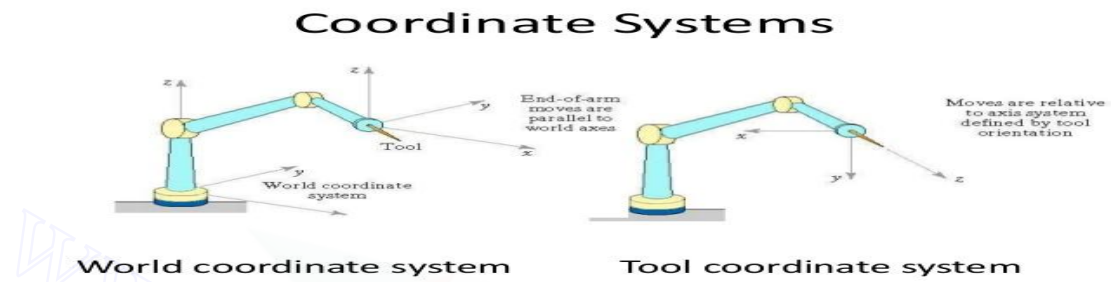
PART-B

1. Briefly explain the different types of robots.

Industrial robots:

Industrial robots are robots used in an industrial manufacturing environment. Usually these are articulated arms specifically developed for such applications as welding, material handling, painting and others. If we judge purely by application this type could also include some automated guided vehicles and other robots.

Domestic or household robots:

Robots used at home. This type of robots includes many quite different devices such as robotic vacuum cleaners, robotic pool cleaners, sweepers, gutter cleaners and other robots that can do different chores. Also, some surveillance and tele-presence robots could be regarded as household robots if used in that environment.

Medical robots:

Robots used in medicine and medical institutions. First and foremost surgery robots. Also, some automated guided vehicles and maybe lifting aides.

Service robots:

Robots that don't fall into other types by usage. These could be different data gathering robots, robots made to show off technologies, robots used for research, etc.

Military robots:

Robots used in military. This type of robots includes bomb disposal robots, different transportation robots, reconnaissance drones. Often robots initially created for military purposes can be used in law enforcement, search and rescue and other related fields.

Entertainment robots:

These are robots used for entertainment. This is a very broad category. It starts with toy robots or the running alarm clock and ends with real heavyweights such as articulated robot arms used as motion simulators.

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Space robots:

This type would include robots used on the International Space Station, Can arm that was used in Shuttles, as well as Mars rovers and other robots used in space.

Hobby and competition robots:

Most of the hobbyist robots are mobile and made to operate by rolling around on wheels propelled by electric motors controlled by an on board microprocessor.

Explorer robots:

The majority of these robots are completely self-reliant due to their sensory systems, however they may also be controlled by humans giving orders through computer commands. The other types of explorer robots are underground mine exploring robots, seeing and walking undersea robots, and even bomb defusing robots used by police.

Laboratory robots:

Laboratory robotics is the act of using robots in biology or chemistry labs. For example, pharmaceutical companies employ robots to move biological or chemical samples around to synthesize novel chemical entities or to test pharmaceutical value of existing chemical matter.

Playback robots:

The playback robots are capable of performing a task by teaching the position. These positions are stored in the memory, and done frequently by the robot. Generally, these playback robots are employed with a complicated control system. It can be divided into two important types, namely:

Point to Point control robots

Continuous Path control robots

2. **Sketch and explain the four basic robot configurations classified according to the coordinate system. (Apr/May 2017), (Nov/Dec 2016).**

Classification Based on Physical

- Cartesian configuration
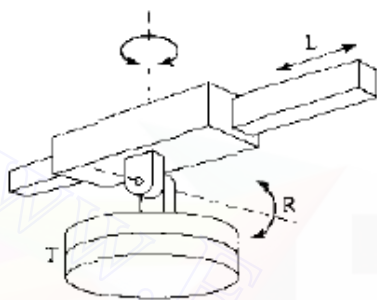- Cylindrical configuration
- Polar configuration

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- Joint-arm configuration
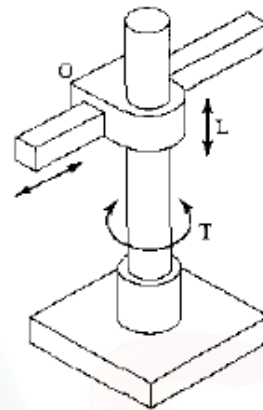
Cartesian Configuration:

Robots with Cartesian configurations consist of links connected by linear joints (L). Gantry robots are Cartesian robots (LLL).

Cylindrical Configuration:

Robots with cylindrical configuration have one rotary (R) joint at the base and linear (L) joints succeeded to connect the links.

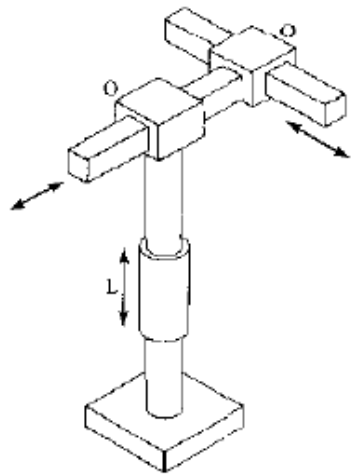Polar coordinate body-and-arm assembly.

Cylindrical body-and-arm assembly.

Polar configuration :

The designation of the arm for this configuration can be TRL or TRR. Robots with the designation TRL are also called spherical robots. Those with the designation TRR are also called articulated robots. An articulated robot more closely resembles the human arm.

Joint-arm Configuration:

The jointed-arm is a combination of cylindrical and articulated configurations. The arm of the robot is connected to the base with a twisting joint. The links in the arm are connected by rotary joints. Many commercially available robots have this configuration.

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Cartesian coordinate body-and-arm assembly.
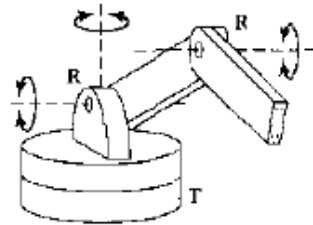
Jointed-arm body-and-arm assembly.

3. Briefly explain the working principle of position sensors with neat sketch.

Position sensors are used to monitor the position of joints. Information about the position is fed back to the control systems that are used to determine the accuracy of positioning.

In most cases in robots, a primary interest is to control the position of the arm. There is a large variety of devices available for sensing position. However, the most popular angular-position sensors are the following devices:

- Encoders
- Synchros
- Resolvers
- Potentiometers

Types of Position Sensor:

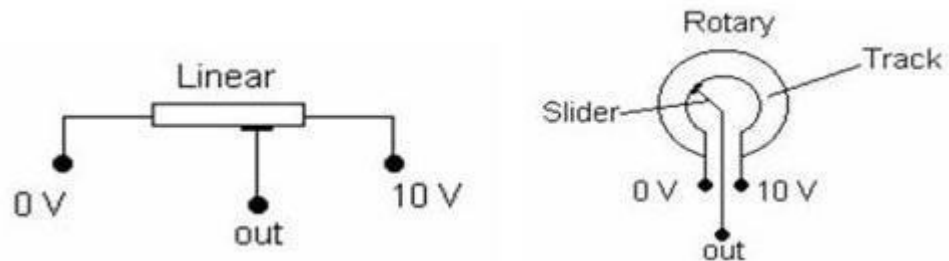Position sensors use different sensing principles to sense the displacement of a body. Depending upon the different sensing principles used for position sensors, they can be classified as follows:

- Resistance-based or Potentiometric Position sensors
- Capacitive position sensors
- Linear Voltage Differential Transformers
- Magnetostrictive Linear Position Sensor
- Eddy Current based position Sensor

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- Hall Effect based Magnetic Position Sensors
- Fiber-Optic Position Sensor
- Optical Position Sensors

Potentio-metric Position Sensors:

Potentio-metric position sensor use resistive effect as the sensing principle. The sensing element is simply a resistive (or conductive) track. A wiper is attached to the body or part of the body whose displacement is to be measured. The wiper is in contact with the track. As the wiper moves, the resistance between one end of the track and the wiper changes. Thus, the resistance becomes a function of the wiper position. The change in resistance per unit change in wiper position is linear.

Resistance, proportional to wiper position, is measured using voltage divider arrangement. A constant voltage is applied across the ends of the track and the voltage across the resistance between the wiper and one end of the track is measured. Thus, voltage output across the wiper and one end of the track is proportional to the wiper position.

The conductive track can be made linear or angular depending upon the requirements. The tracks are made from carbon, resistance wire or piezo resistive material.

4. Briefly explain the Robot Programming Languages in detail.
(Nov/Dec 2016).

Robot languages have been developed for ease of control of motions of robots having different structures and geometrical capabilities.

Some of the robot languages have been developed by modifying the existing general-purpose computer languages and some of them are written in a

completely new style.

Programming languages have been developed by the pioneer efforts of various researchers at Stanford Artificial Intelligence Laboratory; research laboratories of IBM Corporation, under U.S. Air Force sponsorship, General Electric Co., Unimation and many other robot manufacturers.

WAVE and AL:

WAVE, developed at Stanford, demonstrated a robot hand—eye coordination while it was implemented in a machine vision system.

Later a powerful language AL was developed to control robot arms. WAVE incorporated many important features.

Trajectory calculations through coordination of joint movements, end-effectors positions and touch sensing were some of the new features of WAVE. But the algorithm was too complex and not user friendly.

They could not be run in real-time and on-line. On the other hand, trajectory calculations are possible at compile time and they can be modified during run time.

AML:

A manufacturing language, AML was developed by IBM. AML is very useful for assembly operations as different user—robot programming interfaces are possible.

The programming language AML is also used in other automated manufacturing systems.

The advantage of using AML is that integers, real numbers and strings can be specified in the same aggregate which is said to be an ordered set of constants or variables.

MCL:

US Air force ICAM project led to the development of another manufacturing control language known as MCL by McDonnel—Douglas.

This is a modification of the popular APT (Automatically Programmed

Tooling) language used in CNC machine tools as many similar commands are used to control machine tools in CAM applications.

RAIL:

RAIL was developed by Automatic for robotic assembly, inspection, arc welding and machine vision. A variety of data types as used in PASCAL can be used.

An interpreter is used to convert the language into machine language commands. It uses Motorola 68000 type microcomputer system; It supports many commands and control of the vision system.

HELP:

HELP was developed by General Electric Company. It acts more or less like RAIL.

It has the capability to control two robot arms at the same time. The structure of the language is like PASCAL.

JARS:

JARS was developed by NASA JPL. The base of the language is PASCAL. JARS can be interfaced with PUMA 6000 robot for running robotic programs.

RPL:

RPL was developed at SRI International. A compiler is used to convert a program into the codes that can be interpreted by an interpreter. Unimation PUMA 500 can be controlled with the help of RPL. The basic ideas of LISP (an Al language) have been organized into a FORTRAN-like syntax in RPL. It is modular and flexible.

Besides these, there are some other languages like PAL, ADA etc. PAL has been written by Richard Paul by modifying WAVE and incorporating features of PASCAL. But the representations of syntaxes used in the program are difficult to handle. ADA developed by the Department of Defense (DOD) in USA is a real-time system that can be run on several microcomputers like Zilog, VAX, Motorola 68000, etc. ADA is convenient for controlling the robots used in a manufacturing cell.

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Different textual robot languages have different attributes. Far example, VAL, HELP and MC though powerful for many simple tasks, do not have the same structured modular programming capability like AL, AML, JARS and ADA or VAL II. In a manufacturing cell, multiple robots or robotic equipment work in unison. Control of two or more operations done by the robots in a coordinated manner is complex.

Synchronizing the motions of the robots requires necessary software commands. AL, ADA, AML, MCL have the capability of controlling multiple arms. The programming language must be capable of expressing various geometric features like joint angles, coordinate transformations such as rotation, translation, and vector quantities. Homogeneous matrices are used to specify the rotation. Rotation can also be specified by Euler angles. AML, RAIL and VAL use Euler angles while AL manipulates homogeneous matrix for control. AL is very suitable for assembly tasks wherein many sensors are employed, though other languages like AML and HELP are flexible enough to run various subroutines. Slewing and straight- line motions control are available with most of the languages.

5. Explain the various parts of a robot with neat sketch.
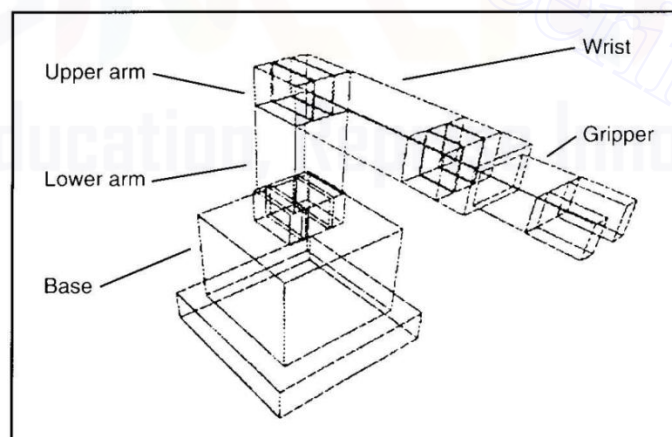
Controller:

Every robot is connected to a computer, which keeps the pieces of the arm working together. This computer is known as the controller. The controller

functions as the "brain" of the robot. The controller also allows the robot to be networked to other systems, so that it may work together with other machines, processes, or robots.

Robots today have controllers that are run by programs - sets of instructions written in code. Almost all robots of today are entirely pre-programmed by people; they can do only what they are programmed to do at the time, and nothing else. In the future, controllers with artificial intelligence, or AI could allow robots to think on their own, even program themselves.

Arm:

Robot arms come in all shapes and sizes. The arm is the part of the robot that positions the end-effectors and sensors to do their pre-programmed business.

Many resemble human arms, and have shoulders, elbows, wrists, even fingers. This gives the robot a lot of ways to position itself in its environment. Each joint is said to give the robot 1 degree of freedom.

Drive:

The drive is the "engine" that drives the links (the sections between the joints into their desired position. Without a drive, a robot would just sit there, which is not often helpful. Most drives are powered by air, water pressure, or electricity.

End-Effectors:

The end-effectors is the "hand" connected to the robot's arm. It is often different from a human hand - it could be a tool such as a gripper, a vacuum pump, tweezers, scalpel, blowtorch - just about anything that helps it do its job. Some robots can change end-effectors, and be reprogrammed for a different set of tasks.

Sensor:

Most robots of today are nearly deaf and blind. Sensors can provide some limited feedback to the robot so it can do its job. The sensor sends information, in the form of electronic signals back to the controller. Sensors give the robot controller information about its surroundings and it knows the exact position of the arm, or the state of the world around it.

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Reg.No: ☐☐☐☐☐☐☐☐☐☐

Question Paper code: 80672

B.E/B.TECH .DEGREE EXAMINATION, NOVEMBER/DECEMBER 2016

Seventh semester

Mechanical Engineering

ME 6703 – COMPUTER INTEGRATED MANUFACTURING SYSTEM

(Common to Mechanical and Automation Engineering)

(Regulation 2013)

Time: Three hours   Maximum: 100 marks

Answer ALL questions

PART A – (10 X 2 =20 Marks)

1. Define concurrent engineering. **(Refer page no: 8, Q.no: 5, unit: 1)**

2. What are the three basic elements of an automated system? **(Refer page no: 10, Q.no: 15, unit: 1)**

3. Differentiate process planning and production planning. **(Refer page no: 24, Q.no: 11, unit: 2)**

4. Distinguish materials requirement planning and manufacturing resource planning. **(Refer page no: 23, Q.no: 9, unit: 2)**

5. What is cellular manufacturing? **(Refer page no: 38, Q.no:3, unit: 3)**

6. Explain composite part concept. **(Refer page no: 40, Q.no: 11, unit: 3)**

7. State any four benefits of FMS. **(Refer page no: 53, Q.no: 2, unit: 4)**

8. List out the types of AGV's. **(Refer page no: 55, Q.no: 12, unit: 4)**

9. Define pitch, yaw and roll. **(Refer page no: 70, Q.no: 11, unit: 5)**

10. What is accuracy and repeatability in industrial robots? **(Refer page no: 71, Q.no: 12, unit: 5)**

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PART B – (5 X 16 = 80 Marks)

11. (a) Write in detail about the production performance metrics. **(Refer page no: 13, Q.no: 2, unit: 1)** **(16)**

Or

(b) (i) Explain the concept of Lean manufacturing and Just-in-time production systems.

(Refer page no: 19, Q.no: 5, unit: 1) (10)

(ii) The average part produced in batch manufacturing plant must be processed sequentially through six machines on average. Twenty new batches of parts are launched each week. Average operation time = 6 min., average set up time = 5 hours, average batch size = 36 parts, and average non-operation time per batch =10 hrs/ machine. There are 18 machines in the plant working in parallel. Each of the machines can be set up for any type of job processed in the plant. The plant operates an average of 70 production hours per week. Scrap rate is negligible. Determine manufacturing lead time for an average part, plant capacity and plant utilization. (6)

12. (a) Explain in detail about the computer aided process planning. (16)

(Refer page no: 25, Q.no: 1, unit: 2)

Or

(b) (i) What is MRP and explain the inputs of MRP. **(Refer page no: 32, Q.no: 4, unit: 2)** (8)

(ii) Enumerate shop floor control system. **(Refer page no: 29, Q.no: 3, unit: 2)** (8)

13. (a) Explain OPITZ parts classification and coding system. **(Refer page no: 41, Q.no: 1, unit: 3)** (16)

Or

(b) (i) Apply the rank ordering clustering technique to the part-machine incidence matrix in the following table to identify logical part families and machine groups. Parts are identified numerically. **(Refer page no: 47, Q.no: 4, unit: 3)** (8)

Parts

Machines	A	B	C	D	E
1		1			
2			1		1
3	1			1	
4		1	1		
5				1	

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(ii)   Four machines used to produce a family of parts are to be arranged into a GT cell. The from to data for the parts processed by the machines are shown in the table below. Determine the most logical sequence of machines for this data by Hollier method. (8)

To

From	1	2	3	4
1	0	10	0	40
2	0	0	0	0
3	50	0	0	20
4	0	50	0	0

14.(a)   Define FMS and explain in detail about the FMS components. **(Refer page no: 62, Q.no: 4, unit: 4)** (16)

Or

(b)   Explain the vehicle guidance technology of AGVs. **(Refer page no: 58, Q.no: 2, unit: 4)** (16)

15.(a) (i)   Explain the types of mechanical joints commonly used in industrial robot construction, with neat sketch.**(Refer page no: 74, Q.no: 2, unit: 5)** (8)

(ii)   Explain about any three types of robot control systems. (8)

Or

(b)   Explain in detail about the types of robot part programming. **(Refer page no: 77, Q.no: 4, unit: 5)** (16)

Reg. No. :

Question Paper Code : 72171

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2017.

Seventh/Eighth Semester

Mechanical Engineering

ME 6703 – COMPUTER INTEGRATED MANUFACTURING SYSTEMS

(Common to Mechanical and Automation Engineering, Robotics and Automation Engineering)

(Regulations 2013)

Time : Three hours   Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What are the factors that lead to the evolution of CIM? Ref. P.No: 11, Q.No: 17, unit:1

2. Illustrate the components of an automated system with simple sketch. Ref P.No: 19 Q.No: 16. Unit:1

3. Comment on the output of aggregate production planning. P.No: 24, Q.No: 12, unit:2

4. List the basic steps in developing a process plan. P.No: 24, Q.No: 13, unit:2

5. How the part families are identified? P.No: 39, Q.No: 8, unit:3

6. What are the problems in implementing Group Technology? P.No: 40, Q.No: 12, unit:3

7. List the four tests for flexibility in FMS research. P.No: 55, Q.No: 11, unit:4

8. What are the applications of AGVS? P.No: 54, Q.No: 7, unit:4

9. Classify the Robot control systems. P.No: 71, Q.No: 13, unit:5

10. Differentiate between world and tool coordinate system in robotics with simple sketch. P.No: 71, Q.No: 14, unit:5

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PART B — (5 × 16 = 80 marks)

11. (a) (i) The average part produced in a certain batch manufacturing plant must be processed through an average six machine. Twenty (20) new batches of parts are launched each week. Average operation time = 6 min, average setup time =5 hr, average batch size = 25 parts and average non operation time per batch= 10 hr/machine. There are 18 machines in the plant. The plant operates an average of 70 production hours per week. Scrap rate is negligible. Determine (1) manufacturing lead time for an average part, (2) plant capacity (3) plant utilization (4) How would you expect the non operation to be affected by the plant? (4×3=12)

(ii) Name the various levels of automation. Ref. P.No: 18, Q.No:4 Unit: 1 (4)

Or

(b) (i) Examine job shop production and mass production. (6)

(ii) Demonstrate the significance of JIT philosophy. (6)

(iii) Discuss about pull type KANBAN system. (4)

12. (a) Illustrate notes on the following.

(i) Phases of shop floor control. P.NO: 29, Q-NO:3, Unit:2 (8)

(ii) Aggregate production planning. (4)

(iii) MRP-II. (4)

Or

(b) (i) Distinguish the features of variant and generative CAPP systems. P.NO:27, Q-NO: Unit:2 (8)

(ii) What are the criteria for Selection of CAPP systems? P.NO: 25, Q.No:1, unit:2 (8)

(iii) Define process planning. What are the activities associated with it? (5)

13. (a) (i) Analyze the rank order clustering technique to the part-machine incidence matrix in the following table to identify logical part families and machine groups. Components are identified by letters, and machines are identified numerically. (10)

P.NO: 47, Q NO:4 Unit:3

Machine	Components						
	A	B	C	D	E	F	G
M1		1		1			
M2			1		1		
M3	1	1		1			1
M4	1		1			1	
M5			1	1	1	1	

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(ii)   Suppose that four machines, 1,2,3, and 4 have been identified as belonging in a GT machine cell. An analysis of 50 parts processed on these machines has been summarized in the From-To chart presented below. Additional information is that 50 parts enter the machine grouping at machine 3, 20 parts leave after processing at machine 1, and 30 parts leave after machine 4. Determine a logical machine arrangement using hollier method.   (6)

From-To Chart

To :		1	2	3	4
	1	0	5	0	25
From :	2	30	0	0	15
	3	10	40	0	0
	4	10	0	0	0

Or

(b)   Describe the followings.   P.NO: 41, Q.NO:1 , UNIT:3   (12)
      (i)   Opitz coding system.   (4)
      (ii) Composite part concept.

14. (a)   A flexible manufacturing cell has just been created. After considering a number of designs, the system engineer chose a layout that consists of two machining workstations plus a load/unload station. In detail, the layout consists of : The load/unload station is station 1. Station 2 performs milling operations and consists of one server (one CNC milling machine) Station 3 has one server that performs drilling (one CNC drill press). The three stations are connected by a part handling system that has one work carrier. The mean transport time in the system is 4 min. The FMC produces three parts, A, B, and C. The part mix fractions and process routings for the three parts are presented in the table below. The operation frequency $f_{ijk} = 1.0$ for all operations. Determine (i) maximum production rate of the FMC, (ii) Corresponding production rates of each product (iii) utilization of each machine in the system, and (iv) number of busy servers at each station.   (16)

Part j	Part Mix p_j	Operation k	Description	Station i	Process time t_{ijk}
A	0.4	1	Load	1	3
		2	Mill	2	20
		3	Drill	3	12
		4	Unload	1	2

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Part j	Part Mix p_j	Operation k	Description	Station i	Process time t_{ijk}
B	0.4	1	Load	1	3
		2	Mill	2	15
		3	Drill	3	30
		4	Unload	1	2
C	0.2	1	Load	1	3
		2	Mill	2	14
		3	Drill	3	22
		4	Unload	1	2

Or

(b) (i) How far the AGVs advantageous over other material handling systems? (5)

(ii) Discuss the AGVs pallet trucks with its application. (5)

(iii) Explain Vehicle Guidance technology. P.NO: 58/Q.NO:2 (6)

15. (a) (i) Sketch following manipulator configurations. (12)

    (1) TRT: R   P.NO:74/Q-NO:2

    (2) TVR: TR

    (3) RR: T

    (ii) Discuss about SCARA Robot. (4)

Or

(b) (i) Explain the various robotic applications. (8)

    (ii) Comment on repeatability and accuracy in robotics. (8)

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FOR MORE EXCLUSIVE

(Civil, Mechanical, EEE, ECE)

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