



BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.:

School of Metal Construction Skills
Session: 2021-22 (Summer Semester)

B. Voc. Program, 3rd Semester,
End-Sem. Examination

Set-A

Course Code: MCS1301

Time: 2 Hour

Course Name: CNC BENDING

Max. Marks: 50

Instruction:

1. Attempt all questions.
2. Use of Calculators is allowed.
3. Section A contains 10 Questions. Each question carries 1 Marks.
4. Section B contains 04 Questions. Each question carries 4 Marks.
5. Section C contains 04 Questions. Each question carries 6 Marks.

Section – A

10X01 = 10 Marks

Q.1 Which of the following materials can be turned into sheet metal?

- | | |
|-------------|-----------------|
| a) Titanium | b) Nickel |
| c) Copper | d) All of above |

Q.2 Which is the type of press brake, according to the bending force?

- | | |
|---------------------------|--------------------------|
| a) Mechanical Press Brake | b) Pneumatic Press Brake |
| c) Hydraulic Press Brake | d) All of above |

Q3. One centimeter is equivalent to

- | | |
|-----------|-----------|
| a) 10 mm | b) 1 mm |
| c) 0.1 mm | d) 100 mm |

Q4. Which is the part of the CNC Press Brake?

- | | |
|------------------|---------------------|
| a) Machine Frame | c) Workbench |
| b) Ram (Slider) | d) All of the above |

Q.5 What is the total standard length of punch and die of the CNC Press Brake?

- | | |
|--------|--------|
| a) 600 | b) 730 |
| c) 800 | d) 835 |

Q.6 In NC machine the process is controlled by-

- | | |
|------------|---------------------|
| a) Number | b) Letters |
| c) Symbols | d) All of the above |

Q.7 What is the full form of CNC?

- a) Computer Numerical control
- b) Computer New Control
- c) Computer next Control
- d) All of the above

Q. 8 What is the full form of CAM?

- a) Computer Aided Manufacturing
- b) Computer Aided Mchining
- c) Computer Aided Management
- d) All of the above

Q.9 How many machines can be controlled by the DNC host Computer?

- a) 2
- b) 3
- c) 1
- d) Many

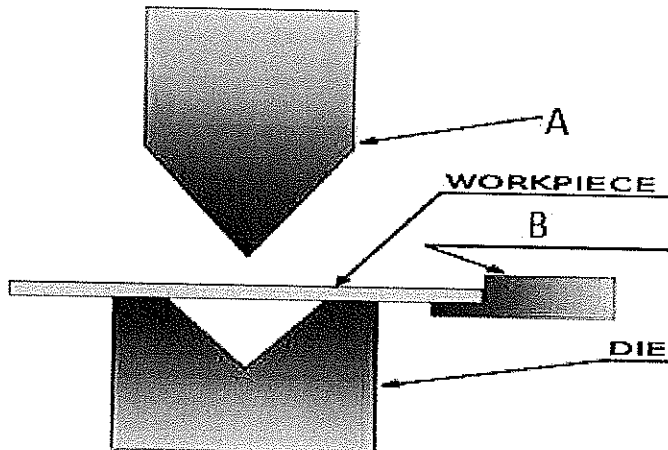
Q. 10 In which type of machine system central control is available?

- a) CNC
- b) DNC
- c) NC
- d) Non of Above

Section – B

04X04 = 16 Marks

Q.11 Write the name of A and B in the given image.



Q12. What is the sheet metal?

Q13. Why bend allowance is used in bending?

Q.14 What is difference between Fabrication and Manufacturing?

Section – C

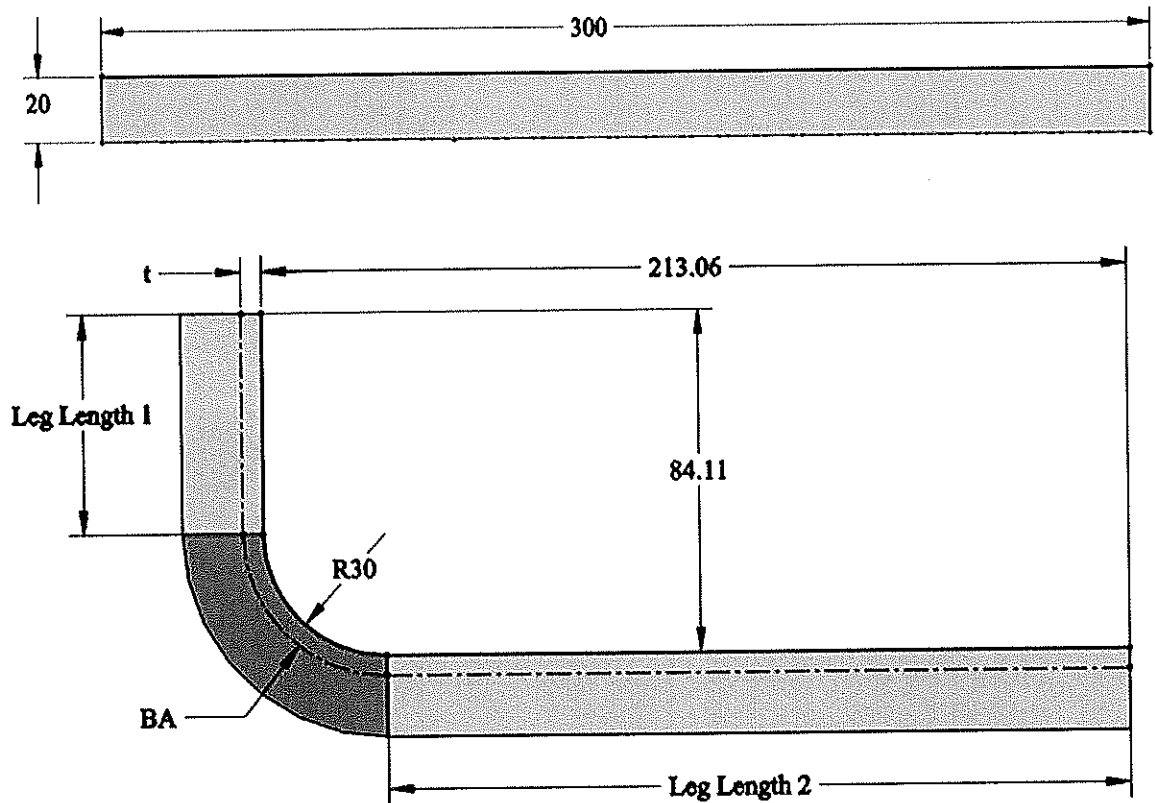
04X06 = 24 Marks

Q.15 Explain Roll Bending, it's principle and name different types of Roll Bending machines.

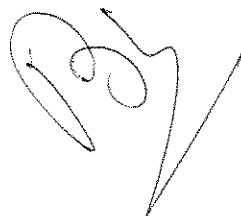
Q.16 draw a neat sketch of bent part with nomenclature.

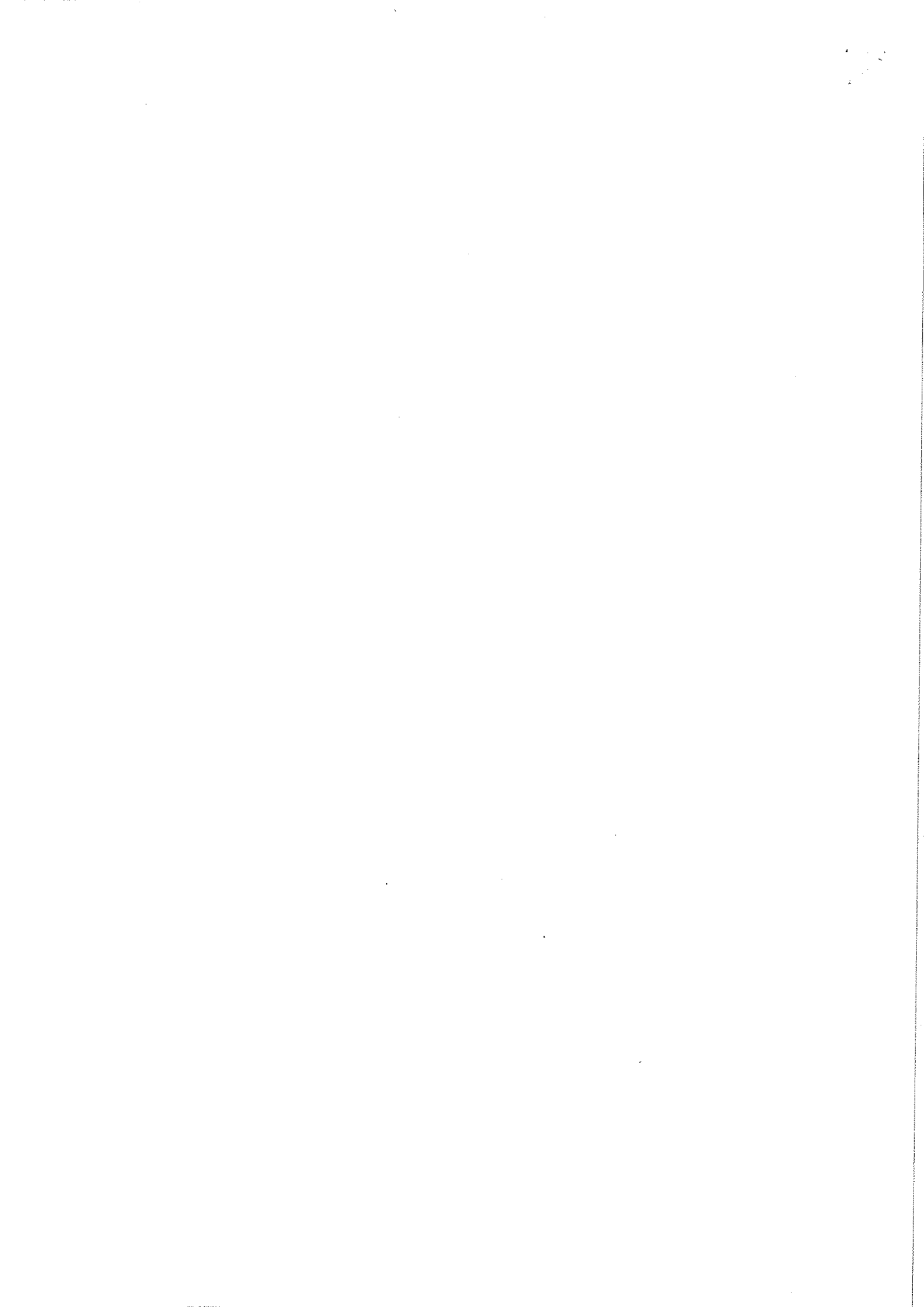
Q.17 Consider a sheet with a 20 mm thickness and a length of 300 mm as shown in Figure. The bending tool has a radius of 30 mm. Calculate the following:

- Bend Allowance
- K-Factor, and
- Bend Deduction



Q.18 Differentiate CNC and DNC machine.







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Ans. d)

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| a) Mechanical Press Brake | b) Pneumatic Press Brake |
| c) Hydraulic Press Brake | d) All of above |

Ans. b)

Q3. One centimeter is equivalent to

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| a) 10 mm | b) 1 mm |
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Ans. a)

Q4. Which is the part of the CNC Press Brake?

- | | |
|------------------|---------------------|
| a) Machine Frame | c) Workbench |
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Ans. d) All of the above

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Ans. d)

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| a) Number | b) Letters |
| c) Symbols | d) All of the above |

Ans. d)

Q.7 What is the full form of CNC?

- | | |
|-------------------------------|-------------------------|
| a) Computer Numerical control | b) Computer New Control |
| c) Computer next Control | d) All of the above |

Ans. a) Computer Numerical control

Q. 8 What is the full form of CAM?

- | | |
|---------------------------------|----------------------------|
| a) Computer Aided Manufacturing | b) Computer Aided Mchining |
| c) Computer Aided Management | d) All of the above |

Ans. a) Computer Aided Manufacturing

Q.9 How many machines can be controlled by the DNC host Computer?

- | | |
|------|---------|
| a) 2 | b) 3 |
| c) 1 | d) Many |

Ans. d) Many

Q. 10 In which type of machine system central control is available?

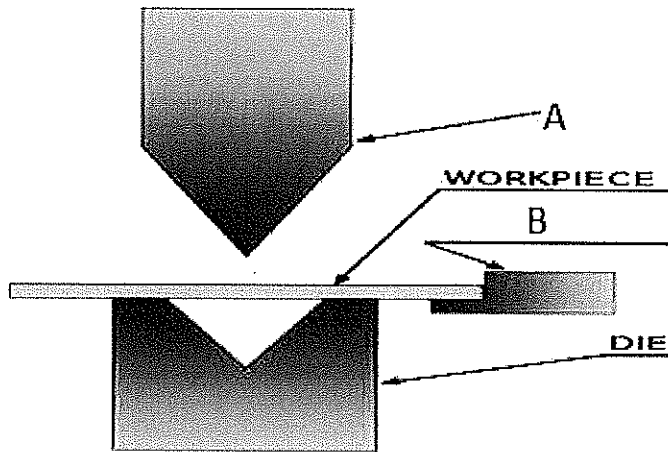
- | | |
|--------|-----------------|
| a) CNC | b) DNC |
| c) NC | d) Non of Above |

Ans. b) DNC

Section – B

04X04 = 16 Marks

Q.11 Write the name of A and B in the given image.



Ans. A is the Punch
B is the back gauge

Q12. What is the sheet metal?

Ans. Sheet metal is any metal in the sheet form, which is thicker than 0.4 mm and thinner than 6mm.

Q13. Why bend allowance is used in bending?

Ans. Bend allowance is used in bending to calculate the flat length of the bent sheet.

Q.14 What is difference between Fabrication and Manufacturing?

Ans. The key difference between manufacturing and fabrication is how much of the process a job involves. Fabrication involves the assembly of standard or specialised parts to form parts of a product to be used in the

manufacture of the finished piece. Manufacturing, however, is a start to finish movement, from the creation of parts through to the final assembly to produce a finished product, often using areas of fabrication within the manufacturing process.

Section – C

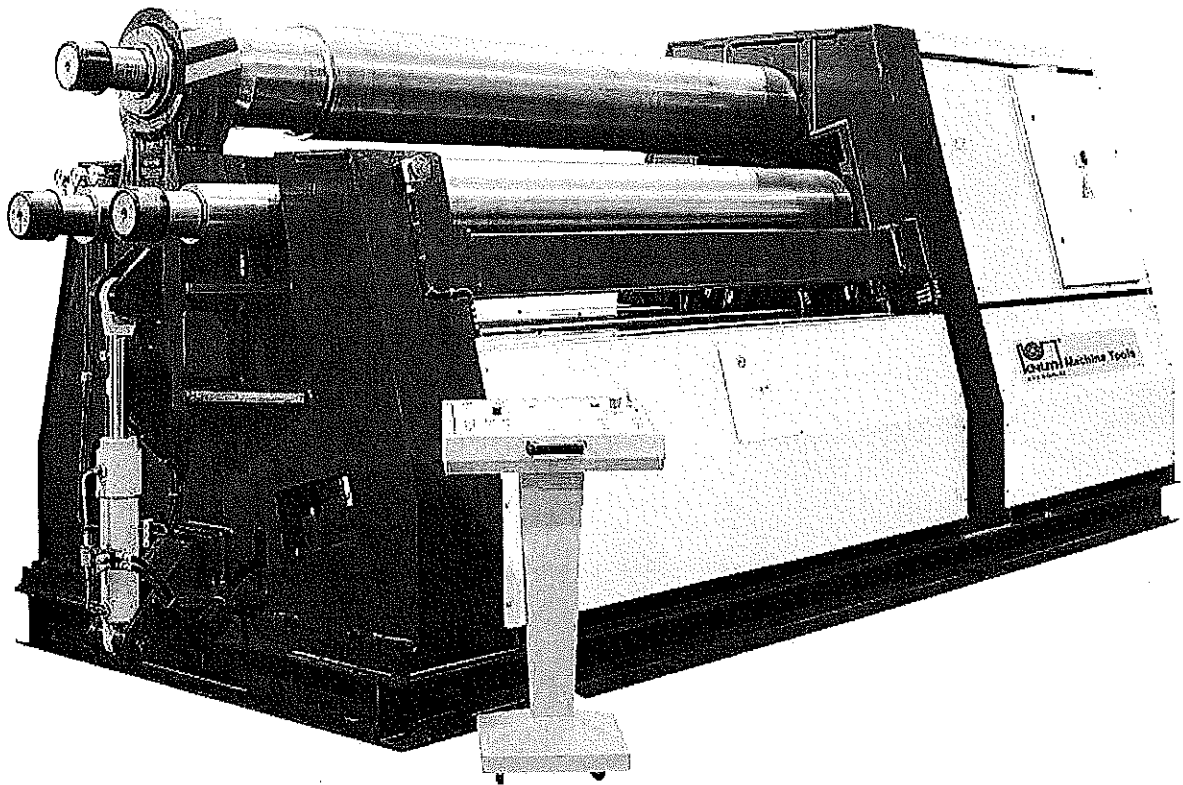
04X06 = 24 Marks

Q.15 Explain Roll Bending, it's principle and name different types of Roll Bending machines.

Ans.

Roll Bending:-

Roll bending machine is a machine tool for continuous bending of the plate, with the function of rolling O-type, U-shaped, multi-segment R and other different shapes of the plate.



Principle:-

The upper roller of symmetrical plate rolling machine does vertical movement at the center of two lower rollers via the hydraulic oil in the cylinder acting on the piston. Through the final reduction gear of the main reducer to drive two lower roller gearing and make the rotary motion, to provide torque for the rolling plate.

Classification of the roll bending machine:-

Roll bending machine can be divided into the three-roller bending machine and the four-roller bending machine.

Three roller bending machine is divided into:

1. Symmetrical 3-roll bending machine
2. Level down three rollers bending machine

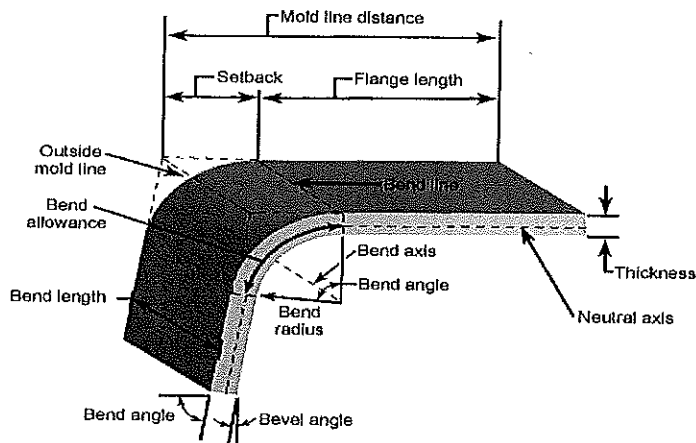
3. Arc down the rolling machine
4. Upper roller universal three-roll bending machine
5. Hydraulic CNC roll bending machine

From the transmission, it is divided into

1. mechanical and
2. Hydraulic rolling machine

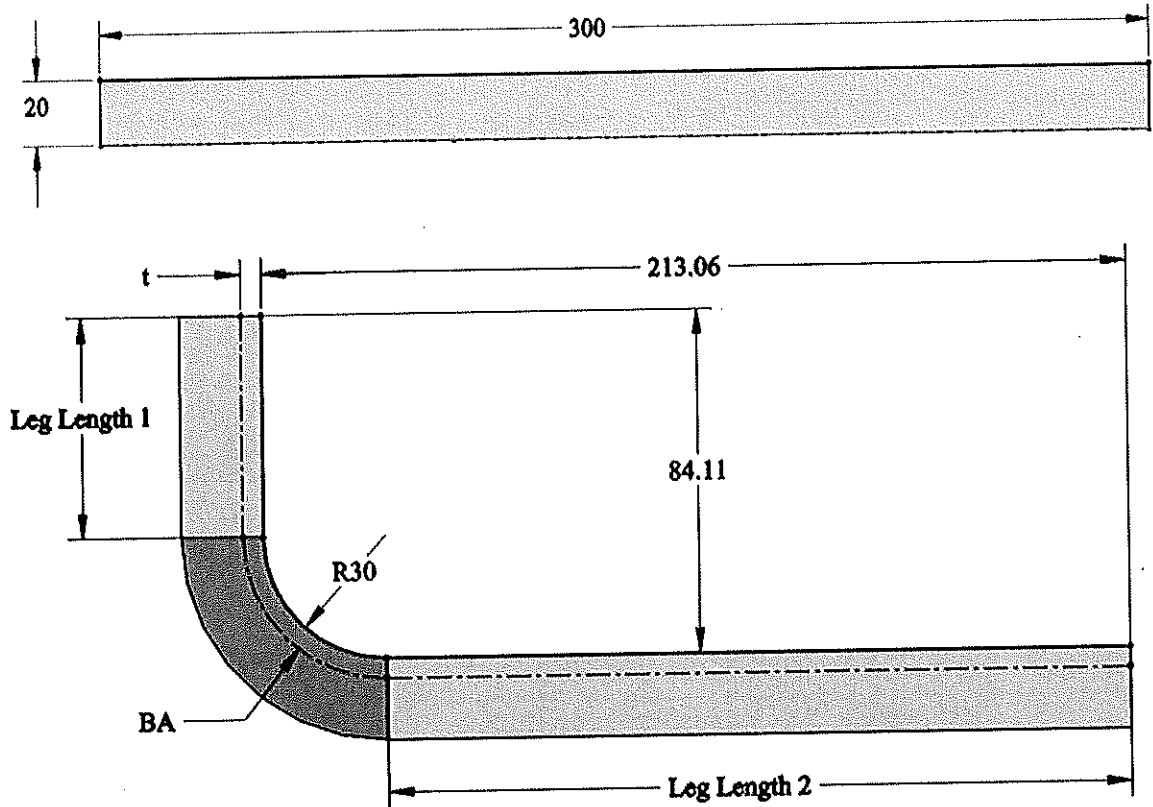
Q.16 draw a neat sketch of bent part with nomenclature.

Ans.



Q.17 Consider a sheet with a 20 mm thickness and a length of 300 mm as shown in Figure. The bending tool has a radius of 30 mm. Calculate the following:

- Bend Allowance
- K-Factor, and
- Bend Deduction



Ans.

$$\text{Leg Length 1} = 84.11 - R = 84.11 - 30 = 54.11$$

$$\text{Leg Length 2} = 213.06 - R = 213.06 - 30 = 183.06$$

At the neutral axis we have:

$$\text{Initial Length} = \text{Leg Length 1} + \text{BA} + \text{Leg Length 2}$$

In this formula the initial length is 300 mm. By replacing Initial Length, Leg Length 1 and 2 in the above equation we can calculate the Bend Allowance as follows:

$$300 = 54.11 + \text{BA} + 183.06$$

$$\text{BA} = 62.83$$

We know that BA is the length of the arc on the neutral axis. The length of the arc for this scenario can be calculated as:

$$\text{BA} = \frac{2 * \pi * R'}{4}$$

Where R' is the radius of the arc on the neutral axis. By inserting the Bend Allowance value in the above equation we reach to:

$$R' = \frac{2 * \text{BA}}{\pi} = \frac{2 * 62.83}{\pi} = 40$$

Now if we subtract R from R' we can find the distance of the neutral axis (t) from the inner face:

$$t = R' - R = 40 - 30 = 10 \text{ mm}$$

From the K-Factor equation we have:



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$$K = \frac{t}{T} = \frac{10}{20} = 0.5$$

Now we calculate the Bend deduction:

Outside Setback (OSSB) = Bend Radius + Material Thickness

$$= 30 + 20 = 50 \text{ mm}$$

Bend Deduction = 2x OSSB – Bend Allowance.

$$= 2 \times 50 - 62.83 = 37.17 \text{ mm}$$

Q.18 Differentiate CNC and DNC machine.

Ans.

Sr. No.	CNC	DNC
1.	Remote controlling of the working operation is not possible.	It facilitates remote control.
2.	CNC is an integral part of the machine	DNC is not integral to machines, DNC computer can locate a distance from machine.
3.	CNC machine has a transferring machining instruction.	DNC machine manages the information distribution to the number of the machine.
4.	CNC machine is a computer-controlled NC machine.	By using the DNC machine programmer can control more than one NC machine as required.
5.	CNC software is used to increase the particular capacity of the machine tool.	Whereas in DNC, it does not only control the equipment but also serves as a part of the management information system.



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Section – A

10X01 = 10 Marks

Q.1 Which of the following is not the fabrication process?

- | | |
|--------------|-----------------|
| a) Machining | b) Shearing |
| c) Punching | d) All of above |

Q.2 In forming process the physical shape is-

- | | |
|-----------------------|-------------------------|
| a) Partially deformed | b) Permanently deformed |
| c) Un-deformed | d) B&C |

Q3. One centimeter is equivalent to

- | | |
|-----------|-----------|
| a) 10 mm | b) 1 mm |
| c) 0.1 mm | d) 100 mm |

Q4. Metal forming is a process in which the metal is deformed plastically to get into the desired shape.

- | | |
|----------|---------------------|
| a) True | c) cannot say |
| b) False | d) All of the above |

Q.5 which type of shape can be produced by using bending process?

- | | |
|------------------|---------------------|
| a) V-Shape | b)U-Shape |
| c) channel shape | d) All of the above |

Q.6 In NC machine the process is controlled by-

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| a) Number | b) Letters |
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Q.7 What is the full form of CNC?

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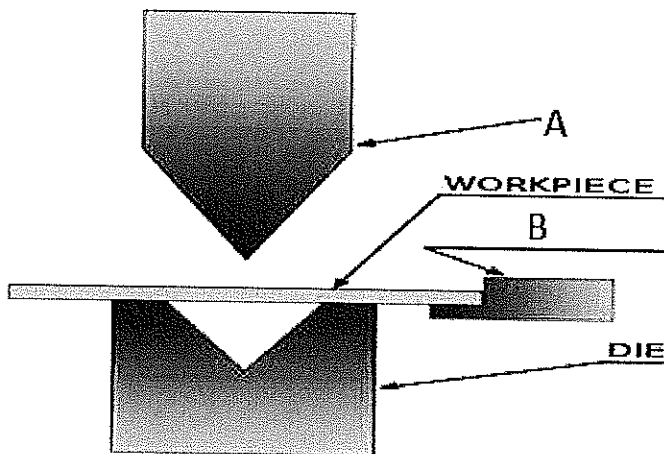
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Section – B

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Section – C

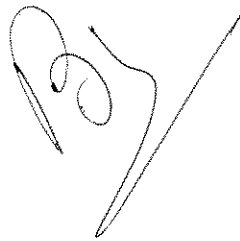
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Q.15 Differentiate NC and CNC machine.

Q.16 draw a neat sketch of bent part with nomenclature.

Q.17 Name and explain the punches used in V bending.

Q.18 Differentiate CNC and DNC machine.







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Set-B

Course Code: MCS1301

Time: 2 Hour

Course Name: CNC BENDING

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Section – A

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Ans. d)

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Ans. a)

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| a) V-Shape | b)U-Shape |
| c) channel shape | d) All of the above |

Ans. d)

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| a) Number | b) Letters |
|-----------|------------|

c) Symbols

d) All of the above

Ans. d)

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c) Computer next Control

d) All of the above

Ans. a) Computer Numerical control

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c) 1

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Ans. d) Many

Q. 10 In which type of machine system central control is available?

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b) DNC

c) NC

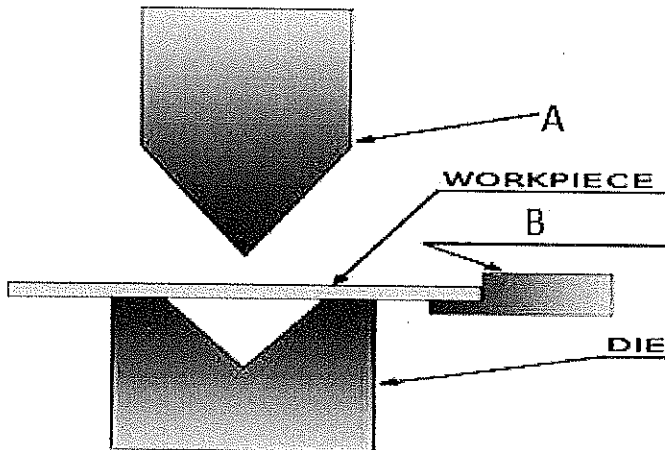
d) Non of Above

Ans. b) DNC

Section – B

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Q.11 Write the name of A and B in the given image.



Ans. A is the Punch

B is the back gauge

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Section – C

04X06 = 24 Marks

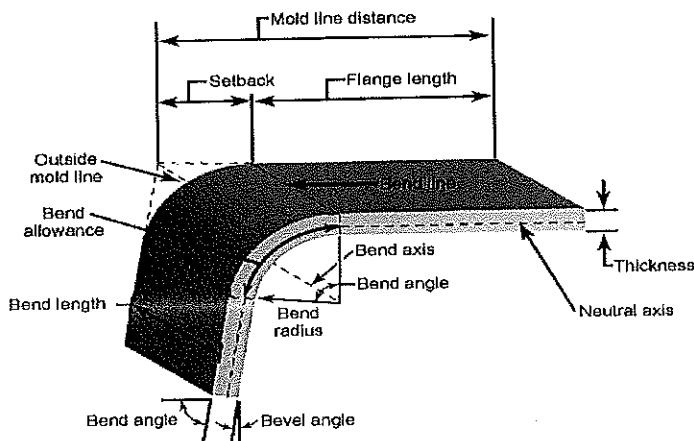
Q.15 Differentiate NC and CNC machine.

Ans.

Sr. No.	NC	CNC
1.	NC stands for numerical control	CNC stands for computer numerical control
2.	Machine is controlled by a set of instructions in the form of numbers, letters, and symbols called a program.	CNC machine is used to control motions of the workpiece and tool with a computer program written in alphanumeric data.
3.	Programs are fed into the punch cards	The programs are fed directly into the computer using a small keyboard.
4.	It is very difficult to modify the program in NC machine if some error occurs and debugging is needed.	Modification of the program is very easy.
5.	Programs cannot be stored.	Program can be stored in computer memory.
6.	Accuracy is less as compared with the job.	It has high accuracy
7.	More cycle time.	Less cycle time

Q.16 draw a neat sketch of bent part with nomenclature.

Ans.





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Q.17 Name and explain the punches used in V bending.

Ans. Normally there are three types of punches, which are used in v-bending

1. straight punch
2. gooseneck punch
3. radius punch
4. Acute punch

Q.18 Differentiate CNC and DNC machine.

Ans.

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Set-A

Course Code: MCS1302

Course Name: CNC PUNCHING

Time: 2 Hour

Max. Marks: 50

Instruction:

1. Attempt all questions.
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3. Section A contains 10 Questions. Each question carries 1 Marks.
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Section – A

10X01 = 10 Marks

Q.1 Which material can be punched by CNC Punching?

- | | |
|--------------------|-----------------|
| a) Aluminium | b) Mild Steel |
| c) Stainless Steel | d) All of Above |

Q.2 Which is the part of the CNC Press Punch?

- | | |
|----------------------|---------------------|
| a) Main control unit | b) Sub control unit |
| c) Turret | d) All of Above |

Q.3 Which is the part of the CNC Press Punch?

- | | |
|----------------|---------------------|
| a) Brush Table | b) Tool Change door |
| c) Foot Switch | d) All of Above |

Q. 4 Which type of shape can be punched by CNC Press Punch?

- | | |
|----------------|-----------------|
| a) Rectangle | b) Circular |
| c) Trapezoidal | d) All of Above |

Q.5 By Using the CNC Punching What can be achieved?

- | | |
|---------------------------|-----------------------|
| a) Increased Productivity | b) Speed and Accuracy |
| c) Efficiency | d) All of Above |

Q.6 What is the use of X-Gauge Block?

- a) For Making Program
- b) For opening program
- c) For Setting the workpiece
- d) For referencing the machine

Q.7 What is the use of tool Balancer?

- a) For installing and removing the punch
- b) For rotating the turret
- c) For Setting the workpiece
- d) For referencing the machine

Q.8 in the given image 1, what is A

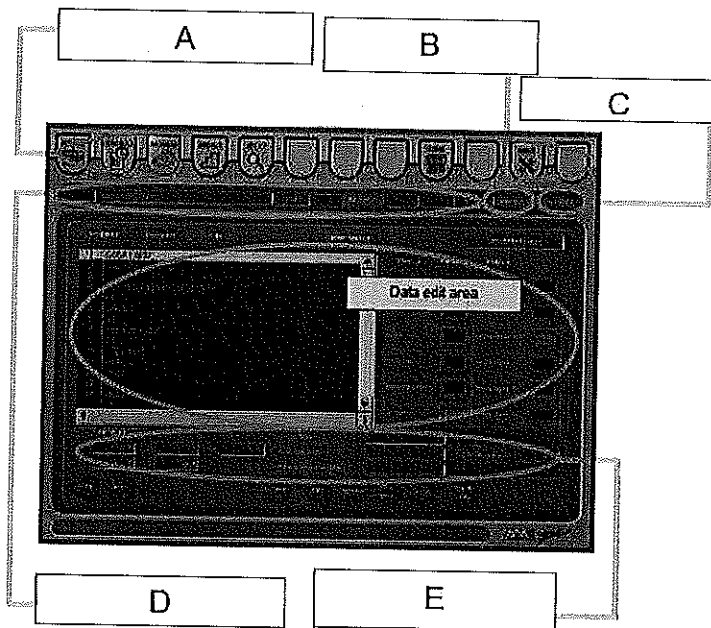


Fig- Image 1

- a) Display selection buttons
- b) Current Pos. Button
- c) SW. Panel Button
- d) Processing status display area

Q. 9 In the given image 1, what is B

- a) Display selection buttons
- b) Current Pos. Button
- c) SW. Panel Button
- d) Processing status display area

Q. 10 In the given image 1, what is C

- a) Display selection buttons
- b) Current Pos. Button
- c) SW. Panel Button
- d) Processing status display area



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Section – B

04X04 = 16 Marks

Q.11 Write applications of cnc punching?

Q.12 What is the use of following buttons-

1. **PROGRAM CHECK button**
2. **SINGLE BLOCK button**

Q.13 What is the use of following buttons-

1. **BLOCK SKIP button**
2. **Multiple-part punching setup buttons**

Q.14 What is the use of following buttons-

1. **OPTIONAL STOP button**
2. **AUTO POWER OFF button**

Section – C

04X06 = 24 Marks

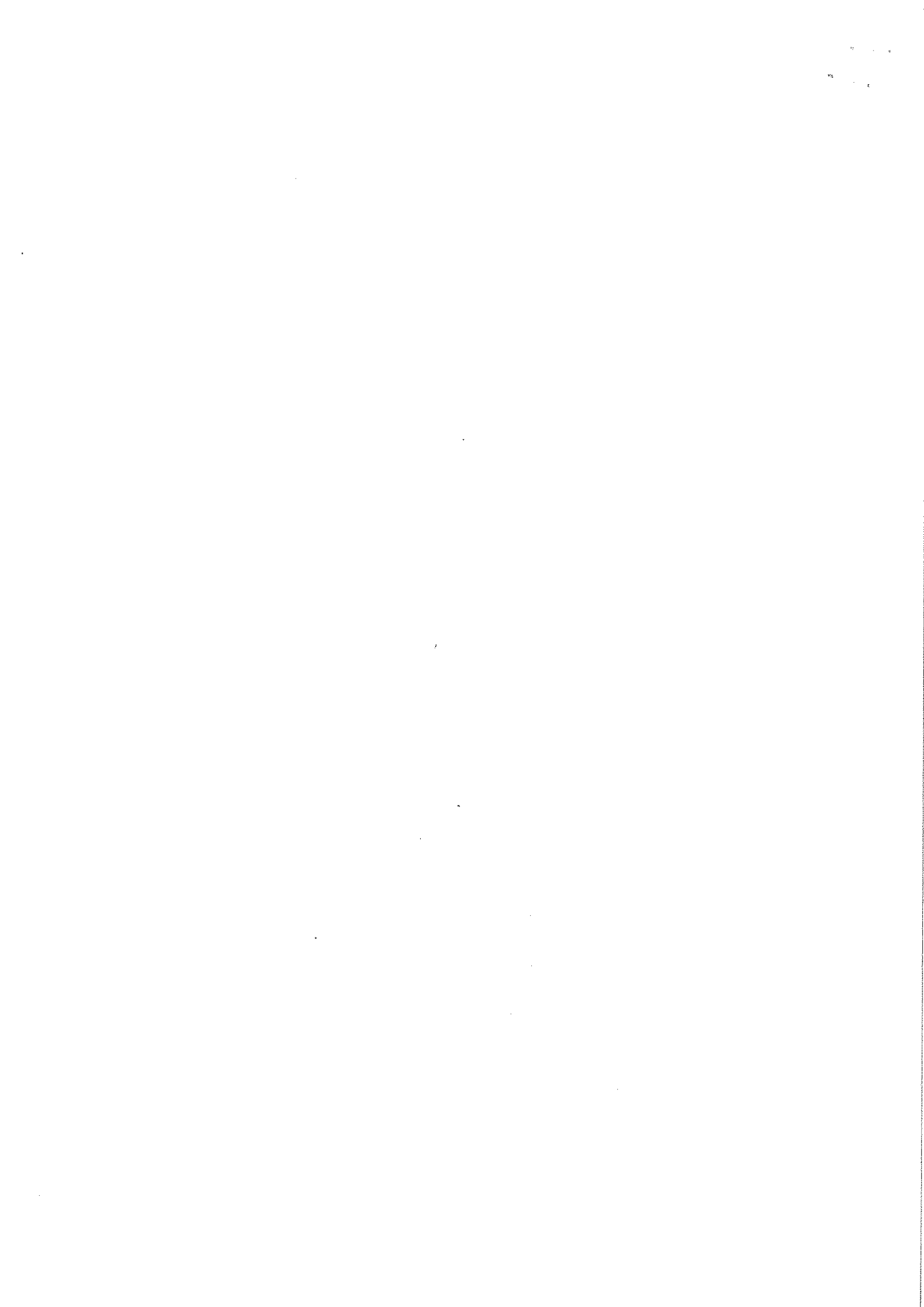
Q.15 Explain the following term:

- Piercing
- Blanking

Q.16 What is the Punch Press? Write down the names of types of Punch Press.

Q.17 Write down the application of CNC Punching.

Q.18 Explain the tool change procedure in CNC Punching.





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Set-A

Answer Key

Course Code: MCS1302

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| a) Aluminium | b) Mild Steel |
| c) Stainless Steel | d) All of Above |

Ans. d) All of Above

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- | | |
|----------------------|---------------------|
| a) Main control unit | b) Sub control unit |
| c) Turret | d) All of Above |

Ans. d) All of Above

Q.3 Which is the part of the CNC Press Punch?

- | | |
|----------------|---------------------|
| a) Brush Table | b) Tool Change door |
| c) Foot Switch | d) All of Above |

Ans. d) All of Above

Q. 4 Which type of shape can be punched by CNC Press Punch?

- | | |
|----------------|-----------------|
| a) Rectangle | b) Circular |
| c) Trapezoidal | d) All of Above |

Ans. d) All of Above

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Ans. d) All of Above

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- c) For Setting the workpiece
- d) For referencing the machine

Ans. c) For Setting the workpiece

Q 7 What is the use of tool Balancer?

- a) For installing and removing the punch
- b) For rotating the turret
- c) For Setting the workpiece
- d) For referencing the machine

Ans. a) For installing and removing the punch

Q.8 in the given image 1, what is A

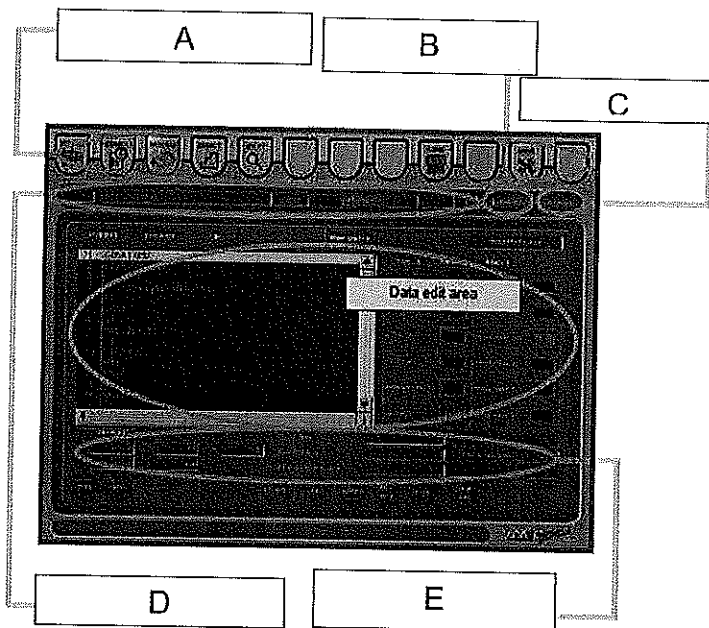


Fig- Image 1

- a) Display selection buttons
- b) Current Pos. Button
- c) SW. Panel Button
- d) Processing status display area

Ans. a) Display selection buttons

Q. 9 In the given image 1, what is B

- a) Display selection buttons
- b) Current Pos. Button
- c) SW. Panel Button
- d) Processing status display area

Ans. b) Current Pos. Button

Q. 10 In the given image 1, what is C

- a) Display selection buttons
- b) Current Pos. Button
- c) SW. Panel Button
- d) Processing status display area

Ans. c) SW. Panel Button

Section – B


04X04 = 16 Marks

Q.11 What Is nibbling process?

Ans.

Nibbling:

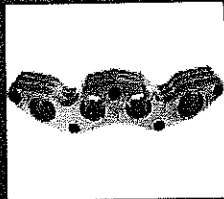
- ▶ In nibbling operation, complicated shapes are cut out from a sheet metal by producing overlapping notches.
- ▶ Without using any special tools, a simple, round or triangular punch is reciprocated at a fixed location.
- ▶ The sheet metal is guided to obtain the desired shape of cut.



Q.12 Write applications of cnc punching?

Ans.

- ▶ Automobile industries.
- ▶ Aerospace industries.
- ▶ Kitchen appliances.
- ▶ Mass production of sheet metal components.



Q.13 What is the use of following buttons-

1. **PROGRAM CHECK button**
2. **SINGLE BLOCK button**

Ans. **PROGRAM CHECK button**

Pressed and illuminated to enable the program check function. The machine does not operate while the program is being checked. For details, refer to "Checking program" in Part VI, Operation.

Pressed again and extinguished to disable the program check function.

SINGLE BLOCK button

Pressed and illuminated to enable the single block operation of the machine. Each time the START button on the main control panel is pressed in the single block operation, the machine executes one block of the program and then stops. Pressed again and extinguished to disable the single block operation of the machine.

Q.14 What is the use of following buttons-

1. **BLOCK SKIP button**



2. Multiple-part punching setup buttons

Ans.

BLOCK SKIP button

Pressed and illuminated. When the program is started, the machine ignores each block with a slash (/) at the beginning and goes to the next block. Pressed again and extinguished. The machine executes blocks with a slash (/) at the beginning without ignoring them.

Multiple-part punching setup buttons

Press one of the multiple-part punching setup buttons to select the multiple-part punching function you want to perform. The button illuminates when pressed. Press the button again to extinguish it.

Q.8 What is the use of following buttons-

1. **OPTIONAL STOP button**
2. **AUTO POWER OFF button**

Ans.

OPTIONAL STOP button

Pressed and illuminated. When the program is started, the machine pauses each time "M01" (optional stop command) is read. When the machine pauses, press the START button on the main control to resume its operation. Pressed again and extinguished. When "M01" is read, the machine ignores it and continues to operate.

AUTO POWER OFF button

Pressed and illuminated to enable the automatic power-off function. Pressed again and extinguished to disable the automatic power-off function. The button changes to flashing after the program is completed, and the power of the NC unit turns off 15 min later. If the machine is not automatically operating, the power of the NC unit can be turned off 2 min later after the button is pressed and held for 2 sec or more. Button illuminated: The automatic power-off function is enabled Button flashing: The power of the NC unit turns off 15 min after the start of flashing.

Section – C

04X06 = 24 Marks

Q.15 Explain the following term:

- Piercing
- Blanking
- Ans.
- **Piercing:** Piercing is a shearing process in which raw metal is pierced with a machining tool, resulting in the creation of a circular or other shaped hole. As the raw metal is pierced, the metal from the newly created hole is considered scrap. The piercing machine forces a tool, known as a blanking punch, through the sheet metal.
- **Blanking:** Blanking is often confused with piercing because both processes involve cutting holes into raw metal. However, they aren't necessarily the same. With blanking, the metal from the hole is saved and used rather than discarded. In other words, manufacturing companies perform blanking to create small pieces of metal, whereas manufacturing companies perform piercing to create metal objects with a single hole.

Q.16 What is the Punch Press? Write down the names of types of Punch Press.

Ans.

Punch Press: -

A **punch press** is a type of machine press used to cut holes in material. It can be small and manually operated and hold one simple die set, or be very large, CNC operated, with a multi-station turret and hold a much larger and complex die set.

Types of Punch Press

The presses are available in different designs and shapes, according to the work requirement. This article throws light upon the sixteen main types of presses. Some of the types are:

1. Manually Operated (Fly) Press
2. Electric Motor Operated Press
3. Hydraulic Press
4. Inclined Press
5. Inclinal Press
6. Gap Press
7. Arch Press
8. Straight-Side Press and Others.

Q.17 Write down the application of CNC Punching.

Ans. By using a combination of single hits and overlapping geometries, complex sheet metal component shapes can be produced. The machine may also punch 3D forms such as dimples, taptite® screw thread plunges, and electrical knockouts etc on either side of the sheet, which are often employed in sheet metal enclosure design. Some modern machines may have the ability to tap threads, fold small tabs, punch sheared edges without any tool witness marks making the machine very productive within the component cycle time. The instruction to drive the machine to create the desired component geometry is known as the CNC program.

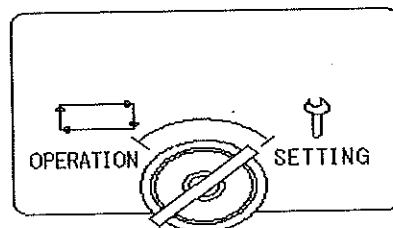
Q.18 Explain the tool change procedure in CNC Punching.

Ans

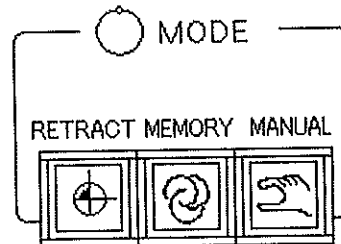
Amada tool changing system

Moving necessary turret station to tool change position Move the turret station where a tool is to be removed or installed to the tool change position as described below.

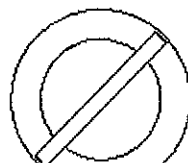
1. Turn the SAFETY DEVICE keyswitch on the main control panel to SETTING.



2. Press and illuminate the MANUAL button on the main control panel.



O F F O N



3. Turn the TOOL CHANGE keyswitch on the subcontrol panel "B" to ON.

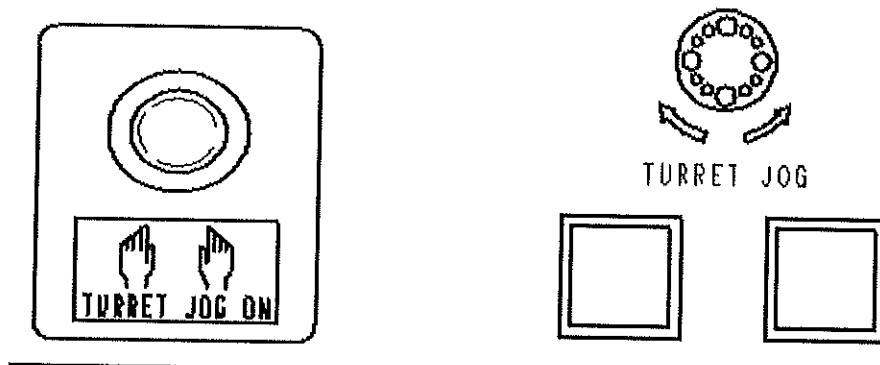


Figure 1 Amada tool changing system

Turn the INDEX PIN switch on the sub-control panel "B" to OUT to remove the turret index pins from the turret. 5 While pressing the TURRET JOG ON button on the sub-control panel "B", press either TURRET JOG button on the sub-control panel "B".

The turret rotates as long as the two buttons are pressed. 6 When the desired turret station approaches the tool change position, release the TURRET JOG ON button and TURRET JOG button.

The turret selects the desired station and stops.

7. Open the upper and lower tool change doors.
8. Check the turret station number stamped on the top surface of the upper turret disk, and install or remove the tool in the turret station as described on the following pages.

Removing tools

1. Remove the punch from the upper turret disk.
2. Loosen the bolt fixing the upper die holder.
3. Remove the upper die holder from the lower turret disk.
4. Lightly tap the upper part of the die with the standard accessory brass bar. The die is loosened for easy removal.
5. Remove the die from the upper die holder.





**School of Metal Construction Skills
Session: 2021-22 (Summer Semester)
B. Voc. Program, 3rd Semester,
End-Sem. Examination
Set: B**

Course Code: MCS1303

Course Name: CNC laser cutting

Time: 2 Hours

Max. Marks: 50

Instruction:

1. Attempt all questions.
2. Use of Calculators is prohibited.
3. Section A contains 10 Questions. Each question carries 10 Marks.
4. Section B contains 04 Questions. Each question carries 16 Marks.
5. Section C contains 04 Questions. Each question carries 24 Marks.

Section – A

10X01 = 10 Marks

Q1. Which color of light has the shortest wave-length ?

- a) Yellow
- b) Blue
- c) Red**
- d) Green

Ans. C

Q2. What is the full form of LASER?

- a) Light Absorbent and Stimulated Emission of Radiations
- b) Light Absorbing Solar Energy Resource
- c) Light Amplification by Stimulated Emission of Radiations**
- d) Light Amplification of Singular Emission of Radiations

Ans. C

Q3. What is the type of laser used most widely in industrial materials processing applications?

- a) Dye Laser
- b) YAG laser**
- c) Ruby Laser
- d) Carbon Dioxide Laser

Ans. B



Q4. Why are lasers used for cutting materials

- a) Repeatability
- b) It has a small "heat affected zone"
- c) Accuracy
- f) **All of the above**

Ans. D

Q5. What is one way to describe a Photon?

- a) Solid as a rock
- b) **A wave packet**
- c) A torpedo
- d) A color

Ans. B

Q6. What determines the color of light?

- a) its intensity
- b) **its wavelength**
- c) its source
- d) Its Frequency

Ans. B

Q7. What is the general lifetime of an atom in an excited state?

- a) 10^{-10}
- b) **10^{-8}**
- c) 10^{-6}
- d) 10^{-4}

Ans. B

Q8. Chemical lasers use _____ to produce their beams.

- a) Excessive amounts of electrical power
- b) Small amounts of electrical power
- c) **No electrical power**
- d) None of the Above

Ans. C



Q9. What is the need to achieve population inversion?

- a) **To excite most of the atoms in higher state energy**
- b) To bring most of the atoms to ground state
- c) To achieve stable condition
- d) To reduce the time of production of laser

Ans. A

Q10. Which of the following is an example of optical pumping?

- a) **Ruby laser**
- b) Helium-Neon laser
- c) Semiconductor laser
- d) Dye laser

Ans. A

Section – B

1. What are the types of laser on the basis of medium? Describe the gas laser in short.

1. Ans. Types of lasers

Lasers are classified into 4 types based on the type of laser medium used:

- Solid-state laser
- Gas laser
- Liquid laser
- Semiconductor laser



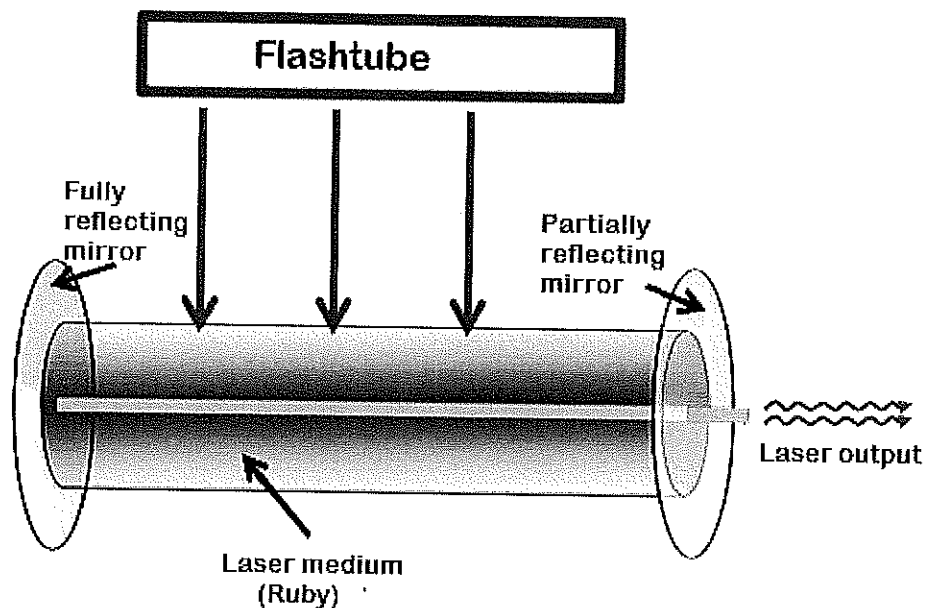
Solid-state laser

A solid-state laser is a laser that uses solid as a laser medium. In these lasers, glass or crystalline materials are used.

Ions are introduced as impurities into host material which can be a glass or crystalline. **The process of adding impurities to the substance is called doping.** Rare earth elements such as cerium (Ce), erbium (Eu), terbium (Tb) etc are most commonly used as dopants.

Materials such as sapphire (Al_2O_3), neodymium-doped yttrium aluminum garnet (Nd:YAG), Neodymium-doped glass (Nd:glass) and ytterbium-doped glass are used as host materials for laser medium. Out of these, neodymium-doped yttrium aluminum garnet (Nd:YAG) is most commonly used.

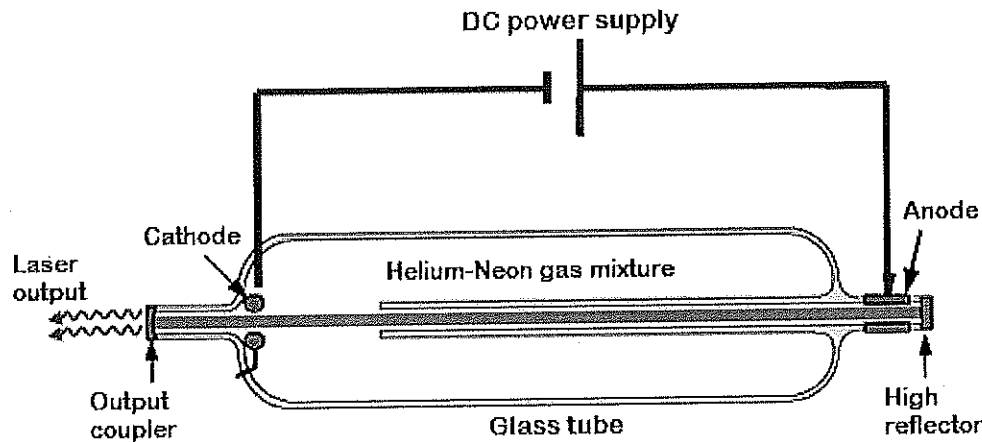
The first solid-state laser was a ruby laser. It is still used in some applications. In this laser, a ruby crystal is used as a laser medium.



In solid-state lasers, light energy is used as pumping source. Light sources such as flashtube, flash lamps, arc lamps, or laser diodes are used to achieve pumping.

Semiconductor lasers do not belong to this category because these lasers are usually electrically pumped and involve different physical processes.

A gas laser is a laser in which an electric current is discharged through a gas inside the laser medium to produce laser light. In gas lasers, the laser medium is in the gaseous state.



Gas lasers are used in applications that require laser light with very high beam quality and long coherence lengths.

In gas laser, the laser medium or gain medium is made up of the mixture of gases. This mixture is packed up into a glass tube. The glass tube filled with the mixture of gases acts as an active medium or laser medium.

A gas laser is the first laser that works on the principle of converting electrical energy into light energy. It produces a laser light beam in the infrared region of the spectrum at $1.15 \mu\text{m}$.

Gas lasers are of different types: they are, Helium (He) – Neon (Ne) lasers, argon ion lasers, carbon dioxide lasers (CO_2 lasers), carbon monoxide lasers (CO lasers), excimer lasers, nitrogen lasers, hydrogen lasers, etc. The type of gas used to construct the laser medium can determine the lasers wavelength or efficiency.

Liquid laser

A liquid laser is a laser that uses the liquid as laser medium. In liquid lasers, light supplies energy to the laser medium.

A dye laser is an example of the liquid laser. A dye laser is a laser that uses an organic dye (liquid solution) as the laser medium.

A dye laser is made up of an organic dye mixed with a solvent. These lasers generate laser light from the excited energy states of organic dyes



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dissolved in liquid solvents. It produces laser light beam in the near ultraviolet (UV) to the near infrared (IR) region of the spectrum.

Semiconductor laser

Semiconductor lasers play an important role in our everyday life. These lasers are very cheap, compact size and consume low power.

Semiconductor lasers are also known as **laser diodes**.

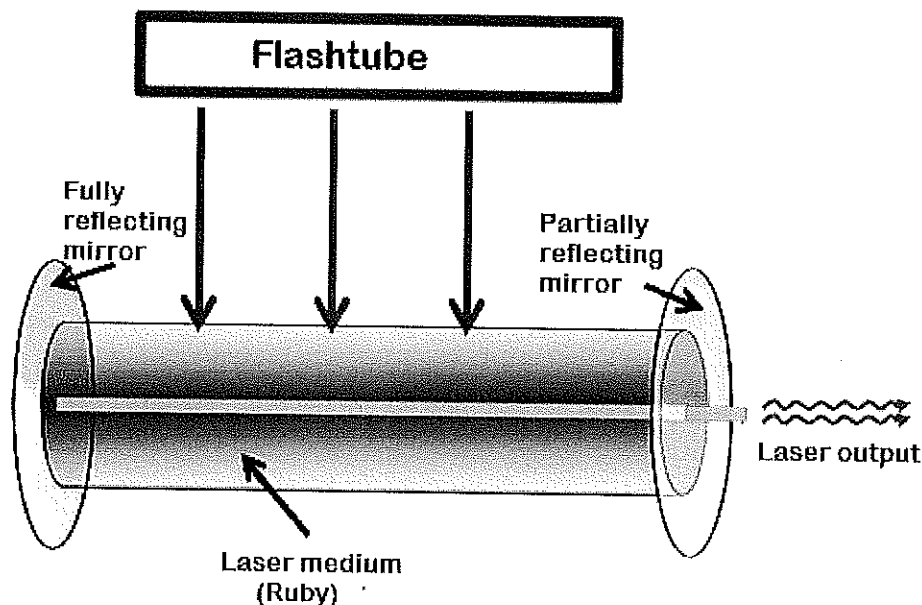
Semiconductor lasers are different from solid-state lasers. In solid-state lasers, light energy is used as the pump source whereas, in semiconductor lasers, electrical energy is used as the pump source.

In semiconductor lasers, a p-n junction of a semiconductor diode forms the active medium or laser medium. The optical gain is produced within the semiconductor material.

2. Explain the laser or gain medium in ruby laser with diagram.

Ans. Laser medium or gain medium in ruby laser

In a ruby laser, a single crystal of ruby ($\text{Al}_2\text{O}_3 : \text{Cr}^{3+}$) in the form of cylinder acts as a laser medium or active medium. The laser medium (ruby) in the ruby laser is made of the host of sapphire (Al_2O_3) which is doped with small amounts of chromium ions (Cr^{3+}). The ruby has good thermal properties.



Pump source or energy source in ruby laser

The pump source is the element of a ruby laser system that provides energy to the laser medium. In a ruby laser, population inversion is



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required to achieve laser emission. Population inversion is the process of achieving the greater population of higher energy state than the lower energy state. In order to achieve population inversion, we need to supply energy to the laser medium (ruby).

In a ruby laser, we use flashtube as the energy source or pump source. The flashtube supplies energy to the laser medium (ruby). When lower energy state electrons in the laser medium gain sufficient energy from the flashtube, they jump into the higher energy state or excited state.

Optical resonator

The ends of the cylindrical ruby rod are flat and parallel. The cylindrical ruby rod is placed between two mirrors. The optical coating is applied to both the mirrors. The process of depositing thin layers of metals on glass substrates to make mirror surfaces is called silvering. Each mirror is coated or silvered differently.

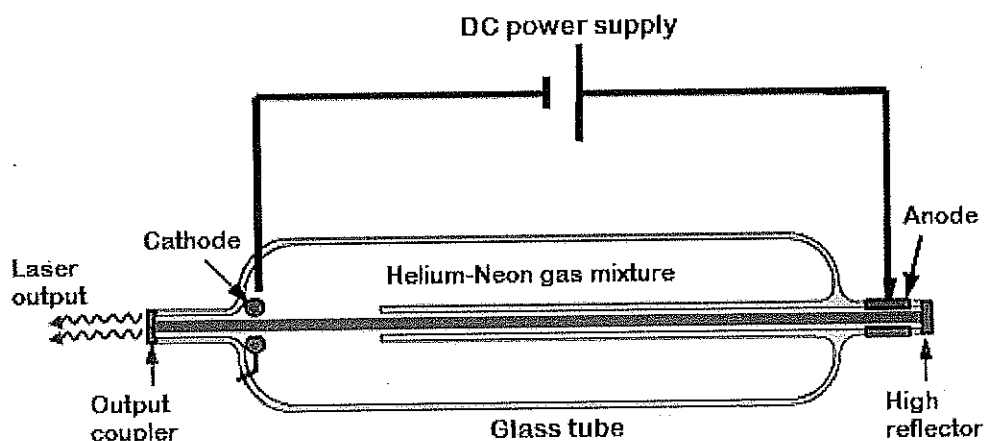
At one end of the rod, the mirror is fully silvered whereas, at another end, the mirror is partially silvered.

The fully silvered mirror will completely reflect the light whereas the partially silvered mirror will reflect most part of the light but allows a small portion of light through it to produce output laser light.

3. Define the gas laser?

Ans. **Gas laser**

A gas laser is a laser in which an electric current is discharged through a gas inside the laser medium to produce laser light. In gas lasers, the laser medium is in the gaseous state.



Gas lasers are used in applications that require laser light with very high beam quality and long coherence lengths.



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In a gas laser, the laser medium or gain medium is made up of the mixture of gases. This mixture is packed up into a glass tube. The glass tube filled with the mixture of gases acts as an active medium or laser medium.

A gas laser is the first laser that works on the principle of converting electrical energy into light energy. It produces a laser light beam in the infrared region of the spectrum at $1.15 \mu\text{m}$.

Gas lasers are of different types: they are, Helium (He) – Neon (Ne) lasers, argon ion lasers, carbon dioxide lasers (CO_2 lasers), carbon monoxide lasers (CO lasers), excimer lasers, nitrogen lasers, hydrogen lasers, etc. The type of gas used to construct the laser medium can determine the lasers wavelength or efficiency.

4. Define the population inversion and also draw the diagram?

Ans. Practically speaking, the process of stimulated emission will not produce a very efficient or even noticeable amplification of light unless a condition called "population inversion" occurs. If only a few atoms of several million are in an excited state, the chances of stimulated emission occurring are small. The greater the percentage of atoms in an excited state, the greater the probability of stimulated emission. In the normal state of matter the population of electrons will be such that most of the electrons reside in the ground or lowest levels, leaving the upper levels somewhat depopulated. When electrons are excited and fill these upper levels to the extent that there are more atoms excited than not excited, the population is said to be inverted

04X04 = 16 Mark

Section – C

04X06 = 24 Marks

Q1. What are the advantages and disadvantages of Nd:YAG laser?

Ans. Advantages of Nd:YAG laser

- Low power consumption
- Nd:YAG laser offers high gain.
- Nd:YAG laser has good thermal properties.
- Nd:YAG laser has good mechanical properties.
- The efficiency of Nd:YAG laser is very high as compared to the ruby laser.

Q2. Write the application of laser?



3. Ans. Applications of Lasers

Laser is an optical device that generates intense beam of coherent monochromatic light by stimulated emission of radiation.

Laser light is different from an ordinary light. It has various unique properties such as coherence, monochromaticity, directionality, and high intensity. Because of these unique properties, lasers are used in various applications.

The most significant applications of lasers include:

- Lasers in medicine
- Lasers in communications
- Lasers in industries
- Lasers in science and technology
- Lasers in military

Lasers in Medicine

1. Lasers are used for bloodless surgery.
2. Lasers are used to destroy kidney stones.
3. Lasers are used in cancer diagnosis and therapy.
4. Lasers are used for eye lens curvature corrections.
5. Lasers are used in fiber-optic endoscope to detect ulcers in the intestines.
6. The liver and lung diseases could be treated by using lasers.
7. Lasers are used to study the internal structure of microorganisms and cells.
8. Lasers are used to produce chemical reactions.
9. Lasers are used to create plasma.
10. Lasers are used to remove tumors successfully.
11. Lasers are used to remove the caries or decayed portion of the teeth.



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12. Lasers are used in cosmetic treatments such as acne treatment, cellulite and hair removal.

Lasers in Communications

1. Laser light is used in optical fiber communications to send information over large distances with low loss.
2. Laser light is used in underwater communication networks.
3. Lasers are used in space communication, radars and satellites.

Lasers in Industries

1. Lasers are used to cut glass and quartz.
2. Lasers are used in electronic industries for trimming the components of Integrated Circuits (ICs).
3. Lasers are used for heat treatment in the automotive industry.
4. Laser light is used to collect the information about the prefixed prices of various products in shops and business establishments from the bar code printed on the product.
5. Ultraviolet lasers are used in the semiconductor industries for photolithography. Photolithography is the method used for manufacturing printed circuit board (PCB) and microprocessor by using ultraviolet light.
6. Lasers are used to drill aerosol nozzles and control orifices within the required precision.

Lasers in Science and Technology

1. A laser helps in studying the Brownian motion of particles.
2. With the help of a helium-neon laser, it was proved that the velocity of light is same in all directions.



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3. With the help of a laser, it is possible to count the number of atoms in a substance.
4. Lasers are used in computers to retrieve stored information from a Compact Disc (CD).
5. Lasers are used to store large amount of information or data in CD-ROM.
6. Lasers are used to measure the pollutant gases and other contaminants of the atmosphere.
7. Lasers helps in determining the rate of rotation of the earth accurately.
8. Lasers are used in computer printers.
9. Lasers are used for producing three-dimensional pictures in space without the use of lens.
10. Lasers are used for detecting earthquakes and underwater nuclear blasts.
11. A gallium arsenide diode laser can be used to setup an invisible fence to protect an area.

Lasers in Military

1. Laser range finders are used to determine the distance to an object.
2. The ring laser gyroscope is used for sensing and measuring very small angle of rotation of the moving objects.
3. Lasers can be used as a secretive illuminators for reconnaissance during night with high precision.
4. Lasers are used to dispose the energy of a warhead by damaging the missile.

Laser light is used in LIDAR's to accurately measure the distance to an object.



Q3. What are the advantages and disadvantages of he-Ne laser

Ans. Advantages of helium-neon laser

- Helium-neon laser emits laser light in the visible portion of the spectrum.
- High stability
- Low cost
- Operates without damage at higher temperatures

Disadvantages of helium-neon laser

- Low efficiency
- Low gain
- Helium-neon lasers are limited to low power tasks

Q4. What is Ruby Laser? Elaborate its working.

Ans. Ruby laser definition

A ruby laser is a solid-state laser that uses the synthetic ruby crystal as its laser medium. Ruby laser is the first successful laser developed by Maiman in 1960.

Ruby laser is one of the few solid-state lasers that produce visible light. It emits deep red light of wavelength 694.3 nm.

Working of ruby laser

The ruby laser is a three level solid-state laser. In a ruby laser, optical pumping technique is used to supply energy to the laser medium. Optical pumping is a technique in which light is used as energy source to raise electrons from lower energy level to the higher energy level.

Consider a ruby laser medium consisting of three energy levels E_1 , E_2 , E_3 with N number of electrons.

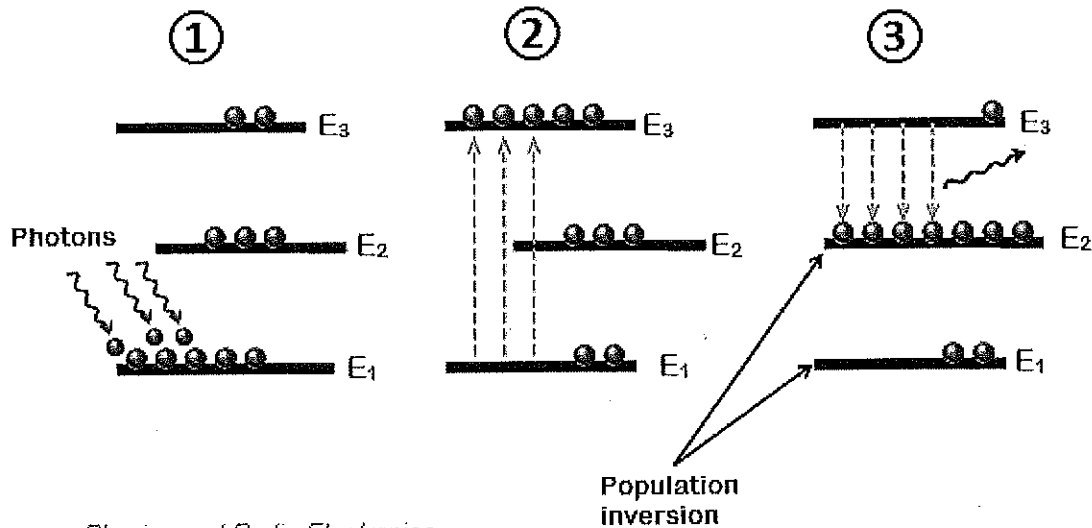
We assume that the energy levels will be $E_1 < E_2 < E_3$. The energy level E_1 is known as ground state or lower energy state, the energy level E_2 is



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known as metastable state, and the energy level E_3 is known as pump state.

Let us assume that initially most of the electrons are in the lower energy state (E_1) and only a tiny number of electrons are in the excited states (E_2 and E_3)



Physics and Radio-Electronics

When light energy is supplied to the laser medium (ruby), the electrons in the lower energy state or ground state (E_1) gain enough energy and jump into the pump state (E_3).

The lifetime of pump state E_3 is very small (10^{-8} sec) so the electrons in the pump state do not stay for long period. After a short period, they fall into the metastable state E_2 by releasing radiation less energy. The lifetime of metastable state E_2 is 10^{-3} sec which is much greater than the lifetime of pump state E_3 . Therefore, the electrons reach E_2 much faster than they leave E_2 . This results in an increase in the number of electrons in the metastable state E_2 and hence population inversion is achieved.

After some period, the electrons in the metastable state E_2 fall into the lower energy state E_1 by releasing energy in the form of photons. This is called spontaneous emission of radiation.

When the emitted photon interacts with the electron in the metastable state, it forcefully makes that electron fall into the ground state E_1 . As a result, two photons are emitted. This is called stimulated emission of radiation.

When these emitted photons again interacted with the metastable state electrons, then 4 photons are produced. Because of this continuous interaction with the electrons, millions of photons are produced.



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In an active medium (ruby), a process called spontaneous emission produces light. The light produced within the laser medium will bounce back and forth between the two mirrors. This stimulates other electrons to fall into the ground state by releasing light energy. This is called stimulated emission. Likewise, millions of electrons are stimulated to emit light. Thus, the light gain is achieved.

The amplified light escapes through the partially reflecting mirror to produce laser light.



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Registration No.:

School of Metal Construction Skills
Session: 2020-21 (Summer Semester)

B. Voc. Program, 3rd Semester,
End-Sem. Examination

Set-B

Course Code: MCS1302

Time: 2 Hour

Course Name: CNC PUNCHING

Max. Marks: 50

Instruction:

1. Attempt all questions.
2. Use of Calculators is prohibited.
3. Section A contains 10 Questions. Each question carries 1 Marks.
4. Section B contains 04 Questions. Each question carries 4 Marks.
5. Section C contains 04 Questions. Each question carries 6 Marks.

Section – A

10X01 = 10 Marks

Q1. As the clearance increases, the punch force required?

- | | |
|-----------------|---------------------------------------|
| a) Decreases | b) Increases |
| c) Remains same | d) First increases and then decreases |

Q2. As the thickness of sheet is increased the clearance needed will also?

- | | |
|--------------|--------------------------------------|
| a) Increase | b) Decrease |
| c) No effect | d) First decreases and then increase |

Q3. Arrange the below operations in operator-controlled machine tool in correct order.

- (A) Operator
- (B) Process planning
- (C) Machine tool
- (D) Component drawing
- (E) Completed component

- | | |
|--------------------------------|--------------------------------|
| a. (A) – (D) – (B) – (C) – (E) | b. (D) – (B) – (C) – (A) – (E) |
| c. (B) – (D) – (C) – (A) – (E) | d. (D) – (B) – (A) – (C) – (E) |



Section – C

04X06 = 24 Marks

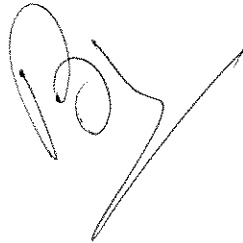
Q.15 Define the following terms-

- a. Notching
- b. Lancing
- c. Slitting

Q.16 What are advantages and disadvantages of cnc punching?

Q.17 Write difference between punching and blanking with diagram?

Q.18 Draw the line diagram of CNC Press Punch Machine.







School of Metal Construction Skills
Session: 2020-21 (Summer Semester)
B. Voc. Program, 3rd Semester,
End-Sem. Examination

Set-B

Answer Key

Course Code: MCS1302

Time: 2 Hour

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Section – A

10X01 = 10 Marks

Q1. As the clearance increases, the punch force required?

- | | |
|-----------------|---------------------------------------|
| a) Decreases | b) Increases |
| c) Remains same | d) First increases and then decreases |

Answer: a

Q2. As the thickness of sheet is increased the clearance needed will also?

- | | |
|--------------|--------------------------------------|
| a) Increase | b) Decrease |
| c) No effect | d) First decreases and then increase |

Answer: a

Q3. Arrange the below operations in operator-controlled machine tool in correct order.

- (A) Operator
- (B) Process planning
- (C) Machine tool
- (D) Component drawing
- (E) Completed component

- | | |
|--------------------------------|--------------------------------|
| a. (A) – (D) – (B) – (C) – (E) | b. (D) – (B) – (C) – (A) – (E) |
| c. (B) – (D) – (C) – (A) – (E) | d. (D) – (B) – (A) – (C) – (E) |

ANSWER: (D) – (B) – (A) – (C) – (E)

sideways on a table. Any scrap is carried to the end of the conveyor and dropped into a bin. Different work pieces can be produced within one work cycle to optimize production.

Q.12 What is CNC punching

Ans. Computer numerically controlled (CNC) punching is a sheet metal manufacturing process that is carried out by CNC punch presses. These machines can be either a single head and tool rail (Trumpf) design or multi-tool turret design.

The processing range for most CNC punch presses is 0.5mm to 6.0mm thick in a range of materials including steel, zinc, galv, stainless steel and Aluminium. The choice of hole punched can be as simple as a circle or rectangle right through to special shapes to suit a specific cut out design.

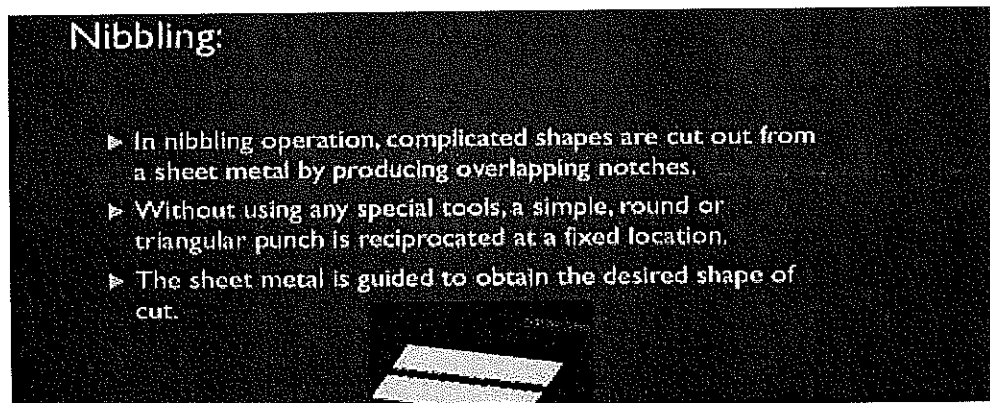
Q.13 Write down the steps for removing the Punching tool.

Ans. Removing tools

1. Remove the punch from the upper turret disk.
2. Loosen the bolt fixing the upper die holder.
3. Remove the upper die holder from the lower turret disk.
4. Lightly tap the upper part of the die with the standard accessory brass bar. The die is loosened for easy removal.
5. Remove the die from the upper die holder.

Q.14 What Is nibbling process?

Ans.



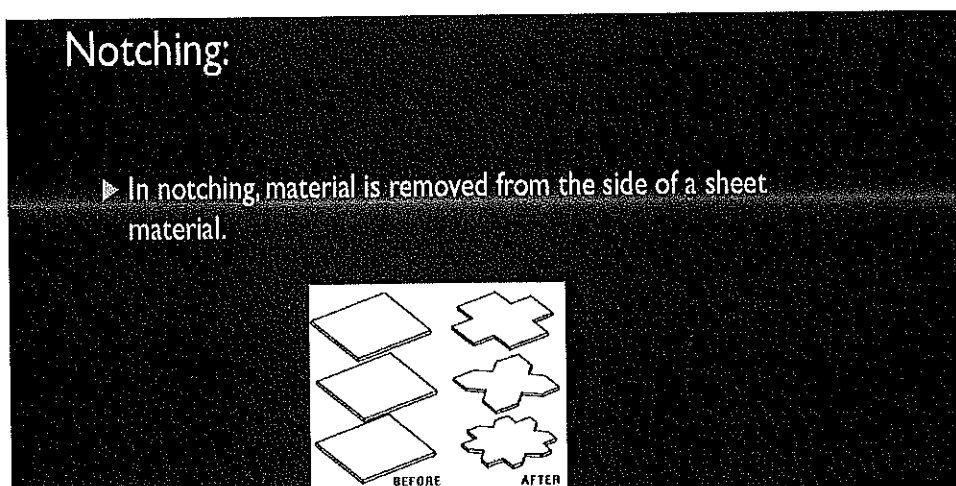
Section – C

04X06 = 24 Marks

Q.15 Define the following terms-

- a. Notching
- b. Lancing
- c. Slitting

Ans.



Lancing:

- ▶ Lancing process makes partway through the metal without producing any scrap.



Slitting:

- ▶ It is an operation to cut a coiled sheet metal lengthwise to produce narrower strips.



Q16 What are advantages and disadvantages of cnc punching?

Ans.

Advantages:

- ▶ Punching and blanking are quick processes.
- ▶ The slug produced may be reused or recycled (depending on material).
- ▶ It is often the cheapest and most cost effective method for medium to high volume of production.
- ▶ It can create multiple shaped holes or same shaped holes very fast.

Disadvantages:

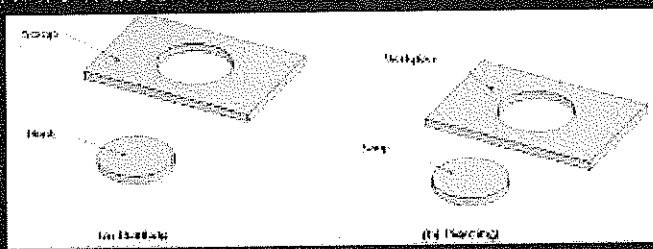
- ▶ Equipment and tooling costs are high.
- ▶ Often needs secondary finishing operations to smooth out burrs along the bottom edge.
- ▶ Fine blanking process is a slow process.

Q.17 Write difference between punching and blanking with diagram?

Ans.

Difference:

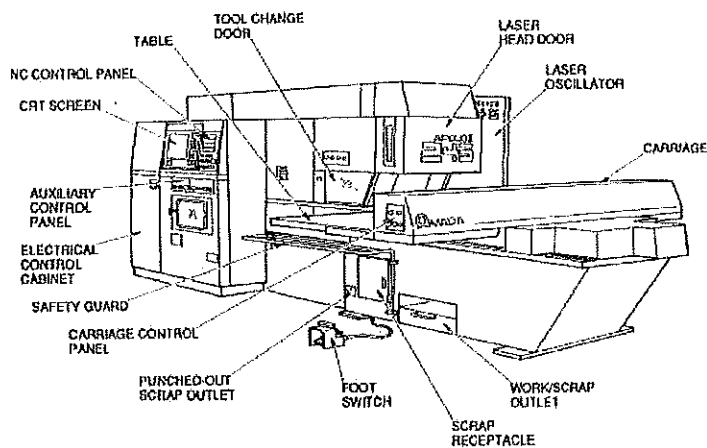
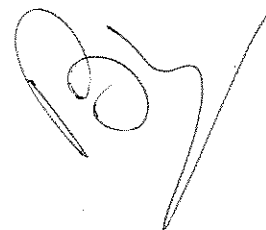
- ▶ In the punching process the final product is the metal sheet from which metal is removed.
- ▶ In blanking process the final product is the removed portion from the sheet.

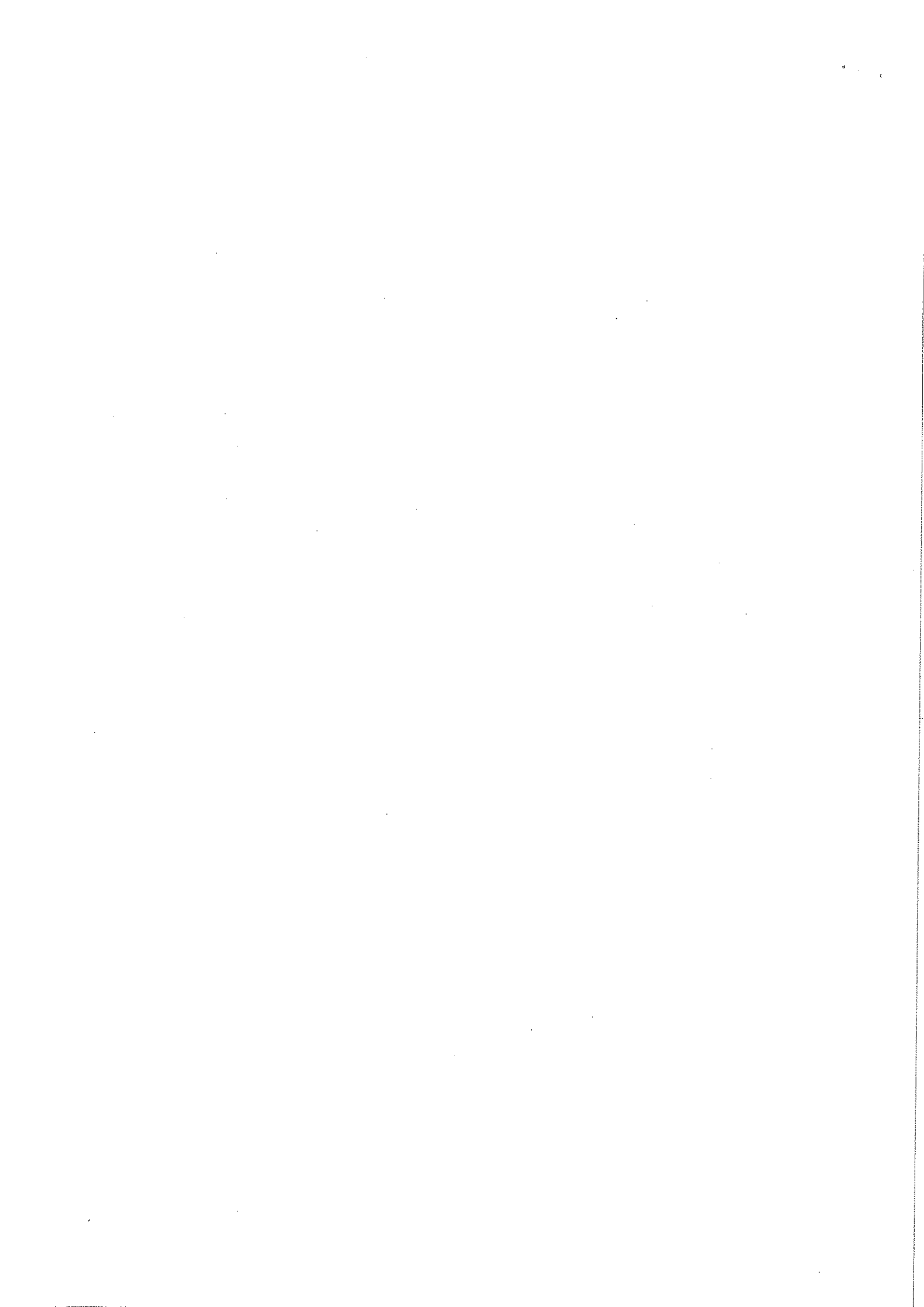


Q.18 Draw the line diagram of CNC Press Punch Machine.

Ans.

General view





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School of Metal Construction Skills

Session: 2021-22 (Summer Semester)

B. Voc. Program, 3rd Semester,

End-Sem. Examination

Set: A

Course Code: MCS1703

Course Name: CNC laser cutting

Time: 2 Hours

Max. Marks: 50

Instruction:

1. Attempt all questions.
2. Use of Calculators is prohibited.
3. Section A contains 10 Questions. Each question carries 10 Marks.
4. Section B contains 04 Questions. Each question carries 16 Marks.
5. Section C contains 04 Questions. Each question carries 24 Marks.

Section – A

10X01 = 10 Marks

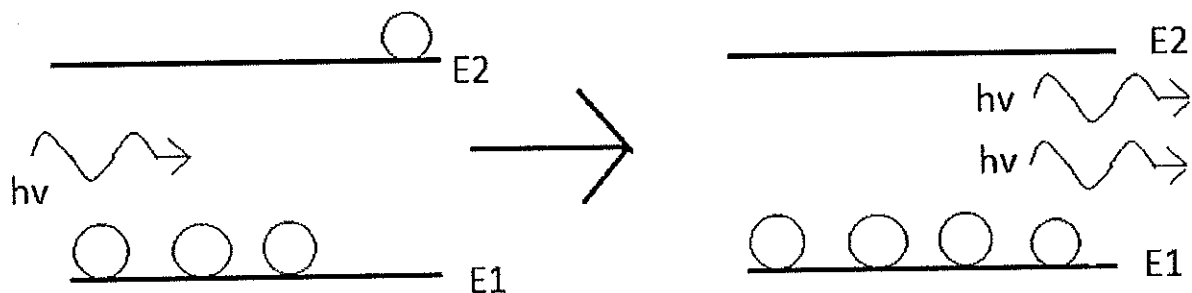
What type of laser is used in Metal Cutting?

- | | |
|------------------|---------|
| a) Semiconductor | b) YAG |
| c) Alexandrite | d) Ruby |

Q2. Which of the following is not a characteristic of LASERS?

- | | |
|------------------|-------------|
| a) Monochromatic | b) Coherent |
| c) Divergent | d) Intense |

Q3. The following graph is pictorial representation of _____



- | | |
|-------------------------|---------------------------|
| a) Spontaneous emission | b) Spontaneous Absorption |
| c) Stimulated emission | d) Stimulated Absorption |

Q4. Which is not gas laser

- a) Co₂ laser
- b) He-ne laser
- c) Ruby laser
- d) None of the above



Q5. What does the acronym MASER stand for?

- a) Microwave Amplification by Stimulated Emission of Radiation
- b) Molecular Absorption by Stimulated Emission of Radiation
- c) The name of Albert Einstein's dog
- d) None of the Above

Q6. Nd: YAG is-

- a) Solid state laser
- b) Gas laser
- c) Chemical laser
- d) All of the above

Q7. Advantage of Nd: YAG laser-

- a) Low power consumption
- b) Nd: YAG laser offers high gain.
- c) Nd: YAG laser has good thermal properties.
- d) All of the above

Q8. In Stimulated emission, the emitted photons are _____

- a) Coherent and Monochromatic
- b) Non-coherent and monochromatic
- c) Coherent and Non-Monochromatic
- d) Non-Coherent and Non-monochromatic

Q9. What is the relationship between E_1 and E_2 ?

Where E_1 is ground state and E_2 is Excited state

- a) $E_2 > E_1$
- b) $E_2 < E_1$
- c) $E_2 = E_1$
- d) No specific relation

Q10. During pumping, the atoms are excited to _____

- a) Higher Excited States
- b) Lower Energy states
- c) Meta Stable states
- d) Not Excited



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Section – B

04X04 = 16 Marks

Q1. What do you understand by laser?

Q2. What is pumping system and which type of pumping system is used in Ruby laser?

Q3. Define the following terms-

a) Absorption

b) Spontaneous emission

Q4. What do you understand by optical resonator in Nd: YAG laser?

Section – C

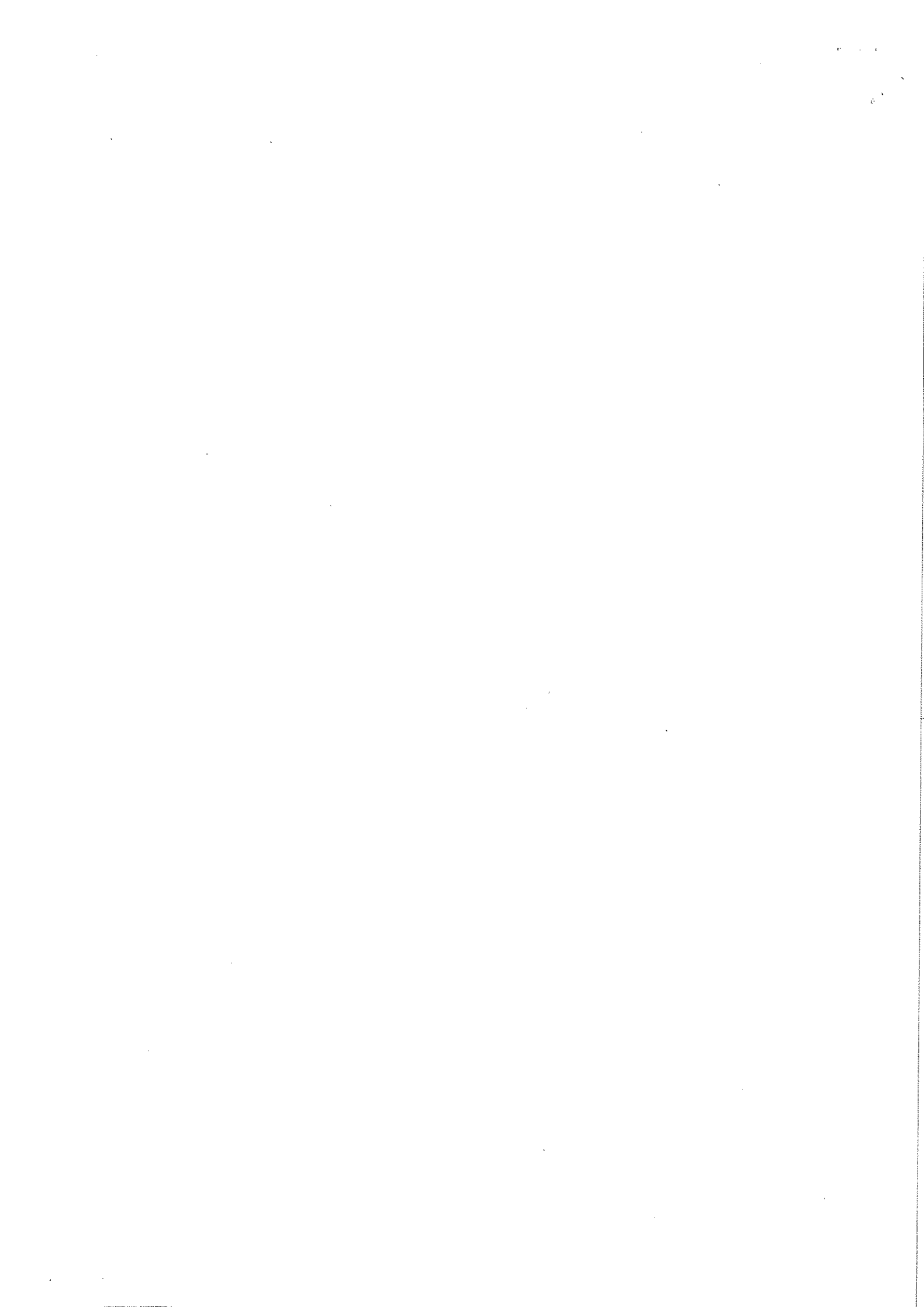
04X06 = 24 Marks

Q1. What are the applications of Nd: YAG laser?

Q2. What are the Applications of laser?

Q3. Describe the Nd: YAG laser?

Q4. What is He-Ne laser? Explain gain medium and working in detail.





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a) Spontaneous emission

b) Spontaneous Absorption

c) Stimulated emission

d) Stimulated Absorption

Ans. C

Q4. Which is not gas laser

a) Co₂ laser

b) He-ne laser

c) Ruby laser

d) None of the above

Ans. C

Q5. What does the acronym MASER stand for?

a) Microwave Amplification by Stimulated Emission of Radiation

b) Molecular Absorption by Stimulated Emission of Radiation

c) The name of Albert Einstein's dog

d) None of the Above

Ans. A

Q6. Nd: YAG is-

a) Solid state laser

b) Gas laser

c) Chemical laser

d) All of the above

Ans. A

Q7. Advantage of Nd: YAG laser-

a) Low power consumption

b) Nd: YAG laser offers high gain.

c) Nd: YAG laser has good thermal properties.

d) All of the above

Ans. D



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Q8. In Stimulated emission, the emitted photons are _____

- a) **Coherent and Monochromatic**
- b) Non-coherent and monochromatic
- c) Coherent and Non-Monochromatic
- d) Non-Coherent and Non-monochromatic

Q9. What is the relationship between E_1 and E_2 ?

Where E_1 is ground state and E_2 is Excited state

- a) $E_2 > E_1$
- b) $E_2 < E_1$
- c) $E_2 = E_1$
- d) No specific relation

Ans A

Q10. During pumping, the atoms are excited to _____

- a) Higher Excited States
- b) Lower Energy states
- c) **Meta Stable states**
- d) Not Excited

Ans. C

Section – B

04X04 = 16 Marks

Q1. What do you understand by laser?

Ans

Definition of Laser : A **laser** is a device that emits light through a process of optical amplification based on the stimulated emission of electromagnetic radiation. The term "laser" originated as an acronym for "**light amplification by stimulated emission of radiation**".

A laser produces a very narrow beam of light that is useful in many technologies and instruments. A laser is an unusual light source. It is quite different from a light bulb or a flash light. The emission generally covers an extremely limited range of visible, infrared, or ultraviolet wavelengths



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Q2. What is pumping system and which type of pumping system is used in Ruby laser?

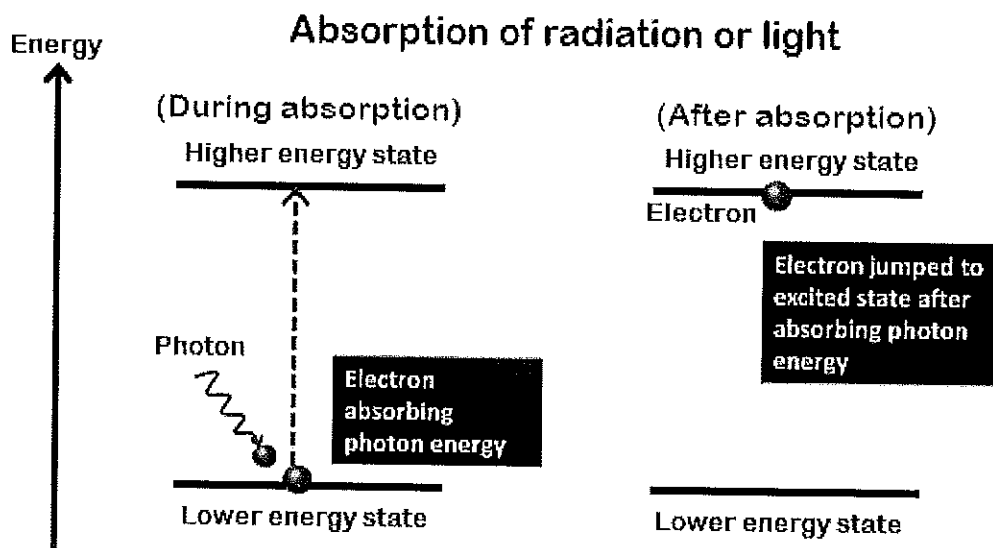
The pumping system imparts energy to the atoms or molecules of the lasing medium enabling them to be raised to an excited "metastable state" creating a population inversion. Optical pumping uses photons provided by a source such as a Xenon gas flash lamp or another laser to transfer energy to the lasing material. The optical source must provide photons which correspond to the allowed transition levels of the lasing material.

Collision pumping relies on the transfer of energy to the lasing material by collision with the atoms (or molecules) of the lasing material. Again, energies which correspond to the allowed transitions must be provided. This is often done by electrical discharge in a pure gas or gas mixture in a tube.

Chemical pumping systems use the binding energy released in chemical reactions to state.

Q3. Define the following terms-

- Absorption
- Absorption of radiation is the process by which electrons in the ground state absorb energy from photons to jump into the higher energy level.
- The electrons orbiting very close to the nucleus are at the lower energy level or lower energy state whereas the electrons orbiting farther away from the nucleus are at the higher energy level. The electrons in the lower energy level need some extra energy to jump into the higher energy level. This extra energy is provided from various energy sources such as heat, electric field, or light.
- Let us consider two energy levels (E_1 and E_2) of electrons. E_1 is the ground state or lower energy state of electrons and E_2 is the excited state or higher energy state of electrons. The electrons in the ground state are called lower energy electrons or ground state electrons whereas the electrons in the excited state are called higher energy electrons or excited electrons.



- e.
- f.

Physics and Radio-Electronics

- g. In general, the electrons in the lower energy state can't jump into the higher energy state. They need sufficient energy in order to jump into the higher energy state.



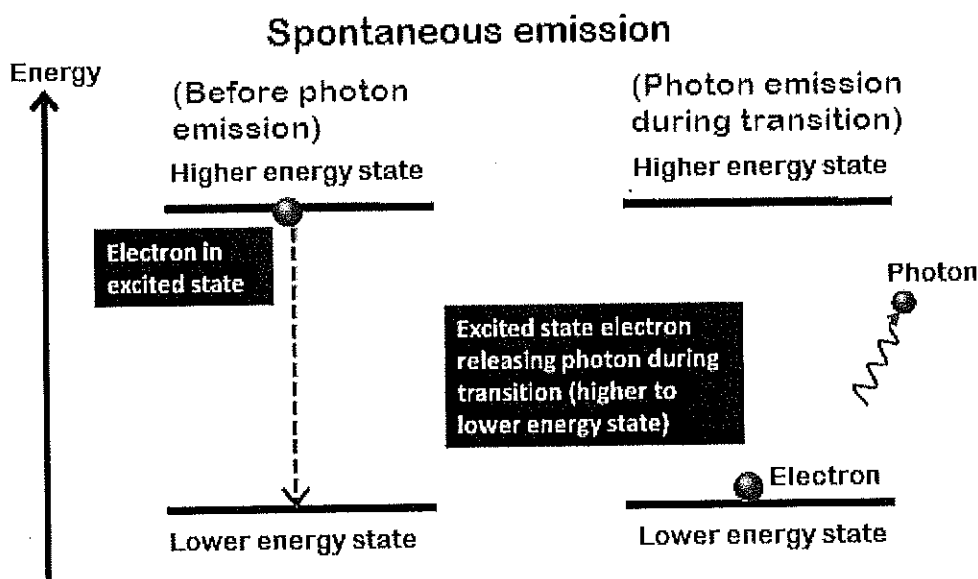
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When photons or light energy equal to the energy difference of the two energy levels ($E_2 - E_1$) is incident on the atom, the ground state electrons gains sufficient energy and jumps from ground state (E_1) to the excited state (E_2).

- i. The absorption of radiation or light occurs only if the energy of incident photon exactly matches the energy difference of the two energy levels ($E_2 - E_1$).
- j. Spontaneous emission

Ans. Spontaneous emission is the process by which electrons in the excited state return to the ground state by emitting photons.

The electrons in the excited state can stay only for a short period. The time up to which an excited electron can stay at higher energy state (E_2) is known as the lifetime of excited electrons. The lifetime of electrons in excited state is 10^{-8} second.



Thus, after the short lifetime of the excited electrons, they return to the lower energy state or ground state by releasing energy in the form of photons.

In spontaneous emission, the electrons move naturally or spontaneously from one state (higher energy state) to another state (lower energy state) so the emission of photons also occurs naturally. Therefore, we have no control over when an excited electron is going to lose energy in the form of light.

The photons emitted in spontaneous emission process constitute ordinary incoherent light. Incoherent light is a beam of photons with frequent and random changes of phase between them. In other words, the photons emitted in the spontaneous emission process do not flow exactly in the same direction of incident photons.

Q4. What do understand by optical resonator in Nd:YAG laser?

Ans. The ends of the cylindrical ruby rod are flat and parallel. The cylindrical ruby rod is placed between two mirrors. The optical coating is applied to both the mirrors. The



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process of depositing thin layers of metals on glass substrates to make mirror surfaces is called silvering. Each mirror is coated or silvered differently.

At one end of the rod, the mirror is fully silvered whereas, at another end, the mirror is partially silvered.

The fully silvered mirror will completely reflect the light whereas the partially silvered mirror will reflect most part of the light but allows a small portion of light through it to produce output laser light.

Section – C

04X06 = 24 Marks

Q1. What are the applications of Nd:YAG laser?

Ans. Military

Nd:YAG lasers are used in laser designators and laser rangefinders. A laser designator is a laser light source, which is used to target objects for attacking. A laser rangefinder is a rangefinder, which uses a laser light to determine the distance to an object.

Medicine

Nd: YAG lasers are used to correct posterior capsular opacification (a condition that may occur after a cataract surgery).

Nd:YAG lasers are used to remove skin cancers.

Manufacturing

Nd:YAG lasers are used for etching or marking a variety of plastics and metals.

Nd:YAG lasers are used for cutting and welding steel.

Q2. What are the Applications of laser?

Ans.

Laser is an optical device that generates intense beam of coherent monochromatic light by stimulated emission of radiation.

Laser light is different from an ordinary light. It has various unique properties such as coherence, monochromaticity, directionality, and high intensity. Because of these unique properties, lasers are used in various applications.

The most significant applications of lasers include:

- Lasers in medicine



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- Lasers in communications
- Lasers in industries
- Lasers in science and technology
- Lasers in military

Lasers in Medicine

1. Lasers are used for bloodless surgery.
2. Lasers are used to destroy kidney stones.
3. Lasers are used in cancer diagnosis and therapy.
4. Lasers are used for eye lens curvature corrections.
5. Lasers are used in fiber-optic endoscope to detect ulcers in the intestines.
6. The liver and lung diseases could be treated by using lasers.
7. Lasers are used to study the internal structure of microorganisms and cells.
8. Lasers are used to produce chemical reactions.
9. Lasers are used to create plasma.
10. Lasers are used to remove tumors successfully.
11. Lasers are used to remove the caries or decayed portion of the teeth.
12. Lasers are used in cosmetic treatments such as acne treatment, cellulite and hair removal.

Lasers in Communications

1. Laser light is used in optical fiber communications to send information over large distances with low loss.
2. Laser light is used in underwater communication networks.
3. Lasers are used in space communication, radars and satellites.

Lasers in Industries

1. Lasers are used to cut glass and quartz.



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2. Lasers are used in electronic industries for trimming the components of Integrated Circuits (ICs).
3. Lasers are used for heat treatment in the automotive industry.
4. Laser light is used to collect the information about the prefixed prices of various products in shops and business establishments from the bar code printed on the product.
5. Ultraviolet lasers are used in the semiconductor industries for photolithography. Photolithography is the method used for manufacturing printed circuit board (PCB) and microprocessor by using ultraviolet light.
6. Lasers are used to drill aerosol nozzles and control orifices within the required precision.

Lasers in Science and Technology

1. A laser helps in studying the Brownian motion of particles.
2. With the help of a helium-neon laser, it was proved that the velocity of light is same in all directions.
3. With the help of a laser, it is possible to count the number of atoms in a substance.
4. Lasers are used in computers to retrieve stored information from a Compact Disc (CD).
5. Lasers are used to store large amount of information or data in CD-ROM.
6. Lasers are used to measure the pollutant gases and other contaminants of the atmosphere.
7. Lasers helps in determining the rate of rotation of the earth accurately.
8. Lasers are used in computer printers.
9. Lasers are used for producing three-dimensional pictures in space without the use of lens.



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10. Lasers are used for detecting earthquakes and underwater nuclear blasts.
11. A gallium arsenide diode laser can be used to setup an invisible fence to protect an area.

Lasers in Military

1. Laser range finders are used to determine the distance to an object.
2. The ring laser gyroscope is used for sensing and measuring very small angle of rotation of the moving objects.
3. Lasers can be used as a secretive illuminators for reconnaissance during night with high precision.
4. Lasers are used to dispose the energy of a warhead by damaging the missile.

Laser light is used in LIDAR's to accurately measure the distance to an object.

Q3. Describe the Nd: YAG laser?

Ans. Nd: YAG laser definition

Neodymium-doped Yttrium Aluminium Garnet (Nd: YAG) laser is a solid state laser in which Nd: YAG is used as a laser medium.

These lasers have many different applications in the medical and scientific field for processes such as Lasik surgery and laser spectroscopy.

Nd: YAG laser is a four-level laser system, which means that the four energy levels are involved in laser action. These lasers operate in both pulsed and continuous mode.

Nd: YAG laser generates laser light commonly in the near-infrared region of the spectrum at 1064 nanometres (nm). It also emits laser light at several different wavelengths including 1440 nm, 1320 nm, 1120 nm, and 940 nm.

Nd: YAG laser construction

Nd: YAG laser consists of three important elements: an energy source, active medium, and optical resonator.

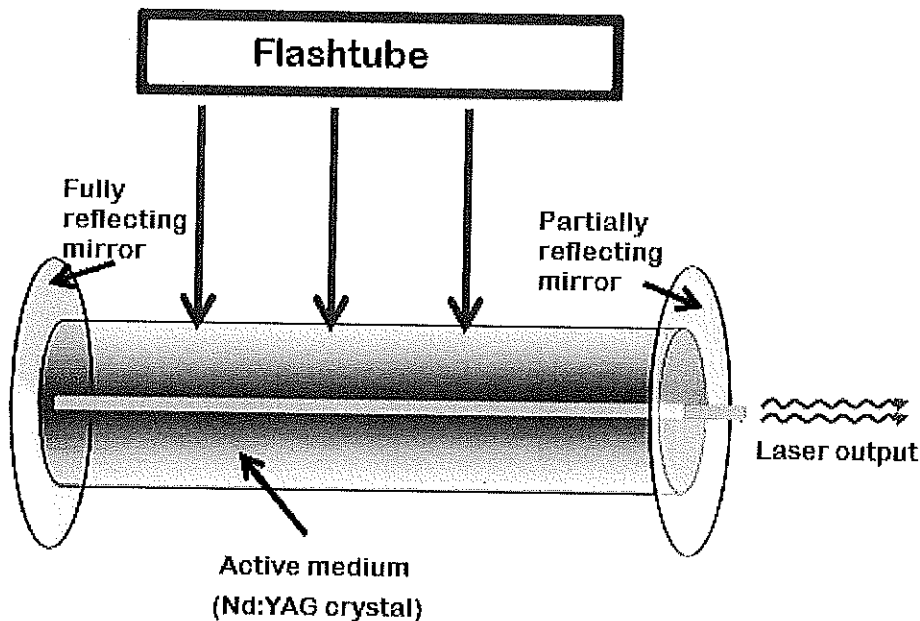
Energy source

The energy source or pump source supplies energy to the active medium to achieve population inversion. In Nd: YAG laser, light energy sources such as flashtube or laser diodes are used as energy source to supply energy to the active medium.



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In the past, flashtubes are mostly used as pump source because of its low cost. However, nowadays, laser diodes are preferred over flashtubes because of its high efficiency and low cost.



Active medium

The active medium or laser medium of the Nd: YAG laser is made up of a synthetic crystalline material (Yttrium Aluminum Garnet (YAG)) doped with a chemical element (neodymium (Nd)). The lower energy state electrons of the neodymium ions are excited to the higher energy state to provide lasing action in the active medium.

Optical resonator

The Nd: YAG crystal is placed between two mirrors. These two mirrors are optically coated or silvered.

Each mirror is silvered or coated differently. One mirror is fully silvered whereas, another mirror is partially silvered. The mirror, which is fully silvered, will completely reflect the light and is known as fully reflecting mirror.

On the other hand, the mirror which is partially silvered will reflect most part of the light but allows a small portion of light through it to produce the laser beam. This mirror is known as a partially reflecting mirror.

Working of Nd: YAG laser

Nd: YAG laser is a four-level laser system, which means that the four energy levels are involved in laser action. The light energy sources such as flashtubes or laser diodes are used to supply energy to the active medium.

In Nd:YAG laser, the lower energy state electrons in the neodymium ions are excited to the higher energy state to achieve population inversion.

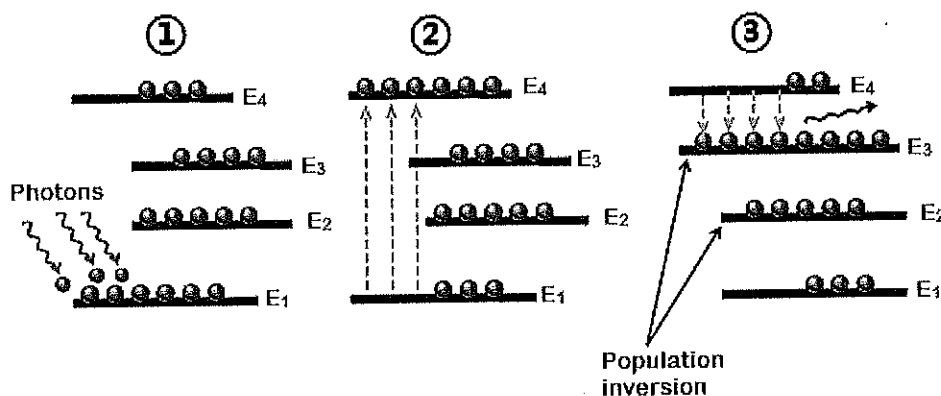


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Consider a Nd: YAG crystal active medium consisting of four energy levels E_1 , E_2 , E_3 , and E_4 with N number of electrons. The number of electrons in the energy states E_1 , E_2 , E_3 , and E_4 will be N_1 , N_2 , N_3 , and N_4 .

Let us assume that the energy levels will be $E_1 < E_2 < E_3 < E_4$. The energy level E_1 is known as ground state, E_2 is the next higher energy state or excited state, E_3 is the metastable state or excited state and E_4 is the pump state or excited state. Let us assume that initially, the population will be $N_1 > N_2 > N_3 > N_4$.

When flashtube or laser diode supplies light energy to the active medium (Nd: YAG crystal), the lower energy state (E_1) electrons in the neodymium ions gains enough energy and moves to the pump state or higher energy state E_4 .

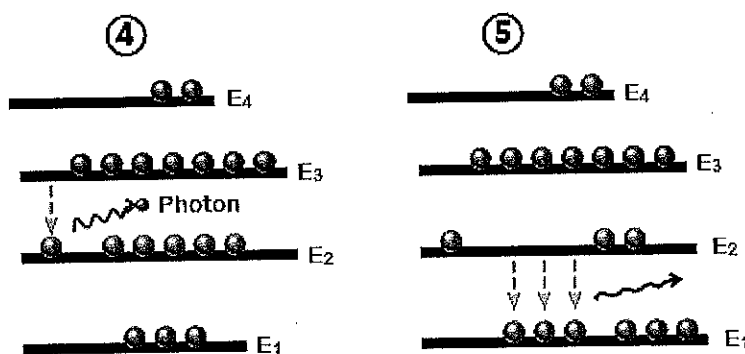


Physics and Radio-Electronics

The lifetime of pump state or higher energy state E_4 is very small (230 microseconds (μs)) so the electrons in the energy state E_4 do not stay for long period. After a short period, the electrons will fall into the next lower energy state or metastable state E_3 by releasing non-radiation energy (releasing energy without emitting photons).

The lifetime of metastable state E_3 is high as compared to the lifetime of pump state E_4 . Therefore, the electrons reach E_3 much faster than they leave E_3 . This results in an increase in the number of electrons in the metastable E_3 and hence population inversion is achieved.

After some period, the electrons in the metastable state E_3 will fall into the next lower energy state E_2 by releasing photons or light. The emission of photons in this manner is called spontaneous emission.



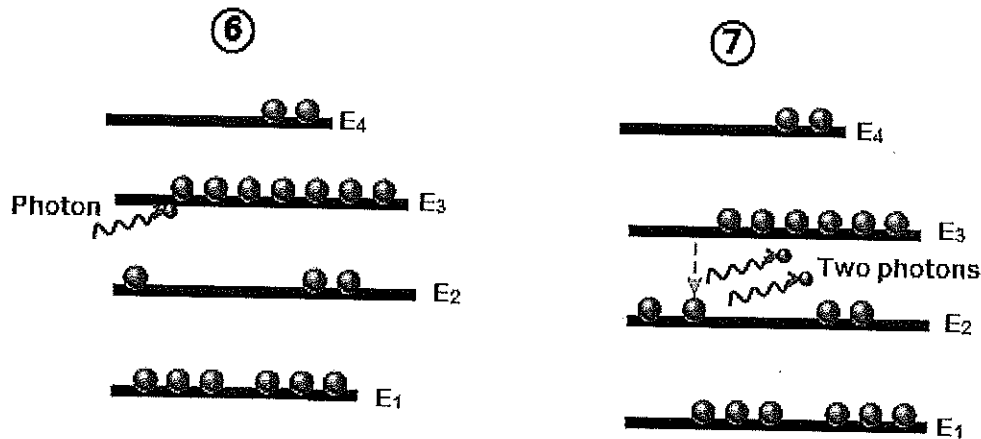
Physics and Radio-Electronics



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The lifetime of energy state E_2 is very small just like the energy state E_4 . Therefore, after a short period, the electrons in the energy state E_2 will fall back to the ground state E_1 by releasing radiationless energy.

When photon emitted due to spontaneous emission is interacted with the other metastable state electron, it stimulates that electron and makes it fall into the lower energy state by releasing the photon. As a result, two photons are released. The emission of photons in this manner is called stimulated emission of radiation.



Physics and Radio-Electronics

When these two photons again interacted with the metastable state electrons, four photons are released. Likewise, millions of photons are emitted. Thus, optical gain is achieved.

Spontaneous emission is a natural process but stimulated emission is not a natural process. To achieve stimulated emission, we need to supply external photons or light to the active medium.

The Nd:YAG active medium generates photons or light due to spontaneous emission. The light or photons generated in the active medium will bounce back and forth between the two mirrors. This stimulates other electrons to fall into the lower energy state by releasing photons or light. Likewise, millions of electrons are stimulated to emit photons.

The light generated within the active medium is reflected many times between the mirrors before it escapes through the partially reflecting mirror.

Q4. What is He-Ne laser? Explain gain medium and working in detail.

Helium-Neon laser is a type of gas laser in which a mixture of helium and neon gas is used as a gain medium. Helium-Neon laser is also known as He-Ne laser.

What is a gas laser?

A gas laser is a type of laser in which a mixture of gas is used as the active medium or laser medium. Gas lasers are the most widely used lasers.



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Gas lasers range from the low power helium-neon lasers to the very high power carbon dioxide lasers. The helium-neon lasers are most commonly used in college laboratories whereas the carbon dioxide lasers are used in industrial applications.

The gain medium of a helium-neon laser is made up of the mixture of helium and neon gas contained in a glass tube at low pressure. The partial pressure of helium is 1 mbar whereas that of neon is 0.1 mbar.

The gas mixture is mostly comprised of helium gas. Therefore, in order to achieve population inversion, we need to excite primarily the lower energy state electrons of the helium atoms.

In He-Ne laser, neon atoms are the active centers and have energy levels suitable for laser transitions while helium atoms help in exciting neon atoms.

Electrodes (anode and cathode) are provided in the glass tube to send the electric current through the gas mixture. These electrodes are connected to a DC power supply.

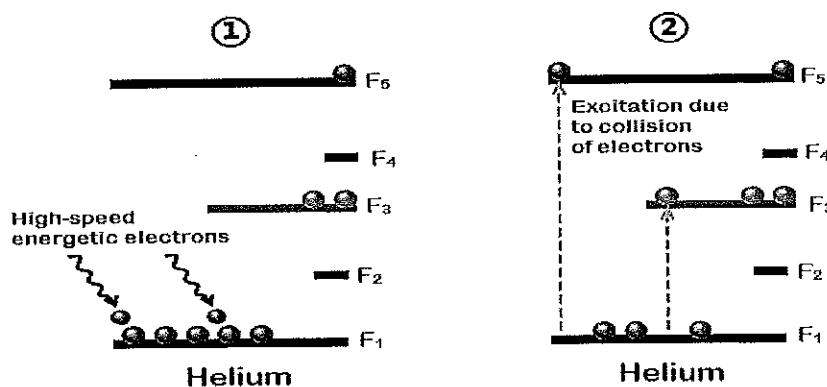
Working of helium-neon laser

In order to achieve population inversion, we need to supply energy to the gain medium. In helium-neon lasers, we use high voltage DC as the pump source. A high voltage DC produces energetic electrons that travel through the gas mixture.

The gas mixture in helium-neon laser is mostly comprised of helium atoms. Therefore, helium atoms observe most of the energy supplied by the high voltage DC.

When the power is switched on, a high voltage of about 10 kV is applied across the gas mixture. This power is enough to excite the electrons in the gas mixture. The electrons produced in the process of discharge are accelerated between the electrodes (cathode and anode) through the gas mixture.

In the process of flowing through the gas, the energetic electrons transfer some of their energy to the helium atoms in the gas. As a result, the lower energy state electrons of the helium atoms gain enough energy and jumps into the excited states or metastable states. Let us assume that these metastable states are F_3 and F_5 .

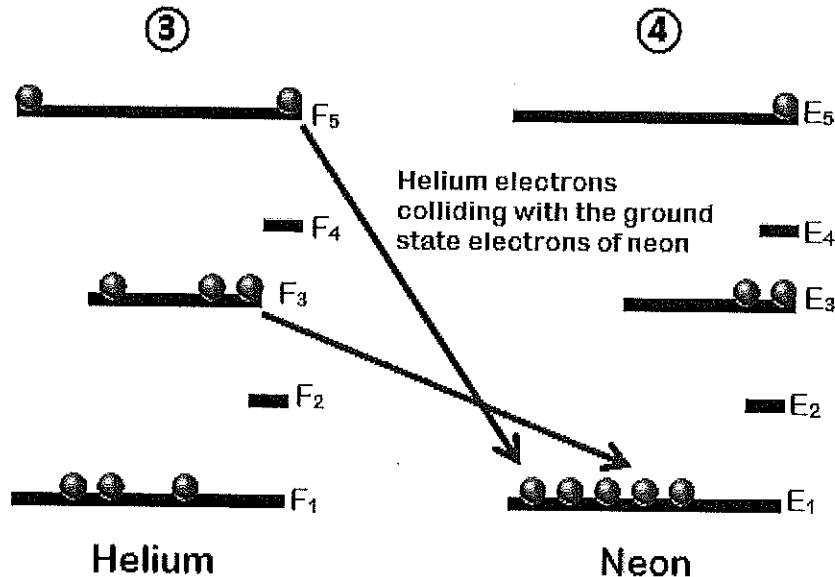




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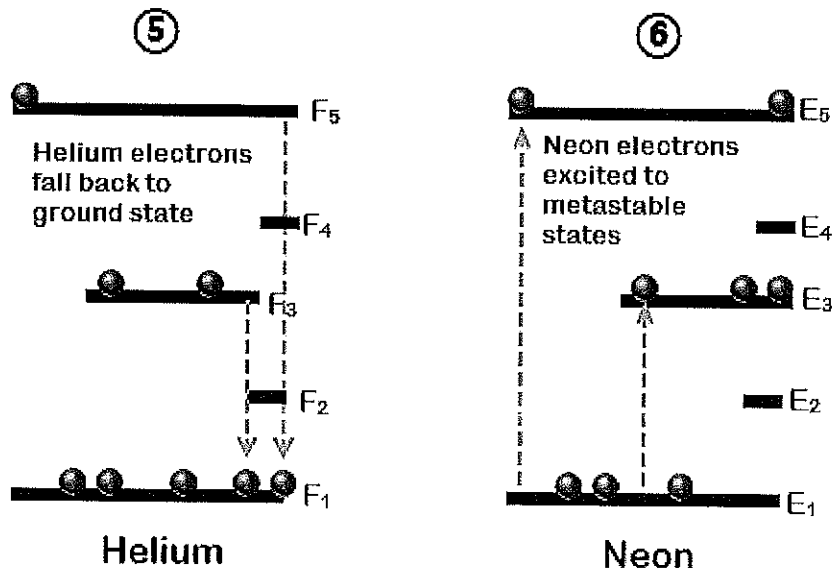
The metastable state electrons of the helium atoms cannot return to ground state by spontaneous emission. However, they can return to ground state by transferring their energy to the lower energy state electrons of the neon atoms.

The energy levels of some of the excited states of the neon atoms are identical to the energy levels of metastable states of the helium atoms. Let us assume that these identical energy states are $F_3 = E_3$ and $F_5 = E_5$. E_3 and E_5 are excited states or metastable states of neon atoms.



Physics and Radio-Electronics

Unlike the solid, a gas can move or flow between the electrodes. Hence, when the excited electrons of the helium atoms collide with the lower energy state electrons of the neon atoms, they transfer their energy to the neon atoms. As a result, the lower energy state electrons of the neon atoms gain enough energy from the helium atoms and jumps into the higher energy states or metastable states (E_3 and E_5) whereas the excited electrons of the helium atoms will fall into the ground state. Thus, helium atoms help neon atoms in achieving population inversion.



Physics and Radio-Electronics

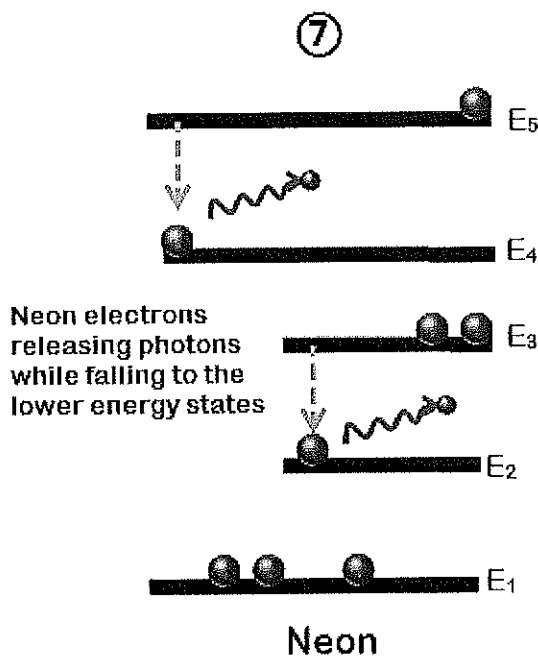


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Likewise, millions of ground state electrons of neon atoms are excited to the metastable states. The metastable states have the longer lifetime. Therefore, a large number of electrons will remain in the metastable states and hence population inversion is achieved.

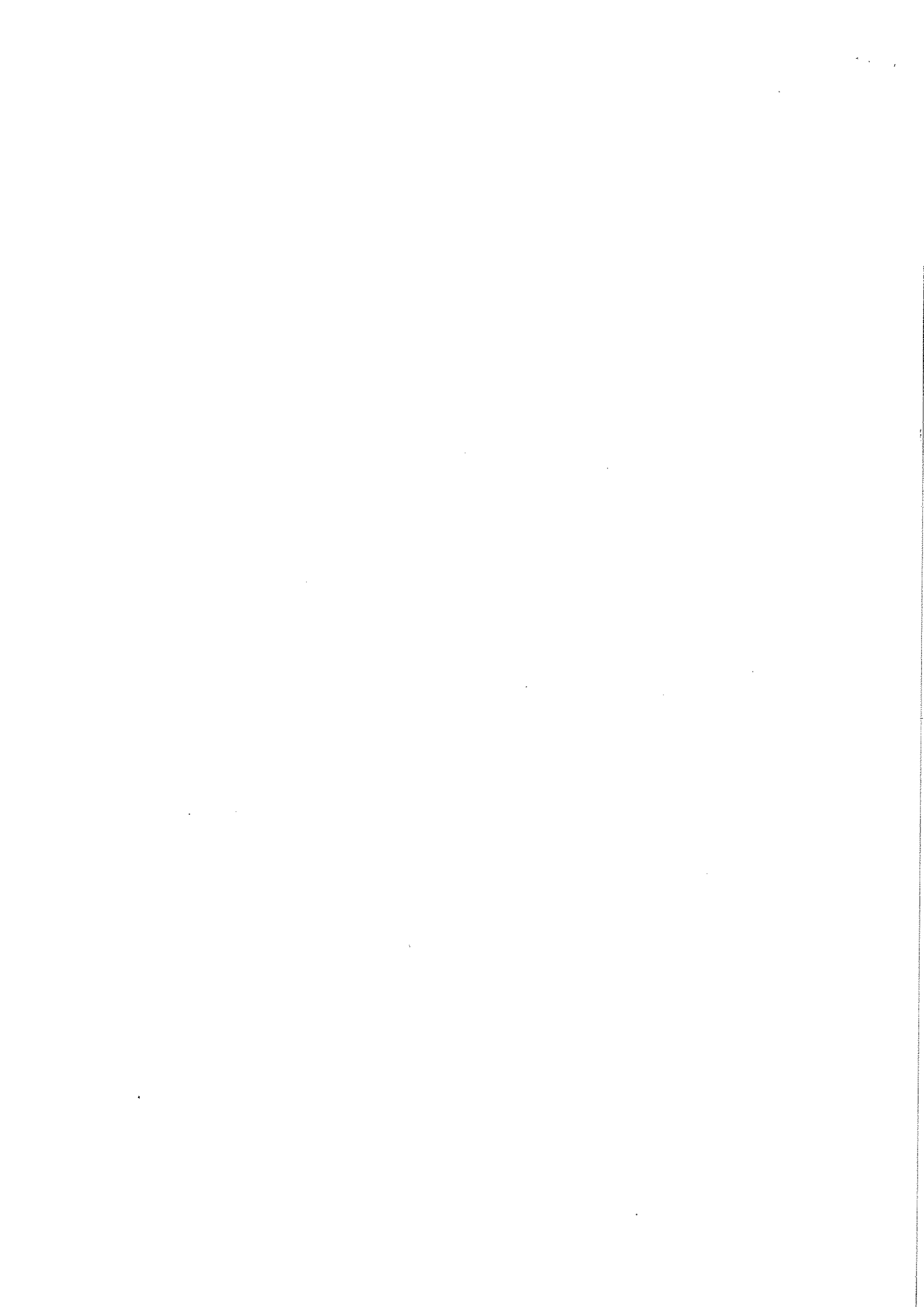
After some period, the metastable states electrons (E_3 and E_5) of the neon atoms will spontaneously fall into the next lower energy states (E_2 and E_4) by releasing photons or red light. This is called spontaneous emission.

The neon excited electrons continue on to the ground state through radiative and nonradiative transitions. It is important for the continuous wave (CW) operation.



The light or photons emitted from the neon atoms will move back and forth between two mirrors until it stimulates other excited electrons of the neon atoms and causes them to emit light. Thus, optical gain is achieved. This process of photon emission is called stimulated emission of radiation.

The light or photons emitted due to stimulated emission will escape through the partially reflecting mirror or output coupler to produce laser light.





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School of Metal Construction Skills

Session: 2021-22 (Summer Semester)

B. Voc. Program, 3rd Semester,

End-Sem. Examination

Set: B

Course Code: MCS1303

Course Name: CNC laser cutting

Time: 2 Hours

Max. Marks: 50

Instruction:

1. Attempt all questions.
2. Use of Calculators is prohibited.
3. Section A contains 10 Questions. Each question carries 10 Marks.
4. Section B contains 04 Questions. Each question carries 16 Marks.
5. Section C contains 04 Questions. Each question carries 24 Marks.

Section – A

10X01 = 10 Marks

Q1. Which color of light has the shortest wave-length?

- | | |
|-----------|----------|
| a) Yellow | b) Blue |
| c) Red | d) Green |

Q2. What is the full form of LASER?

- a) Light Absorbent and Stimulated Emission of Radiations
- b) Light Absorbing Solar Energy Resource
- c) Light Amplification by Stimulated Emission of Radiations
- d) Light Amplification of Singular Emission of Radiations

Q3. What is the type of laser used most widely in industrial materials processing applications?

- | | |
|---------------|-------------------------|
| a) Dye Laser | b) YAG laser |
| c) Ruby Laser | d) Carbon Dioxide Laser |

Q4. Why are lasers used for cutting materials

- | | |
|------------------|--|
| a) Repeatability | b) It has a small "heat affected zone" |
| c) Accuracy | d) All of the above |

Q5. What is one way to describe a Photon?

- | | |
|--------------------|------------------|
| a) Solid as a rock | b) A wave packet |
| c) A torpedo | d) A color |



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Q6. What determines the color of light?

- a) its intensity
- b) its wavelength
- c) its source
- d) Its Frequency

Q7. What is the general lifetime of an atom in an excited state?

- a) 10^{-10}
- b) 10^{-8}
- c) 10^{-6}
- d) 10^{-4}

Q8. Chemical lasers use _____ to produce their beams.

- a) Excessive amounts of electrical power
- b) Small amounts of electrical power
- c) No electrical power
- d) None of the Above

Q9. What is the need to achieve population inversion?

- a) To excite most of the atoms
- b) To bring most of the atoms to ground state
- c) To achieve stable condition
- d) To reduce the time of production of laser

Q10. Which of the following is an example of optical pumping?

- a) Ruby laser
- b) Helium-Neon laser
- c) Semiconductor laser
- d) Dye laser

Section – B

04X04 = 16 Mark

1. What are the types of laser on the basis of medium? Describe the gas laser in short.
2. Explain the laser or gain medium in ruby laser with diagram.
3. Define the gas laser?
4. Define the population inversion and also draw the diagram?

Section – C

04X06 = 24 Marks

- Q1. What are the advantages and disadvantages of Nd: YAG laser?
- Q2. Write the application of laser?
- Q3. What are the advantages and disadvantages of he-Ne laser?
- Q4. What is Ruby Laser? Elaborate it's working.



**School of Metal Construction Skills
Session: 2021-22 (Summer Semester)
B. Voc. Program, 3rd Semester,
End-Sem. Examination
Set: A**

Course Code: MCS1304

Time: 2 Hours

Course Name: Advanced Welding

Max. Marks: 50

Instruction:

1. Attempt all questions.
2. Use of Calculators is prohibited.
3. Section A contains 10 Questions. Each question carries 10 Marks.
4. Section B contains 04 Questions. Each question carries 16 Marks.
5. Section C contains 04 Questions. Each question carries 24 Marks.

Section – A

1. Which is a Stainless Steel type:
 - a) Austenitic
 - b) Low alloy
 - c) Ferritic-Martensitic
 - d) None of the Above
2. Which of the following joint have high corrosion resistance?
 - a) Welding joint
 - b) Riveted joint
 - c) Bolted joint
 - d) None of the above
3. Which of the following ray is not produced during welding?
 - a) Gamma rays
 - b) Visible light rays
 - c) Infrared ray
 - d) Ultra violet rays
4. Which of the following types is not fillet weld?
 - a) butt joint
 - b) lap joint
 - c) T-joint
 - d) Corner joint
5. ISO standard position for overhead fillet weld:
 - a) PA
 - b) PB
 - c) PC
 - d) PD
6. Which of the following is an example of fusion welding?
 - a) Arc welding
 - b) Forge welding
 - c) Resistance welding
 - d) Thermit welding with pressure



7. In which of the following process, heat is created by blacksmith fire
- a) Forge welding
 - b) Spot welding
 - c) Projection welding
 - d) Seam welding
8. Which is not a factor of cold cracking:
- a) Presence of hydrogen
 - b) Susceptible microstructure
 - c) Tensile Strength
 - d) None of the Above
9. What is full form of WPS?
- a) Welding Performance Specification
 - b) Welding Procedure Specification
 - c) Welder Performance Specification
 - d) None of the Above
10. What are the percentage of carbon in low alloy steels?
- a) Less than 0.2%
 - b) More than 0.2%
 - c) Equal to 0.2%
 - d) All of the Above

Section – B

04X04 = 16 Marks

11. What are the differences between PAW and TIG?
12. What do you understand by weldability of stainless steel?
13. What is preliminary welding procedure specification?
14. What are the effects of alloying elements and impurities in stainless steels?

Section – C

04X06 = 24 Marks

15. What is submerged arc welding? Explain its process and features.
16. What is laser beam welding? Write down its advantages and limitations.
17. Explain the following terms-
- a. WPS
 - b. PQR
 - c. WPQ
18. What is austenitic stainless steel and ferritic stainless steel? Explain in detail.



BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.:

School of Metal Construction Skills
Session: 2021-22 (Summer Semester)

B. Voc. Program, 3rd Semester,

End-Sem. Examination
Answer sheet

Set: A

Course Code: MCS1304

Course Name: Advanced Welding

Time: 2 Hours

Max. Marks: 50

Instruction:

1. Attempt all questions.
2. Use of Calculators is prohibited.
3. Section A contains 10 Questions. Each question carries 10 Marks.
4. Section B contains 04 Questions. Each question carries 16 Marks.
5. Section C contains 04 Questions. Each question carries 24 Marks.

Section – A

1. Which is a Stainless Steel type:
a) **Austenitic**
b) Low alloy
c) Ferritic-Martensitic
d) None of the Above

Ans. A

2. Which of the following joint have high corrosion resistance?
a) **Welding joint**
b) Riveted joint
c) Bolted joint
d) None of the above

Ans. A

3. Which of the following ray is not produced during welding?
a) **Gamma rays**
b) Visible light rays
c) Infrared ray
d) Ultra violet rays

Ans. A

4. Which of the following types is not fillet weld?
a) **butt joint**
b) lap joint
c) T-joint
d) Corner joint

Ans. A

5. ISO standard position for overhead fillet weld:
a) PA
b) PB
c) PC



Ans. D

d) PD

6. Which of the following is an example of fusion welding?

- a) Arc welding
- b) Forge welding
- c) Resistance welding
- d) Thermit welding with pressure

Ans. A

7. In which of the following process, heat is created by blacksmith fire

- a) Forge welding
- b) Spot welding
- c) Projection welding
- d) Seam welding

Ans. A

8. Which is not a factor of cold cracking:

- a) Presence of hydrogen
- b) Susceptible microstructure
- c) Tensile Strength
- d) None of the Above

Ans. D

9. What is full form of WPS?

- a) Welding Performance Specification
- b) Welding Procedure Specification
- c) Welder Performance Specification
- d) None of the Above

Ans. B

10. What are the percentage of carbon in low alloy steels?

- a) Less than 0.2%
- b) More than 0.2%
- c) Equal to 0.2%
- d) All of the Above

Ans. A

Section – B

04X04 = 16 Marks

11. What are the differences between PAW and TIG?

Ans.

Difference between TIG & PAW

PAW	TIG
<input type="checkbox"/> Two gases are used, One for Plasma Gas and	<input type="checkbox"/> Only one gas used, which forms plasma other for Shielding Gas, as well as shields the arc and molten weld pool.
<input type="checkbox"/> Uses Constricted Arc.	<input type="checkbox"/> Uses Non-Constricted Arc.
<input type="checkbox"/> Temp. of about 11000°C is achieved.	<input type="checkbox"/> Temp. of about 4000°C is achieved.
<input type="checkbox"/> Deep Penetration is achieved.	<input type="checkbox"/> Penetration obtained is not so deeper.
<input type="checkbox"/> No Filler Material is required.	<input type="checkbox"/> More Filler Material is required.
<input type="checkbox"/> Fast Metal Deposition Rate.	<input type="checkbox"/> Metal Deposition Rate is not so faster.
<input type="checkbox"/> Inert Gas Consumption is very high.	<input type="checkbox"/> Inert Gas Consumption is very low.
<input type="checkbox"/> Costly welding equipment.	<input type="checkbox"/> Less costly welding equipment.
<input type="checkbox"/> Cutting of Hard and Brittle Material is possible.	<input type="checkbox"/> Cutting of Hard and Brittle Material is not possible.



12. What do you understand by weldability of stainless steel?

Ans. Stainless steels are a group of high alloy steels that contain at least 12% chromium. In general, they are alloyed with a number of other elements that make them resistant to a variety of different environments. These elements also modify the microstructure of the alloy, which in turn has a distinct influence on their mechanical properties and weldability. Stainless steels can be broadly classified into five groups as detailed below:

- Austenitic stainless steels, which contain 12–27% chromium and 7–25% nickel.
- Ferritic stainless steels, which contain 12–30% chromium with a carbon content below 0.1%.
- Martensitic stainless steels, which have chromium content between 12 and 18% with 0.15–0.30% carbon.
- Ferritic-austenitic (Duplex) stainless steels, which contain 18–25% chromium, 3–5% nickel and up to 3% molybdenum.
- Martensitic-austenitic steels, which have 13–16% chromium, 5–6% nickel and 1–2% molybdenum.

The first three of these groups will be discussed in greater detail below.

13. What is preliminary welding procedure specification?

Ans. PWPS is essentially a guide for the person that is going to weld the PQR test coupon and it can also be used as a document to get in principal approval from the client. You give the client the change to review what you intend to do, ie. if I run the test like this and do this testing, will you be happy with it.

This is not always required, but it is specified in some standards. It can save heartache by ensuring the client is happy with the WPS at the end.

14. What are the effects of alloying elements and impurities in stainless steels?

Ans. **carbon (c)**

A strong austenite former

Added to some high-strength alloys for hardening and strengthening effects

Manganese (Mn)

Austenite former

Silicon (Si)

A ferrite former

used to increase the corrosion resistance of austenitic steels

used to improve high-temperature scaling resistance

used to improve resistance of high-temperature steels to carburization

Promotes wetting by weld metal at 0.8–1.0%

chromium (cr)

A ferrite former

Primary contributor to resistance to scaling and corrosion

12% chromium minimum essential for passivation

nickel (ni)

An austenite former

Provides good low temperature toughness

used to improve the general corrosion resistance against non-oxidizing liquids

Sometimes added in small amounts to straight chromium grades to improve the mechanical properties

Molybdenum (Mo)

A ferrite former

used to improve high-temperature strength and creep resistance

used to improve general corrosion resistance of steels in non-oxidizing media, and

resistance to pitting corrosion in all media

copper (cu)

used to improve corrosion resistance of stainless steel in environments that are reducing rather than oxidizing

niobium (nb)



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A strong carbide former. used to stabilize austenitic stainless steels against the harmful precipitation of chromium carbides in the range 480–820°C

A strong ferrite former

Added to some high strength alloys for hardening and strengthening effects

Added to some martensitic straight chromium stainless steels to tie up the carbon and hence reduce the hardening tendency of the steels

Section – C

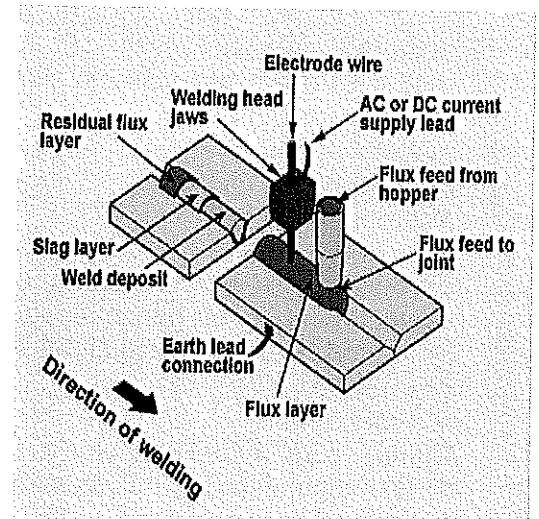
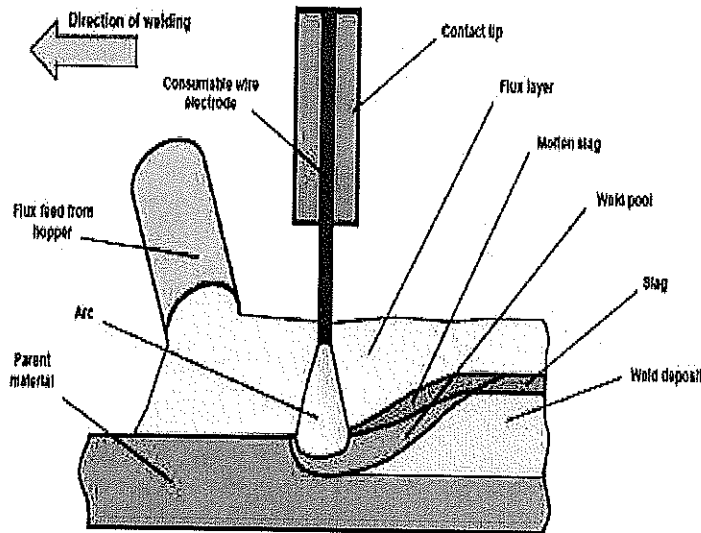
04X06 = 24 Marks

15. What is submerged arc welding? Explain its process and features.

- Ans. **Submerged arc welding (SAW)** is a method in which the heat required to fuse the metal is generated by an arc formed by an electric current passing between the electrode and the work piece
- There is no visible arc and no sparks, spatter or fume. The electrode may be a solid or cored wire or a strip.
- SAW is normally a mechanized process.

Process of SAW

- The molten weld and the arc zone are protected from atmospheric contamination by being "submerged" under a blanket of granular fusible flux.
- flux consists of lime, silica, manganese oxide, calcium fluoride, and other compounds.
- When molten, the flux becomes conductive, and provides a current path between the electrode and the work.
- This thick layer of flux completely covers the molten metal thus preventing spatter and sparks as well as suppressing the intense ultraviolet radiation and fumes that are a part of the shielded metal arc welding (SMAW) process



Feature of SAW

- **Flux Hopper** : It stores the flux and controls the rate of flux deposition on the welding joint.
- **Welding head** : It feeds flux and filler metal to the welding joint. Electrode (filler metal) gets energized here
- **Flux** : The granulated flux shields and thus protects molten weld from atmospheric contamination. The flux cleans weld metal and can modify its chemical composition also.
- **Electrode** : SAW filler material usually is a standard wire as well as other special forms. This wire normally has a thickness of 1.6 mm to 6 mm (1/16 in. to 1/4 in.). In certain circumstances, twisted wire can be used to give the arc an oscillating movement. This helps fuse the toe of the weld to the base metal. The electrode



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composition depends upon the material being welded. Alloying elements may be added in the electrodes. Electrodes are available to weld mild steels, high carbon steels, low and special alloy steels, stainless steel and some of the nonferrous of copper and nickel.

16. What is laser beam welding? Write down its advantages and limitations.

Ans. The term laser is an acronym for Light Amplification by Stimulated Emission of Radiation.

A laser beam is a powerful, narrow, monochromatic and directional beam of electromagnetic radiation.

Often, these beams are within the visible spectrum of light.

A laser device excites the atoms in a lasing medium. The electrons of these atoms move to a higher orbit, then release photons, creating a laser beam.

Advantages

- Low possibility of HAZ in the joint
- No need for filler metal
- Reduce Latency
- No tool wear
- LBW is not influenced by magnetic fields

Limitations

Joints must be accurately positioned

- Maximum weld penetration is limited (19-21mm)
- High reflectivity and high thermal conductivity of materials like Aluminum effect the weldability of the joint

17. Explain the following terms-

- a. WPS
- b. PQR
- c. WPQ

6. WPS is essentially a welder's guide that includes applicable code requirements and production standards. It controls the welding process.
7. It has been compared to a recipe for welders. When cooking a roast, the recipe includes all the ingredients you need, plus the actual steps you will need to make sure the roast works out right and is repeatable.
8. A WPS is very similar. It includes details on what you will need and the welding processes to follow that will create a sound weld. However, instead of listing type of meat, barbeque temperature, time you should for, a WPS lists information such as base metal grade, amps, volts and travel speed along with many other details.
9. The WPS is a proven process of welding and is important to ensure welding operators in the field are maintaining the same, required standards across the board. The mechanical properties of a weld cannot be verified in production welds after welding so control of the welding process using a WPS is critical.
10. If either a novice or experienced welder follow the WPS, they should be able to produce welds with similar mechanical properties. This helps new welders grow to the same level as experienced welders. It ensures clients are receiving serviceable welds that are the strength, toughness and soundness required by the design.
11. **A WPS always has ranges** to allow for joint and operator technique variation, it is unlikely every joint is the same or every welder uses the same technique. These ranges are different for every standard. The ranges are based on what is known as essential variables. Things which if changed require you to requalify the WPS.

b. PQR

All WPSs start with a PQR. It is a record of the test. It **DOES NOT have any ranges**. It lists the actual values recorded during the welding of a test piece. It proves the welding process.



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Then using the essential variables (ranges) from the relevant code/standard a WPS can be generated from this record of actual values.

PQR is essentially the 'actual' method that is used to create and test the welds to ensure they meet all applicable requirements.

The test procedures and final results are documented in the PQR. If the PQR meets the set standards of the welding world, then it will serve as the foundation on which one or more WPSs are drafted.

Even though a PQR eventually leads to a WPS, it is important for welders to have knowledge of both documents. In critical applications and in mechanised and automatic welds welders can refer to the PQR and replicate the actual values used in the test weld, this removes all the variation.

On face value, these documents look very similar but serve completely different purposes.

The best way to think of it is;

- PQR is an office document
- WPS is a workshop document

Both are necessary in most cases. The PQR supports the WPS as evidence of qualification.

C WPQ

While WPS and PQR are used to define and prove the welding process.

WQT/WPQ is used to test the actual welder. Is the welder able to produce a sound weld;

- With a particular welding process ie. GMAW or GTAW
- In a given position Horizontal, Vertical or Overhead
- On a particular joint configuration Butt weld or Fillet weld.

A WQT does not test the mechanical properties, it looks at weld soundness only in most cases.

A Welder Qualification Test is recorded on documentation known as a test certificate that details the ranges that welder is qualified. Ranges or essential variables for WQT are not always the same as those for a WPS. An example would be that is a welder can weld in the overhead position (more difficult) it is logical they be qualified in the flat position (less difficult).

The welder completes a test coupon under supervision following a WPS. The weld is then tested using the method prescribed in the relevant standard.

The testing always includes as a minimum visual examination but may also require;

1. Bend tests – root/face or sides
2. Macro test – cross section view of weld
3. Fillet weld break test
4. Nick Break
5. Radiographic examination
6. Ultrasonic examination

18. What is austenitic stainless steel and ferritic stainless steel? Explain in detail.

Ans. **Austenitic stainless steels**

This is by far the largest and most important group in the stainless steel range. These steels, which exhibit a high level of weldability, are available in a wide range of compositions such as the 19/9 AISI 304 types, 25/20 AISI310 types and 19/12/2 AISI316 types, which are used for general stainless steel fabrications, elevated temperature applications and resistance to pitting corrosion respectively.

As the name implies the microstructure of austenitic stainless steel consists entirely of fine grains of austenite in the wrought condition. When subjected to welding, however, a secondary ferrite phase may be formed on the austenite grain boundaries, in the heat affected zone and in the weld metals. The extent of the formation of this secondary phase may depend on the composition of the steel or filler material and the heat input during welding.



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While delta ferrite formation can have negative effects on the resistance to corrosion and formation of the sigma phase at Operating temperatures between 500 and 900°C, delta ferrite in weld metal is necessary to overcome the possibility of hot cracking (tearing).

In general, austenitic welding consumables deposit a weldment containing 4–12% delta ferrite. For special applications (i.e. when dissimilar steels are welded under conditions of high restraint), austenitic consumables having weld metal delta ferrite contents as high as 40% may be required. The delta ferrite content can be calculated by using the procedure given at the end of this section with the aid of the Schaeffler diagram.

The carbon content of austenitic stainless steels is kept at very low levels to overcome any possibility of carbide precipitation, where chromium combines with available carbon in the vicinity of the grain boundaries, to produce an area depleted in chromium, and thus becomes susceptible to inter-granular corrosion.

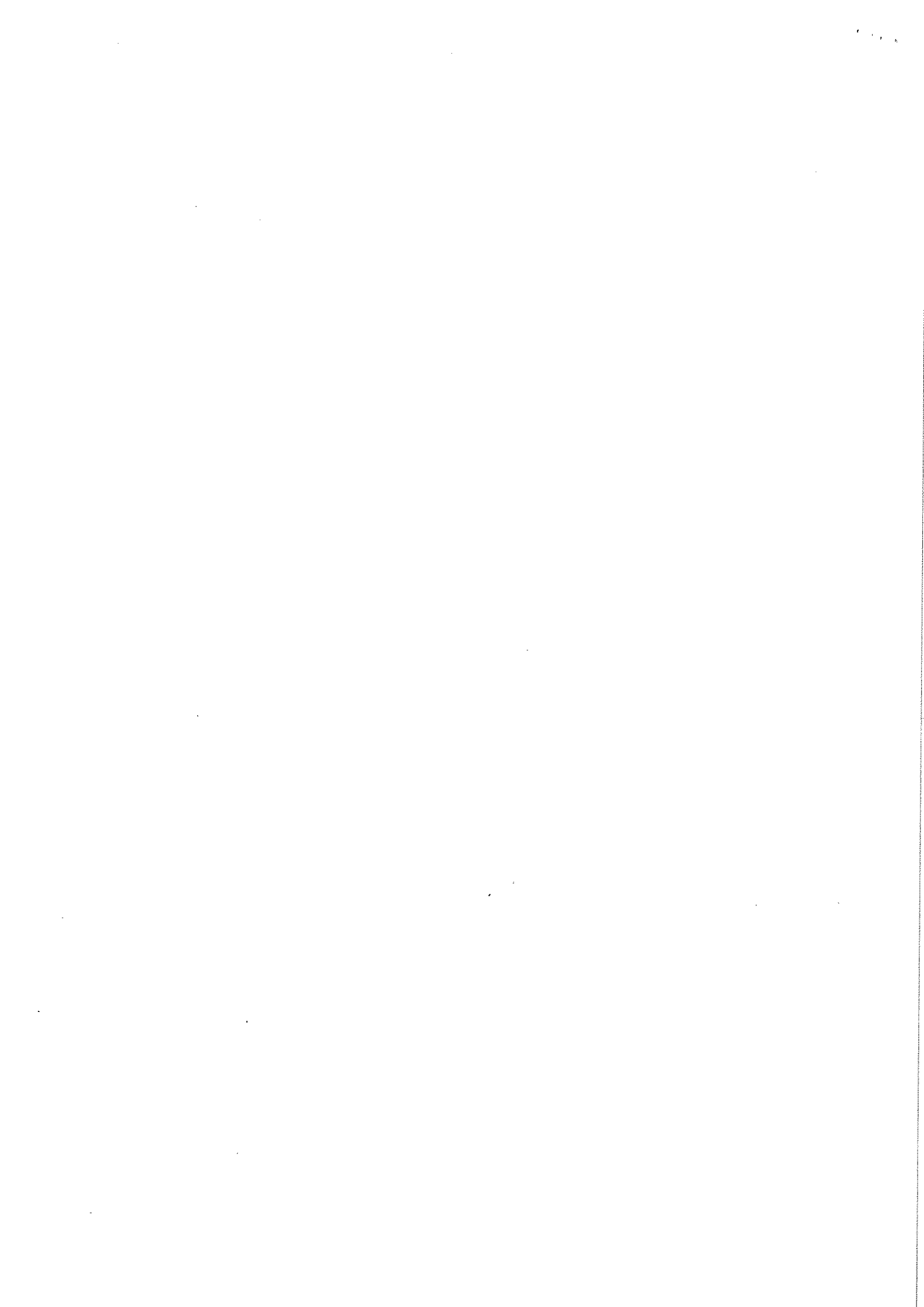
The titanium and niobium stabilized AISI 321 and 347 steels, together with ELC (extra low carbon) grades, are available to further overcome this problem.

Ferritic stainless steels

These steels, which contain 12–30% chromium with a carbon content below 0.10% do not exhibit the good weldability of the austenitic type. They become fully ferritic at high temperatures and undergo rapid grain growth, which leads to brittle, heat affected zones in the fabricated product. No refinement of this coarse structure is possible without cold working and recrystallization.

In addition, austenite formed at elevated temperatures may form martensitic upon transformation, which can cause cracking problems. The brittleness and poor ductility of these materials have limited their applications in the welded condition. Ferritic stainless steels are also subject to inter-granular corrosion as a result of chromium depletion from carbide precipitations. Titanium and niobium stabilized ferritic steels and steels with extra low interstitials (i.e. C,N) are available to overcome this problem.

As this material has a coefficient of expansion lower than that of carbon manganese steels, warpage and distortion during welding is considerably less. They are magnetic, however, and therefore subject to magnetic arc blow. Ferritic stainless steels cannot be hardened by conventional heat treatment processes.





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Registration No.:

School of Metal Construction Skills
Session: 2021-22 (Summer Semester)
B. Voc. Program, 3rd Semester,
End-Sem. Examination
Set: B

Course Code: MCS1304

Course Name: Advanced Welding

Time: 2 Hours

Max. Marks: 50

Instruction:

1. Attempt all questions.
2. Use of Calculators is prohibited.
3. Section A contains 10 Questions. Each question carries 10 Marks.
4. Section B contains 04 Questions. Each question carries 16 Marks.
5. Section C contains 04 Questions. Each question carries 24 Marks.

Section – A

1. Carbon is a
 - a) Austenitic Former
 - b) Ferrite Former
 - c) Martensitic Former
 - d) None of the Above
2. Which of the following joint have high corrosion resistance?
 - a) Welding joint
 - b) Riveted joint
 - c) Bolted joint
 - d) None of the above
3. Which of the following ray is not produced during welding?
 - a) Gamma rays
 - b) Visible light rays
 - c) Infrared ray
 - d) Ultra violet rays
4. The layer protects the aluminium against corrosion.
 - a) Carbide Layer
 - b) Oxide Layer
 - c) Nitride Layer
 - d) None of the Above
5. ISO standard position for overhead fillet weld:
 - a) PA
 - b) PB
 - c) PC
 - d) PD



6. Which of the following is an example of fusion welding?
- a) Arc welding
 - b) Forge welding
 - c) Resistance welding
 - d) Thermit welding with pressure
7. In which of the following process, heat is created by blacksmith fire
- a) Forge welding
 - b) Spot welding
 - c) Projection welding
 - d) Seam welding
8. What is the process number for TIG Welding?
- a) 121
 - b) 131
 - c) 141
 - d) None of the Above
9. What is full form of WPS?
- a) Welding Performance Specification
 - b) Welding Procedure Specification
 - c) Welder Performance Specification
 - d) None of the Above
10. What are the percentage of carbon in low alloy steels?
- a) Less than 0.2%
 - b) More than 0.2%
 - c) Equal to 0.2%
 - d) All of the Above

Section – B

04X04 = 16 Marks

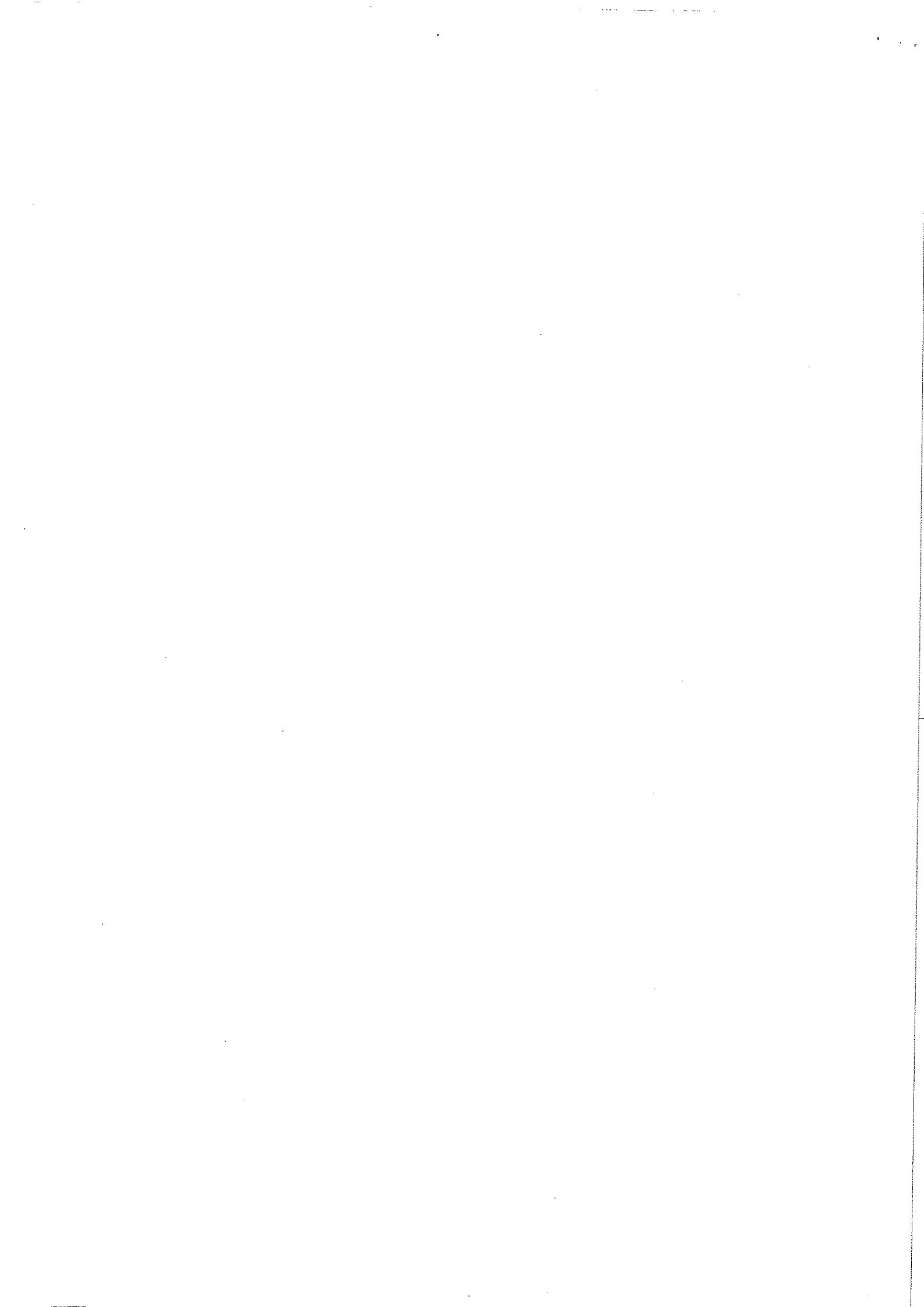
11. What is gas tungsten arc welding? Explain
12. What do you understand by weldability of stainless steel?
13. What is preliminary welding procedure specification?
14. Write short note on Martensitic stainless steel.



Section – C

04X06 = 24 Marks

15. What is gas metal arc welding? Explain in detail.
16. What is laser beam welding? Write down its advantages and limitations.
17. Explain the following terms-
 - a. WPS
 - b. PQR
 - c. WPQ
18. What is austenitic stainless steel and ferritic stainless steel? Explain in detail.





School of Metal Construction Skills
Session: 2021-22 (Summer Semester)

B. Voc. Program, 3rd Semester,

End-Sem. Examination

Answer sheet

Set: B

Course Code: MCS1304

Course Name: Advanced Welding

Time: 2 Hours

Max. Marks: 50

Instruction:

1. Attempt all questions.
2. Use of Calculators is prohibited.
3. Section A contains 10 Questions. Each question carries 10 Marks.
4. Section B contains 04 Questions. Each question carries 16 Marks.
5. Section C contains 04 Questions. Each question carries 24 Marks.

Section – A

1. Carbon is a

- a) Austenitic Former
- b) Ferrite Former
- c) Martensitic Former
- d) None of the Above

Ans. A

2. Which of the following joint have high corrosion resistance?

- a) **Welding joint**
- b) Riveted joint
- c) Bolted joint
- d) None of the above

Ans. A

3. Which of the following ray is not produced during welding?

- a) **Gamma rays**
- b) Visible light rays
- c) Infrared ray
- d) Ultra violet rays

Ans. A

4. The layer **protects the aluminium against corrosion.**

- a) Carbide Layer
- b) **Oxide Layer**
- c) Nitride Layer
- d) None of the Above

Ans. B



ISO standard position for overhead fillet weld:

- a) PA
- b) PB
- c) PC
- d) PD

Ans. D

6. Which of the following is an example of fusion welding?

- a) **Arc welding**
- b) Forge welding
- c) Resistance welding
- d) Thermit welding with pressure

Ans. A

7. In which of the following process, heat is created by blacksmith fire

- a) **Forge welding**
- b) Spot welding
- c) Projection welding
- d) Seam welding

Ans. A

8. What is the process number for TIG Welding?

- a) 121
- b) 131
- c) **141**
- d) None of the Above

Ans. C

9. What is full form of WPS?

- a) Welding Performance Specification
- b) **Welding Procedure Specification**
- c) Welder Performance Specification
- d) None of the Above

Ans. B

10. What are the percentage of carbon in low alloy steels?

- a) **Less than 0.2%**
- b) More than 0.2%
- c) Equal to 0.2%
- d) All of the Above

Ans. A

11. What is gas tungsten arc welding? Explain

Ans. Tungsten Inert Gas (TIG) welding uses the heat generated by an electric arc struck between a non-consumable tungsten electrode and the workpiece to fuse metal in the joint area and produce a molten weld pool. The arc area is shrouded in an inert or reducing gas shield to protect the weld pool and the non-consumable electrode. The process may be operated autogenously, that is, without filler, or filler may be added by feeding a consumable wire or rod into the established weld pool. TIG produces very high quality welds across a wide range of materials with thicknesses up to about 8 or 10mm. It is particularly well suited to sheet material.

The success of this welding process hinges on various factors such as the choice of shielding gas, welding wire, tungsten electrode and the welding technique.

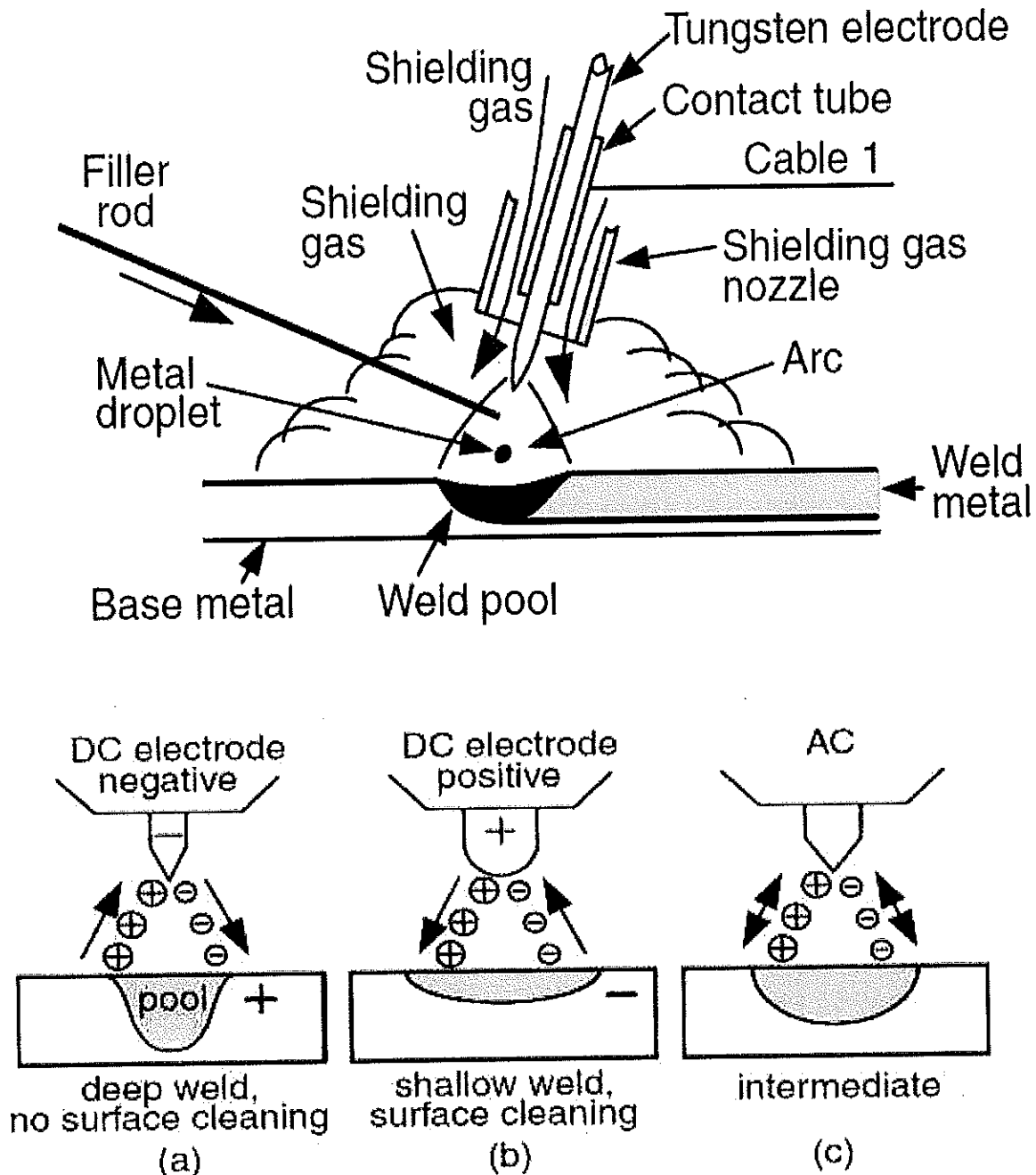


Figure 1.12 Three different polarities in GTAW.



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What do you understand by weldability of stainless steel?

Ans. Stainless steels are a group of high alloy steels that contain at least 12% chromium. In general, they are alloyed with a number of other elements that make them resistant to a variety of different environments. These elements also modify the microstructure of the alloy, which in turn has a distinct influence on their mechanical properties and weldability. Stainless steels can be broadly classified into five groups as detailed below:

- Austenitic stainless steels, which contain 12–27% chromium and 7–25% nickel.
- Ferritic stainless steels, which contain 12–30% chromium with a carbon content below 0.1%.
- Martensitic stainless steels, which have chromium content between 12 and 18% with 0.15–0.30% carbon.
- Ferritic-austenitic (Duplex) stainless steels, which contain 18–25% chromium, 3–5% nickel and up to 3% molybdenum.
- Martensitic-austenitic steels, which have 13–16% chromium, 5–6% nickel and 1–2% molybdenum.

The first three of these groups will be discussed in greater detail below.

13. What is preliminary welding procedure specification?

Ans. PWPS is essentially a guide for the person that is going to weld the PQR test coupon and it can also be used as a document to get in principal approval from the client. You give the client the change to review what you intend to do, ie. if I run the test like this and do this testing, will you be happy with it.

This is not always required, but it is specified in some standards. It can save heartache by ensuring the client is happy with the WPS at the end.

14. Write short note on Martensitic stainless steel.

Ans. Martensitic stainless steels contain between 12 and 18% chromium with 0.15–0.30% carbon. Because of their composition, these steels are capable of air hardening and thus special precautions should be taken during welding to overcome possible cracking. Cold cracking as a result of hydrogen, which is experienced with low alloy steels, can also occur in martensitic stainless steels and thus hydrogen-controlled consumables should be used.

Martensitic steels, because of their lower chromium content and responsiveness to heat treatment, have limited applications for corrosion resistance but are successfully used where their high strength and increased hardness can be utilized (e.g. turbine blades, cutlery, shafts etc.).

As in the case of ferritic stainless steels, the martensitic types have a lower coefficient of expansion than mild steels and are magnetic.

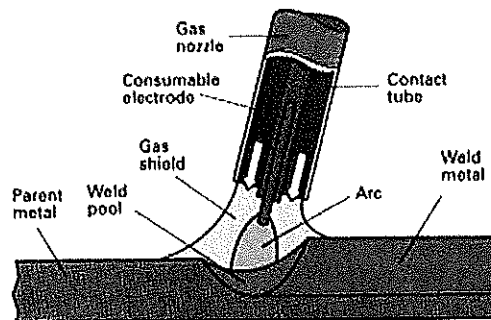
Section – C

04X06 = 24 Marks

15. What is gas metal arc welding? Explain in detail.

Ans. **Metal Inert Gas (MIG) welding is an arc welding process that uses a continuous solid wire electrode heated and fed into the weld pool from a welding gun. The two base materials are melted together forming a join. The gun feeds a shielding gas alongside the electrode helping protect the weld pool from airborne contaminants.**

Metal Inert Gas (MIG) welding was first patented in the USA in 1949 for welding aluminium. The arc and weld pool formed using a bare wire electrode was protected by helium gas, readily available at that time. From about 1952, the process became popular in the UK for welding aluminium using argon as the shielding gas, and for carbon steels using CO₂. CO₂ and argon-CO₂ mixtures are known as metal active gas (MAG) processes. MIG is an attractive alternative to MMA, offering high deposition rates and high productivity.



Process Characteristics

MIG/MAG welding is a versatile technique suitable for both thin sheet and thick section components. An arc is struck between the end of a wire electrode and the workpiece, melting both of them to form a weld pool. The wire serves as both heat source (via the arc at the wire tip) and filler metal for the welding joint. The wire is fed through a copper contact tube (contact tip) which conducts welding current into the wire. The weld pool is protected from the surrounding atmosphere by a shielding gas fed through a nozzle surrounding the wire. Shielding gas selection depends on the material being welded and the application. The wire is fed from a reel by a motor drive, and the welder moves the welding torch along the joint line. Wires may be solid (simple drawn wires), or cored (composites formed from a metal sheath with a powdered flux or metal filling). Consumables are generally competitively priced compared with those for other processes. The process offers high productivity, as the wire is continuously fed.

Manual MIG/MAG welding is often referred as a semi-automatic process, as the wire feed rate and arc length are controlled by the power source, but the travel speed and wire position are under manual control. The process can also be mechanised when all the process parameters are not directly controlled by a welder, but might still require manual adjustment during welding. When no manual intervention is needed during welding, the process can be referred to as automatic.



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The process usually operates with the wire positively charged and connected to a power source delivering a constant voltage. Selection of wire diameter (usually between 0.6 and 1.6mm) and wire feed speed determine the welding current, as the burn-off rate of the wire will form an equilibrium with the feed speed

16. What is laser beam welding? Write down its advantages and limitations.

17. Explain the following terms-

a. WPS

b. PQR

c. WPQ

a. WPS-

6. WPS is essentially a welder's guide that includes applicable code requirements and production standards. It controls the welding process.

7. It has been compared to a recipe for welders. When cooking a roast, the recipe includes all the ingredients you need, plus the actual steps you will need to make sure the roast works out right and is repeatable.

8. A WPS is very similar. It includes details on what you will need and the welding processes to follow that will create a sound weld. However, instead of listing type of meat, barbeque temperature, time you should for, a WPS lists information such as base metal grade, amps, volts and travel speed along with many other details.

9. The WPS is a proven process of welding and is important to ensure welding operators in the field are maintaining the same, required standards across the board. The mechanical properties of a weld cannot be verified in production welds after welding so control of the welding process using a WPS is critical.

10. If either a novice or experienced welder follow the WPS, they should be able to produce welds with similar mechanical properties. This helps new welders grow to the same level as experienced welders. It ensures clients are receiving serviceable welds that are the strength, toughness and soundness required by the design.

11. **A WPS always has ranges** to allow for joint and operator technique variation, it is unlikely every joint is the same or every welder uses the same technique. These ranges are different for every standard. The ranges are based on what is known as essential variables. Things which if changed require you to requalify the WPS.

b. PQR

All WPSs start with a PQR. It is a record of the test. It **DOES NOT have any ranges**. It lists the actual values recorded during the welding of a test piece. It proves the welding process.

Then using the essential variables (ranges) from the relevant code/standard a WPS can be generated from this record of actual values.

PQR is essentially the 'actual' method that is used to create and test the welds to ensure they meet all applicable requirements.



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The test procedures and final results are documented in the PQR. If the PQR meets the set standards of the welding world, then it will serve as the foundation on which one or more WPSs are drafted.

Even though a PQR eventually leads to a WPS, it is important for welders to have knowledge of both documents. In critical applications and in mechanised and automatic welds welders can refer to the PQR and replicate the actual values used in the test weld, this removes all the variation.

On face value, these documents look very similar but serve completely different purposes.

The best way to think of it is;

- PQR is an office document
- WPS is a workshop document

Both are necessary in most cases. The PQR supports the WPS as evidence of qualification.

C WPQ

While WPS and PQR are used to define and prove the welding process.

WQT/WPQ is used to test the actual welder. Is the welder able to produce a sound weld;

- With a particular welding process ie. GMAW or GTAW
- In a given position Horizontal, Vertical or Overhead
- On a particular joint configuration Butt weld or Fillet weld.

A WQT does not test the mechanical properties, it looks at weld soundness only in most cases.

A Welder Qualification Test is recorded on documentation known as a test certificate that details the ranges that welder is qualified. Ranges or essential variables for WQT are not always the same as those for a WPS. An example would be that is a welder can weld in the overhead position (more difficult) it is logical they be qualified in the flat position (less difficult).

The welder completes a test coupon under supervision following a WPS. The weld is then tested using the method prescribed in the relevant standard.

The testing always includes as a minimum visual examination but may also require;

1. Bend tests – root/face or sides
2. Macro test – cross section view of weld
3. Fillet weld break test
4. Nick Break
5. Radiographic examination
6. Ultrasonic examination



18. What is austenitic stainless steel and ferritic stainless steel? Explain in detail.

Ans. . **Austenitic stainless steels**

This is by far the largest and most important group in the stainless steel range.

These steels, which exhibit a high level of weldability, are available in a wide range of compositions such as the 19/9 AISI 304 types, 25/20 AISI310 types and 19/12/2 AISI316 types, which are used for general stainless steel fabrications, elevated temperature applications and resistance to pitting corrosion respectively.

As the name implies the microstructure of austenitic stainless steel consists entirely of fine grains of austenite in the wrought condition. When subjected to welding, however, a secondary ferrite phase may be formed on the austenite grain boundaries, in the heat affected zone and in the weld metals. The extent of the formation of this secondary phase may depend on the composition of the steel or filler material and the heat input during welding.

While delta ferrite formation can have negative effects on the resistance to corrosion and formation of the sigma phase at Operating temperatures between 500 and 900°C, delta ferrite in weld metal is necessary to overcome the possibility of hot cracking (tearing).

In general, austenitic welding consumables deposit a weldment containing 4–12% delta ferrite. For special applications (i.e. when dissimilar steels are welded under conditions of high restraint), austenitic consumables having weld metal delta ferrite contents as high as 40% may be required. The delta ferrite content can be calculated by using the procedure given at the end of this section with the aid of the Schaeffler diagram.

The carbon content of austenitic stainless steels is kept at very low levels to overcome any possibility of carbide precipitation, where chromium combines with available carbon in the vicinity of the grain boundaries, to produce an area depleted in chromium, and thus becomes susceptible to inter-granular corrosion.

The titanium and niobium stabilized AISI 321 and 347 steels, together with ELC(extra low carbon) grades, are available to further overcome this problem.

Ferritic stainless steels

These steels, which contain 12–30% chromium with a carbon content below 0.10% do not exhibit the good weldability of the austenitic type. They become fully ferritic at high temperatures and undergo rapid grain growth, which leads to brittle, heat affected zones in the fabricated product. No refinement of this coarse structure is possible without cold working and recrystallization.

In addition, austenite formed at elevated temperatures may form martensitic upon transformation, which can cause cracking problems. The brittleness and poor ductility of these materials have limited their applications in the welded condition.

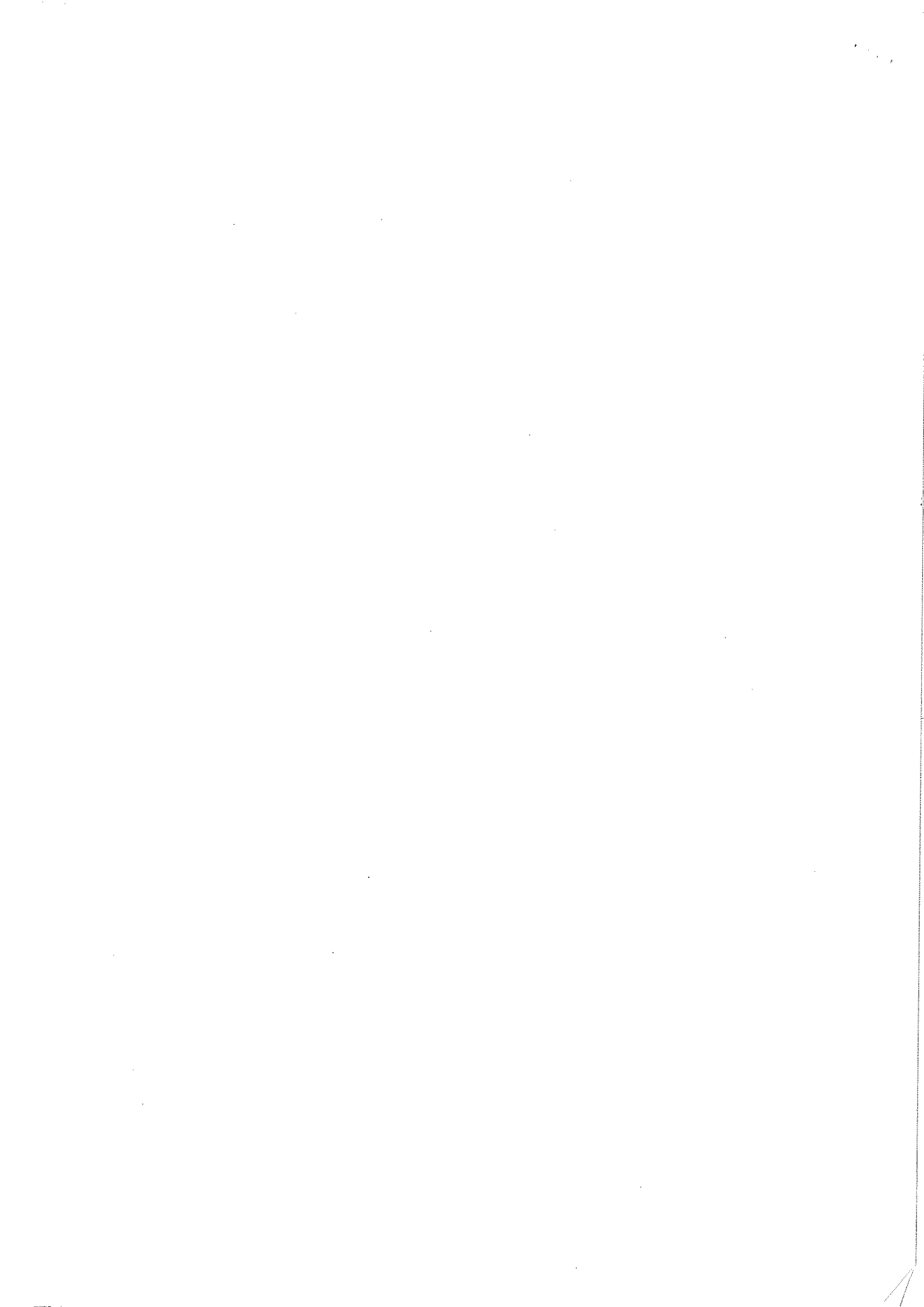


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Ferritic stainless steels are also subject to inter-granular corrosion as a result of chromium depletion from carbide precipitations. Titanium and niobium stabilized ferritic steels and steels with extra low interstitials (i.e. C,N) are available to overcome this problem.

As this material has a coefficient of expansion lower than that of carbon manganese steels, warpage and distortion during welding is considerably less. They are magnetic, however, and therefore subject to magnetic arc blow. Ferritic stainless steels cannot be hardened by conventional heat treatment processes.

A handwritten signature in black ink, consisting of a large, stylized 'B' followed by a series of loops and a long, sweeping underline.





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Registration No.:

School of Metal Construction Skills
Session: 2021-22 (Summer Semester)
B. Voc. Program, 3rd Semester,
End-Sem. Examination

Set-A

Course Code: MCS1306
Course Name: Material Science

Time: 2 Hour
Max. Marks: 50

Instruction:

1. Attempt all questions.
2. Section A contains 10 Questions. Each question carries 1 Marks.
3. Section B contains 04 Questions. Each question carries 4 Marks.
4. Section C contains 04 Questions. Each question carries 6 Marks.

Section – A

10X01 = 10 Marks

Q1. What is the atomic number of Iron in periodic table?

- | | |
|-------|-------|
| a) 12 | b) 25 |
| c) 26 | d) 28 |

Q.2 What is the atomic number of aluminium?

- | | |
|-------|-------|
| a)15 | b) 20 |
| c) 30 | d) 13 |

Q.3 He, Ne, Ar, are the -----

- | | |
|------------------|------------------------|
| a) Alkali metals | b) Alkali earth metals |
| c) Noble gases | d) Halogens |

Q.4 What is the atomic number of the Carbon?

- | | |
|------|------|
| a)5 | b) 2 |
| c) 3 | d) 6 |

Q.5 What is the atomic number of the Oxygen?

- | | |
|------|------|
| a) 8 | b) 2 |
| c) 9 | d) 3 |

Q.6 What has the highest density?

- | | |
|------------|---------------|
| a) Metal | b) Ceramic |
| c) Polymer | d) Composites |

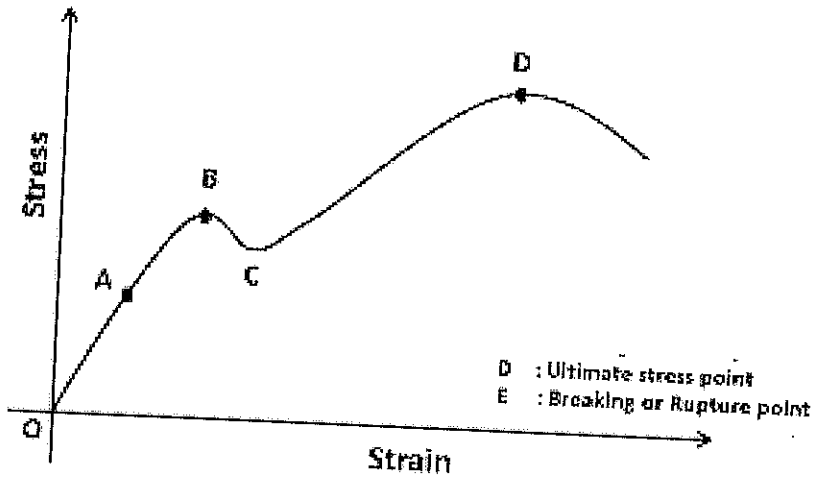
Q.7 What is the unit of the stress?

- | | |
|----------------------|--------|
| a) Pa | b) bar |
| c) N/mm ² | d) N |

Q.8 What is the unit of the strain?

- a) Unit less
- b) bar
- c) N/mm²
- d) N

Q.9 In the given figure, what denotes 'OA'?



- a) Proportional Limit
- b) Elastic limit
- c) Yield Stress point
- d) Ultimate stress point

Q.10 9xxx series is for which steels?

- a) Carbon Steels
- b) Nickel Steels
- c) Chromium Steel
- d) Silicon-manganese steels

Section – B

04X04 = 16 Marks

Q1 Define material science.

Q.2 Define material.

Q.3 What is element?

Q.4 Classify the material based on the structure.



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Section – C

04X06 = 24 Marks

Q1 Classify engineering materials. Explain metals in detail.

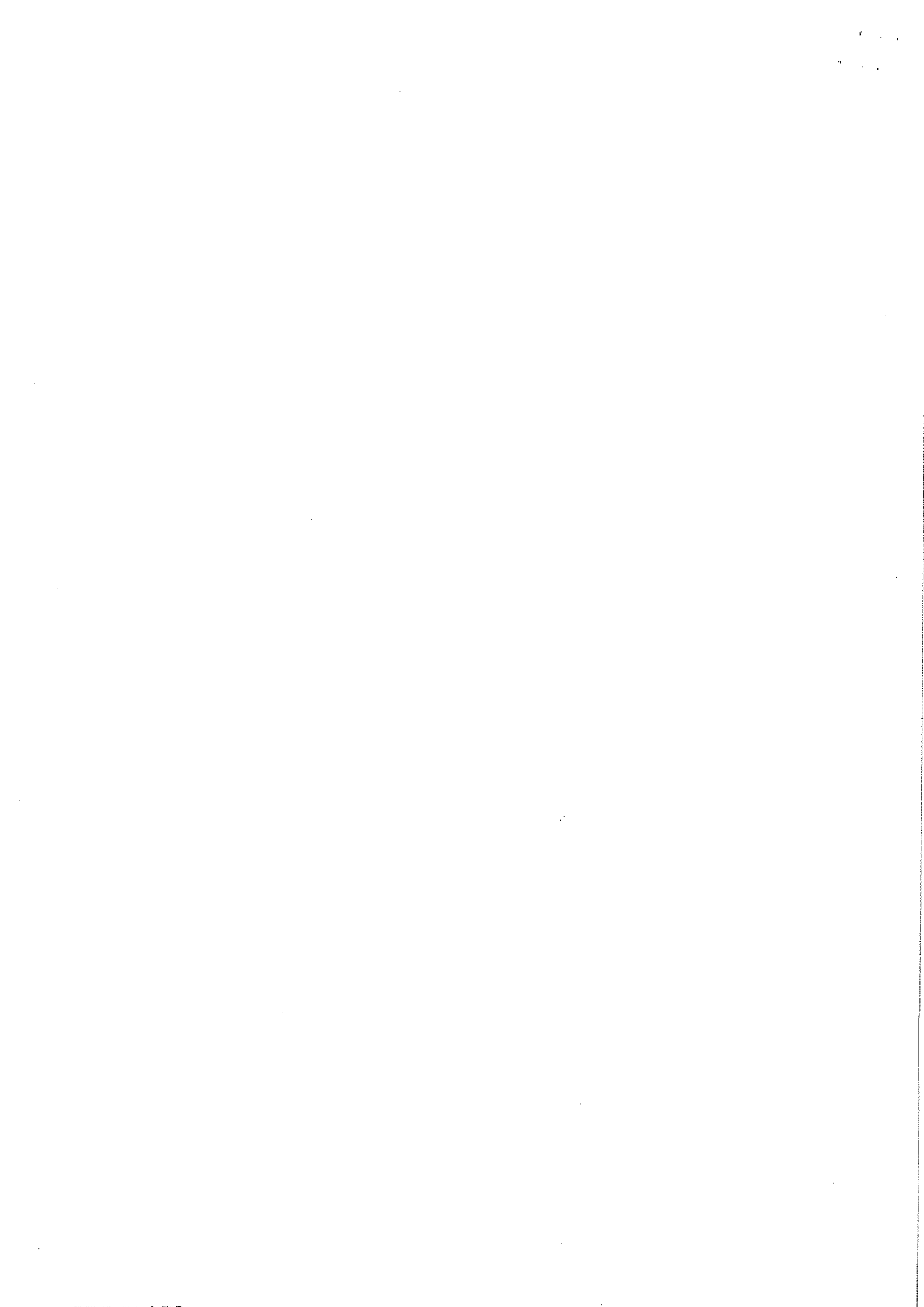
Q.2 Explain stress- strain curve.

Q.3 Explain the following physical properties of materials.

1. Density
2. Hardness
3. Toughness

Q.4 Explain the following chemical properties of materials.

1. Toxicity
2. Radioactivity
3. Chemical stability





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Registration No.:

**School of Metal Construction Skills
Session: 2021-22 (Summer Semester)**

**B. Voc. Program, 3rd Semester,
End-Sem. Examination**

Set-A

Course Code: MCS1306

Time: 2 Hour

Course Name: Material Science

Max. Marks: 50

Instruction:

1. Attempt all questions.
2. Section A contains 10 Questions. Each question carries 1 Marks.
3. Section B contains 04 Questions. Each question carries 4 Marks.
4. Section C contains 04 Questions. Each question carries 6 Marks.

Section – A

10X01 = 10 Marks

Q1. What is the atomic number of Iron in periodic table?

- | | |
|-------|-------|
| a) 12 | b) 25 |
| c) 26 | d) 28 |

Ans. c) 26

Q.2 What is the atomic number of aluminium?

- | | |
|-------|-------|
| a) 15 | b) 20 |
| c) 30 | d) 13 |

Ans. d) 13

Q.3 He, Ne, Ar, are the -----

- | | |
|------------------|------------------------|
| a) Alkali metals | b) Alkali earth metals |
| c) Noble gases | d) Halogens |

Ans. c) Noble gases

Q.4 What is the atomic number of the Carbon?

- | | |
|------|------|
| a) 5 | b) 2 |
| c) 3 | d) 6 |

Ans. d) 6

Q.5 What is the atomic number of the Oxygen?

- | | |
|------|------|
| a) 8 | b) 2 |
| c) 9 | d) 3 |

Ans. a) 8

Q.6 What has the highest density?

- a) Metal
 b) Ceramic
 c) Polymer
 d) Composites

Ans. a) Metal

Q.7 What is the unit of the stress?

- a) Pa
 b) bar
 c) N/mm²
 d) N

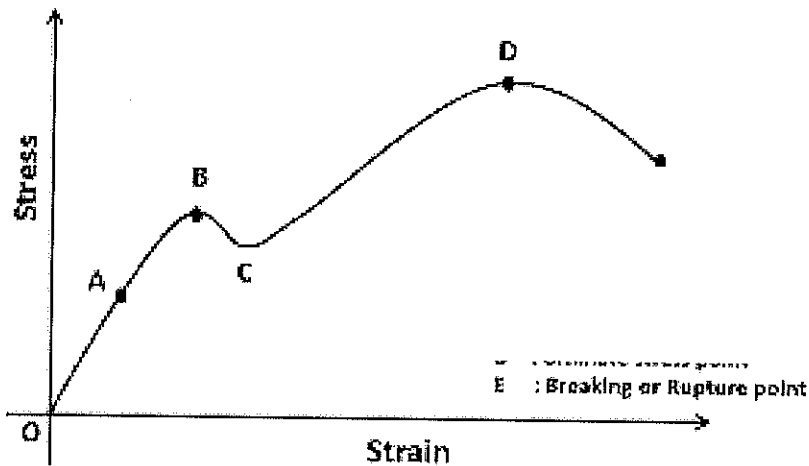
Ans. c) N/mm²

Q.8 What is the unit of the strain?

- a) Unit less
 b) bar
 c) N/mm²
 d) N

Ans. a) Unit less

Q.9 In the given figure, what denotes 'OA'?



- a) Proportional Limit
 b) Elastic limit
 c) Yield Stress point
 d) Ultimate stress point

Ans. a) Proportional Limit

Q.10 9xxx series is for which steels?

- a) Carbon Steels
 b) Nickel Steels
 c) Chromium Steel
 d) Silicon-manganese steels

Ans. d) Silicon-manganese steels

Section – B

04X04 = 16 Marks

Q11 Define material science.

- Ans. 1. The scientific study of the properties and applications of materials of construction or manufacture (such as ceramics, metals, polymers, and composites).
 2. Materials science is an interdisciplinary field involving the properties of matter and its applications to various areas of science and engineering. It includes elements of



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applied physics and chemistry, as well as chemical, mechanical, civil and electrical engineering. With significant media attention to nanoscience and nanotechnology in the recent years, materials science has been propelled to the forefront at many universities, sometimes controversially.

Q.12 Define material.

Ans. A **material** is a substance or mixture of substances that constitutes an object. Materials can be pure or impure, living or non-living matter.

Q.13 What is element?

Ans. An element is a substance that is made entirely from one type of atom.

Q.14 Classify the material based on the structure.

Ans. Materials can be either

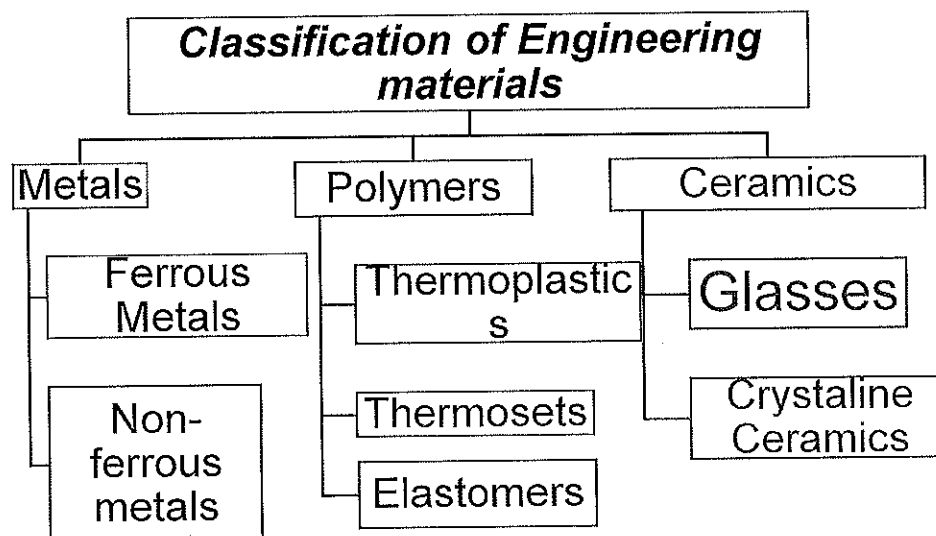
1. **Crystalline** (where they have a repeating grid-like structure) or
A crystal or crystalline solid is a solid material whose constituents (such as atoms, molecules, or ions) are arranged in a highly ordered microscopic structure, forming a crystal lattice that extends in all directions.
2. **Amorphous** (where the elements don't have a repetition in their structure).

Section – C

04X06 = 24 Marks

Q15 Classify engineering materials. Explain metals in detail.

Ans. Classification of Engineering Materials:



Metals: -

Metals have good electrical and thermal conductivity and capable of malleable (*able to be hammered or pressed into shape without breaking or cracking*).

In periodic table out of 118 elements, 90 are metals only. See the periodic table for the metals.

Ferrous Metals

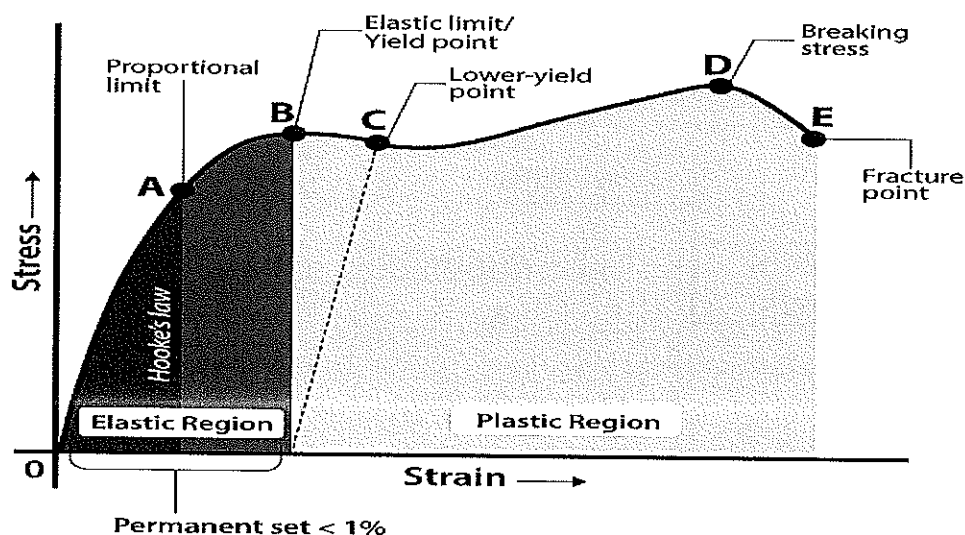
Ferrous metals are rich in iron. Iron such as cast iron wrought iron, steel is the main constituents in ferrous metals. Ferrous metals are magnetic and capable of little resistance to the corrosion too.

Examples for ferrous metals are cast iron, carbon steels, alloy steels, stainless steels, tool steels and die steels. Non-Ferrous Metals: -

Non-ferrous metals include aluminium, copper, lead, zinc and tin, as well as precious metals like gold and silver. Their main advantage over ferrous materials is their malleability. They also have no iron content, giving them a higher resistance to rust and corrosion, and making them ideal for gutters, liquid pipes, roofing and outdoor signs. Lastly, they are non-magnetic, which is important for many electronic and wiring applications.

Q.16 Explain stress- strain curve.

Ans. The stress-strain relationship for materials is given by the material's stress-strain curve. Under different loads, the stress and corresponding strain values are plotted. An example of a stress-strain curve is given below.





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The stress-strain graph has different points or regions as follows:

- Proportional limit
- Elastic limit
- Yield point
- Ultimate stress point
- Fracture or breaking point

(i) Proportional Limit

It is the region in the stress-strain curve that obeys Hooke's Law. In this limit, the ratio of stress with strain gives us proportionality constant known as young's modulus. The point OA in the graph is called the proportional limit.

(ii) Elastic Limit

It is the point in the graph up to which the material returns to its original position when the load acting on it is completely removed. Beyond this limit, the material doesn't return to its original position and a plastic deformation starts to appear in it.

(iii) Yield Point

The yield point is defined as the point at which the material starts to deform plastically. After the yield point is passed, permanent plastic deformation occurs. There are two yield points (i) upper yield point (ii) lower yield point.

(iv) Ultimate Stress Point

It is a point that represents the maximum stress that a material can endure before failure. Beyond this point, failure occurs.

(v) Fracture or Breaking Point

It is the point in the stress-strain curve at which the failure of the material takes place.

Q.17 Explain the following physical properties of materials.

1. Density
2. Hardness
3. Toughness

Ans. 1. Density



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Density, often expressed as pounds per cubic inch, or grams per cubic centimeter, etc., describes the mass of the alloy per unit volume. SI unit of density is Kg/M^3 . The density of the alloy will determine how much a component of a certain size will weigh. This factor is important in applications like aerospace or automotive where weight is important. Engineers looking for lower weight components may seek alloys that are less dense, but must then consider the strength to weight ratio. A higher density material like steel might be chosen, for example, if it provides higher strength than a lower density material. Such a part could be made thinner so that less material could help compensate for the higher density.

2. Hardness

Hardness is defined as a material's ability to resist permanent indentation (that is plastic deformation). Typically, the harder the material, the better it resists wear or deformation. The term hardness, thus, also refers to local surface stiffness of a material or its resistance to scratching, abrasion, or cutting. Hardness is measured by employing such methods as Brinell, Rockwell, and Vickers, which measure the depth and area of a depression by a harder material, including a steel ball, diamond, or other indenter.

3. Toughness

Measured using the Charpy impact test similar to Impact Resistance, toughness represents a material's ability to absorb impact without fracturing at a given temperature. Since impact resistance is often lower at low temperatures, materials may become more brittle. Charpy values are commonly prescribed in ferrous alloys where the possibilities of low temperatures exist in the application (e.g., offshore oil platforms, oil pipelines, etc.) or where instantaneous loading is a consideration (e.g., ballistic containment in military or aircraft applications).

Q.18 Explain the following chemical properties of materials.

1. Toxicity
2. Radioactivity
3. Chemical stability

Ans.

1. Toxicity

How much a substance can damage an animal, plant, cell, organ, or other organism is its toxicity. Materials with the chemical property of toxicity include lead, chlorine gas, hydrofluoric acid, and mercury. Toxicity is measured by how the lead, chlorine gas, mercury, or other substance affects the organism – basically, by how much damage it does to the



organism and how quickly that damage occurs.

For example, lead is a toxic substance that can damage various parts of the human body, including bones, the heart, kidneys, intestines, and the nervous and reproductive systems.

2. Radioactivity

- The emission of radiation from an atom with an unstable nucleus, is a chemical property. On the periodic table of elements, the elements that have no stable isotopes are considered radioactive.

Some of the most radioactive elements are hydrogen, beryllium, carbon, calcium, cobalt, zinc and iron.

3. Chemical stability

This chemical property in a given environment, also referred to as thermodynamic stability of a chemical system, refers to the stability that takes place when a chemical system is in its lowest energy state – a state of chemical equilibrium, or balance, with its environment.

This equilibrium will last indefinitely unless something happens to change the system.

Half-life - This chemical property is the amount of time it will take for half of the original substance to decay.

It is used in nuclear chemistry and nuclear physics to describe the time required for half of the unstable radioactive atoms in a sample to experience radioactive decay.



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Registration No.:

School of Metal Construction Skills
Session: 2021-22 (Summer Semester)

B. Voc. Program, 3rd Semester,
End-Sem. Examination

Set-B

Course Code: MCS1306

Time: 2 Hour

Course Name: Material Science

Max. Marks: 50

Instruction:

1. Attempt all questions.
2. Section A contains 10 Questions. Each question carries 1 Marks.
3. Section B contains 04 Questions. Each question carries 4 Marks.
4. Section C contains 04 Questions. Each question carries 6 Marks.

Section – A

10X01 = 10 Marks

Q.1 1xxx series is for which steels?

- | | |
|-------------------|-----------------------------|
| a) Carbon Steels | b) Nickel Steels |
| c) Chromium Steel | d) Silicon-manganese steels |

Q.2 Which material is used for the manufacturing of reactor pressure vessel?

- | | |
|----------|-----------|
| a) SS304 | b) SS304L |
| c) SS308 | d) SS316L |

Q. 3 A homogeneous portion of a system that has uniform physical and chemical characteristics is called?

- | | |
|---------------------|--------------|
| a) Solubility limit | b) component |
| c) Phase | d) System |

Q. 4 How many variables are there in Binary Phase Diagram?

- | | |
|------|------|
| a) 1 | b) 2 |
| c) 3 | d) 4 |

Q. 5 What is the melting point of aluminium?

- | | |
|------------|------------|
| a) 2000 °C | b) 3000 °C |
| c) 200 °C | d) 660 °C |

Q. 6 What is the melting point of copper?

- | | |
|------------|------------|
| a) 2000 °C | b) 3000 °C |
| c) 200 °C | d) 1085 °C |

Q.7 What is the chemical formula of IRON-CARBIDE?



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Registration No.:

School of Metal Construction Skills
Session: 2021-22 (Summer Semester)

B. Voc. Program, 3rd Semester,
End-Sem. Examination

Set-B

Course Code: MCS1306

Time: 2 Hour

Course Name: Material Science

Max. Marks: 50

Instruction:

1. Attempt all questions.
2. Section A contains 10 Questions. Each question carries 1 Marks.
3. Section B contains 04 Questions. Each question carries 4 Marks.
4. Section C contains 04 Questions. Each question carries 6 Marks.

Section – A

10X01 = 10 Marks

Q.1 1xxx series is for which steels?

- | | |
|-------------------|-----------------------------|
| a) Carbon Steels | b) Nickel Steels |
| c) Chromium Steel | d) Silicon-manganese steels |

Ans. a) Carbon Steels

Q.2 Which material is used for the manufacturing of reactor pressure vessel?

- | | |
|----------|-----------|
| a) SS304 | b) SS304L |
| c) SS308 | d) SS316L |

Ans. d) SS316L

Q. 3 A homogeneous portion of a system that has uniform physical and chemical characteristics is called?

- | | |
|---------------------|--------------|
| a) Solubility limit | b) component |
| c) Phase | d) System |

Ans. c) Phase

Q. 4 How many variables are there in Binary Phase Diagram?

- | | |
|------|------|
| a) 1 | b) 2 |
| c) 3 | d) 4 |

Ans. b) 2

Q. 5 What is the melting point of aluminium?

- | | |
|------------|------------|
| a) 2000 °C | b) 3000 °C |
| c) 200 °C | d) 660 °C |



- Covalent Bonding
- Metallic Bonding

Q.13 Write down the types of Secondary or Van Der Waals Bonds.

Ans.

SECONDARY BONDING OR VAN DER WAALS BONDING

- Fluctuating Induced Dipole Bonds
- Polar Molecule-Induced Dipole Bonds
- Permanent Dipole Bonds

Q.14 Explain the body centered Crystal Structure.

Ans. In body centered crystal structure, one atom is placed at each corner of the unit cell like a simple cubic crystal structure but, in addition to this, there is one atom at the center of the unit cell. A body-centered crystal structure is more complex as compared to the simple cubic crystal structure.

Center atom in the body centered crystal structure does not come in contact with another atom, hence it remains unshared. An average number of atoms per unit cell in body centered crystal structure is two. Metals like Li, K, Na, V, Ta, etc. has this type of crystal structure.

Section – C

04X06 = 24 Marks

Q.15 Explain the following Optical properties.

1. Refraction
2. Reflection
3. Absorption

Ans.

1. Refraction

When light photons are transmitted through a material, they causes polarization of the electrons in the material and by interacting with the polarized materials, photons lose some of their energy. As a result of this, the speed of light is reduced and the beam of light changes direction

2. Reflection:

When a beam of photons strikes a material, some of the light is scattered at the interface between that we media even if both are transparent. Reflectivity, R, is a measure of fraction of incident light which is reflected at the interface.

3. Absorption:



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When a light beam is strike on a material surface, portion of the incident beam that is not reflected by the material is either absorbed or transmitted through the material. The fraction of beam that is absorbed is related to the thickness of the materials and the manner in which the photons interact with the material's structure.

Q.16 What is the phase diagram? Explain the solubility limit.

Ans. Phase diagram - Phase diagram is a graphical representation of the physical states of a substance under different conditions of temperature and pressure. A typical phase diagram has pressure on the y-axis and temperature on the x-axis. As we cross the lines or curves on the phase diagram, a phase change occurs. In addition, two states of the substance coexist in equilibrium on the lines or curves.

SOLUBILITY LIMIT

For many alloy systems and at some specific temperature, there is a maximum concentration of solute atoms that may dissolve in the solvent to form a solid solution; this is called a **solubility limit**. The addition of solute in excess of this solubility limit results in the formation of another solid solution or compound that has a distinctly different composition.

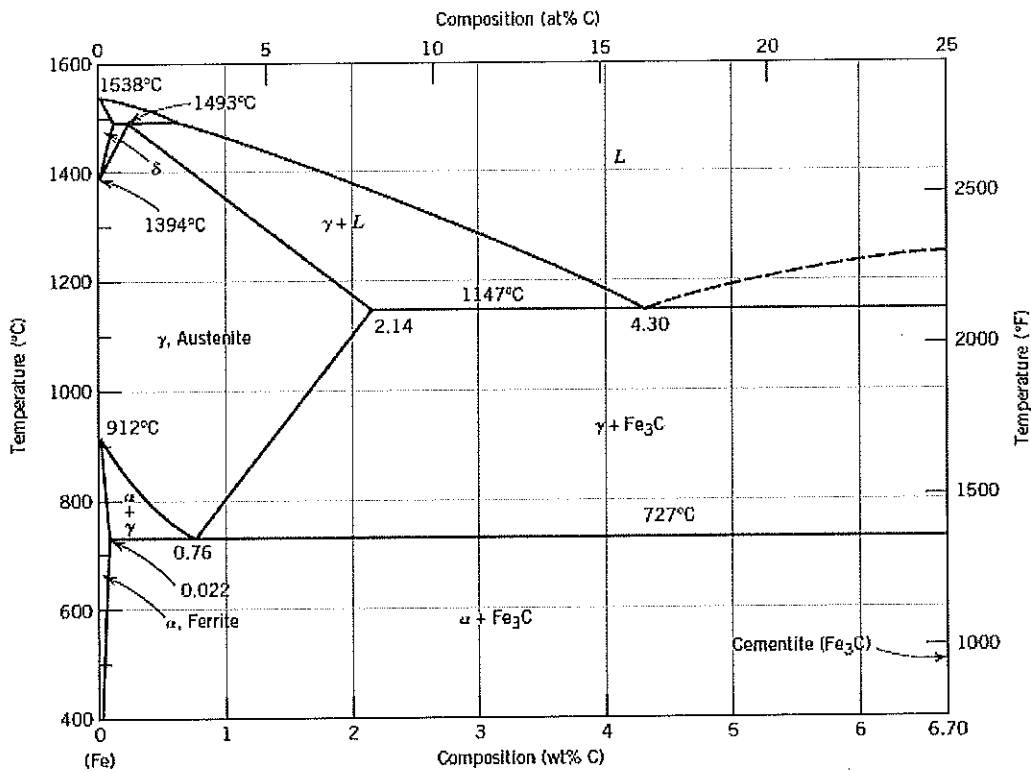
To illustrate this concept, consider the sugar–water ($C_{12}H_{22}O_{11}$ – H_2O) system. Initially, as sugar is added to water, a sugar–water solution or syrup forms. As more sugar is introduced, the solution becomes more concentrated, until the solubility limit is reached or the solution becomes saturated with sugar. At this time, the solution is not capable of dissolving any more sugar, and further additions simply settle to the bottom

of the container. Thus, the system now consists of two separate substances: a sugar–water syrup liquid solution and solid crystals of undissolved sugar. This solubility limit of sugar in water depends on the temperature of the water and may be represented in graphical form on a plot of temperature along the ordinate and composition (in weight percent sugar) along the abscissa, as shown in Figure 9.1. Along

the composition axis, increasing sugar concentration is from left to right, and percentage of water is read from right to left. Because only two components are involved (sugar and water), the sum of the concentrations at any composition will equal 100 wt%. The solubility limit is represented as the nearly vertical line in the figure. For compositions and temperatures to the left of the solubility line, only the syrup liquid solution exists; to the right of the line, syrup and solid sugar coexist. The solubility limit at some temperature is the composition that corresponds to the intersection of the given temperature coordinate and the solubility limit line. For example, at 20_C, the maximum solubility of sugar in water is 65 wt%. The solubility limit increases slightly with rising temperature.

Q.17 Draw the phase diagram of iron – iron carbide.

Ans.



Q.18 Explain the following crystal structures.

1. Simple cubic
2. Body centered
3. Face Centered

Ans. 1. **Simple Cubic Crystal Structure (SC):**

In this type of crystal structure, one atom is situated at each corner of the unit cell as shown in the figure. In the simple cubic crystal structure, the total number of atoms is equal to eight. Simple cubic crystal structure does not have an atom at the center of the unit cell or faces of the unit cell. Now we can say that the average number of atoms per unit in a simple cubic crystal structure one. This type of crystal structure does not exist in any engineering material.

2. **Body-Centered Crystal Structure (BCC):**

In body centered crystal structure, one atom is placed at each corner of the unit cell like a simple cubic crystal structure but, in addition to this, there is one atom at the center of the unit cell. A body-centered crystal structure is more complex as compared to the simple cubic crystal structure.



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Center atom in the body centered crystal structure does not come in contact with another atom, hence it remains unshared. An average number of atoms per unit cell in body centered crystal structure is two. Metals like Li, K, Na, V, Ta, etc. has this type of crystal structure.

3. Face Centered Crystal Structure (FCC):

In the face-centered crystal structure, an atom is placed at each corner of the unit cell that is eight corner atoms. One atom is placed at each face center that is six face atoms. In Face centered crystal structure, there is no center atom. In this type of crystal structure, an average number of atoms per unit cell is four. Metals like Cu, Ag, Al, Ca, Pt, etc. contain this type of crystal structure.