## MID TERM EXAMINATION [NOVEMBER-2023]
## FIRST SEMESTER [B.TECH]
## MANUFACTURING PROCESS [ES-119]

Time: 1:5 Hrs. Max. Marks: 30

**Note: Attempt Q. No. 1 which is compulsory and any two more questions from remaining.**

**Q.1. (a) Explain importance of manufacturing.** (2)

**Ans. Importance of manufacturing is crucial for several reasons:**

**1. Economic Growth:** Manufacturing drives economic growth by creating jobs, fostering innovation, and generating revenue. It often acts as a catalyst for other sectors of the economy, including services and technology.

**2. Job Creation:** It provides employment opportunities in various roles, from assembly line workers to engineers and managers. This can support a wide range of skill levels and backgrounds.

**3. Innovation:** The manufacturing sector often leads in technological advancements and innovation. It develops new products and processes that can improve quality of life and increase efficiency.

**4. Trade Balance:** Manufacturing contributes significantly to exports, which can improve a country's trade balance and reduce trade deficits.

**Q.1. (b) Explain core and its function.** (2)

**Ans. Core:** A core is a crucial component used to create internal cavities or complex shapes within a cast part. Function of a core in the casting process:

**Creating Internal Shapes:** Cores are used to form hollow sections or internal features that cannot be achieved through the outer mold alone. This is essential for parts like engine blocks or pipes.

**Q.1. (c) Why allowances are provided?** (2)

**Ans.** The pattern is a replica of the casting, but it is slightly larger in size. This variation in pattern and casting dimensions is due to casting allowances. When the cast solidifies, it shrinks slightly due to metal shrinkage during cooling, so the pattern is slightly larger to compensate. Allowances are made for the pattern in the casting process due to the shrinkage property of cast metal.

**Q.1. (d) Explain homogeneous and heterogeneous welding?** (2)

**Ans.** In welding, the terms "homogeneous" and "heterogeneous" refer to the types of materials being joined and the resulting weld characteristics. Here's a breakdown:

**Homogeneous Welding Process:** Homogeneous welding involves joining materials of the same type. This means welding of similar metals or materials together.

**Examples:**

- **Welding Steel to Steel:** Joining two pieces of steel.
- **Welding Aluminum to Aluminum:** Joining two pieces of aluminum.

**Common Applications:** Used in many industries where parts are made from the same material, such as structural steelwork, automotive manufacturing, and aerospace.

**Heterogeneous Welding Process:** Heterogeneous welding involves joining dissimilar materials. This means welding different types of metals or materials together.

**Examples:**

- **Welding Steel to Aluminum:** Joining steel and aluminum.
- **Welding Stainless Steel to Carbon Steel:** Joining stainless steel with carbon steel.

**Common Applications:** Used in applications where different materials must be joined for their specific properties, such as in aerospace, automotive, and certain industrial applications where diverse materials are used together.

**Q.1. (e) Explain advantages of welding.** **(2)**

**Ans.** Refer to Q.7 (a) of End Term Examination 2018 (Pg. No. 21–2018).

**Q.2. (a) Explain principle, advantages and disadvantages of shell casting method with suitable diagram.** **(5)**

**Ans. Shell Mold Casting**

**Principle:** The first step in the shell mold casting process is to manufacture the shell mold. The sand we use for the shell molding process is of a much smaller grain size than the typical greens and mold. This fine grained sand is mixed with a thermosetting resin binder. A special metal pattern is coated with a parting agent, (typically silicone), which will latter facilitate in the removal of the shell. The metal pattern is then heated to a temperature of 350F–700F degrees, (175C–370C).

The sand mixture is then poured or blown over the hot casting pattern. Due to the reaction of the thermosetting resin with the hot metal pattern a thin shell forms on the surface of the pattern. The desired thickness of the shell is dependent upon the strength requirements of the mold for the particular metal casting application. A typical industrial manufacturing mold for a shell molding casting process could be 7.5mm thick. The thickness of the mold can be controlled by the length of time the sand mixture is in contact with the metal casting pattern.

The excess "loose" sand is then removed leaving the shell and pattern.

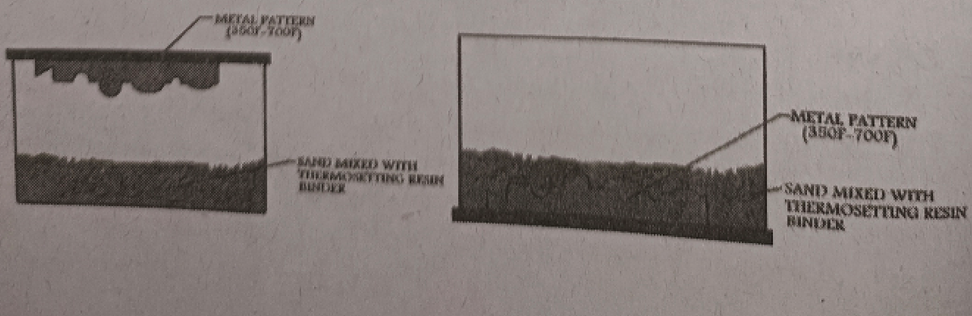
The shell and pattern are then placed in an oven for a short period of time, (minutes), which causes the shell to harden onto the casting pattern.

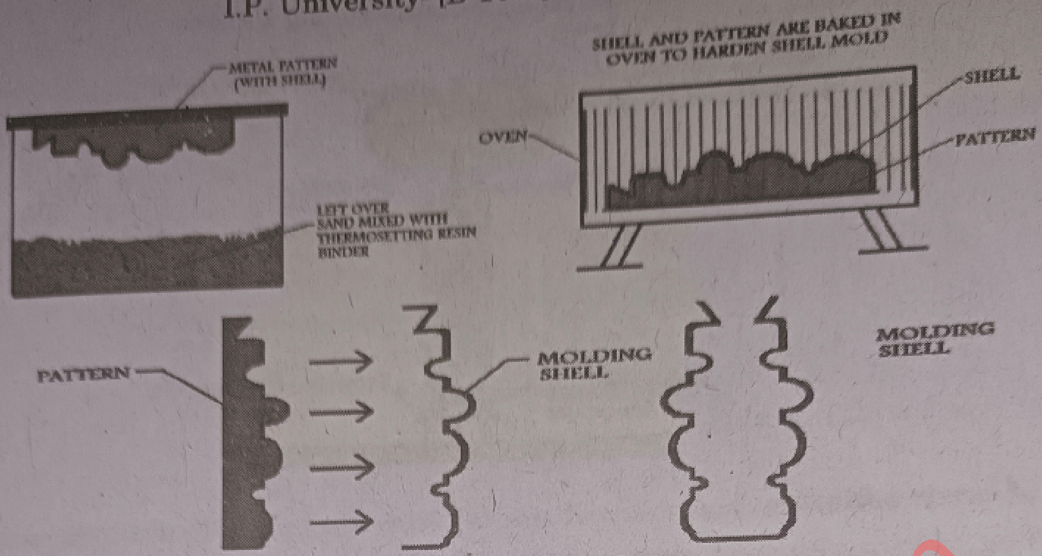
Once the baking phase of the manufacturing process is complete the hardened shell is separated from the casting pattern by way of ejector pins built into the pattern. It is of note that this manufacturing technique used to create the mold in the shell molding process can also be employed to produce highly accurate fine grained mold cores for other metal casting processes.

Two of these hardened shells, each representing half the mold for the casting are assembled together either by gluing or clamping.

The manufacture of the shell mold is now complete and ready for the pouring of the metal casting. In many shell molding processes the shell mold is supported by sand or metal shot during the casting process.








**Advantages:**

**1. Precision:** Shell casting can produce highly detailed and accurate parts with excellent surface finish. It is ideal for intricate and complex geometries.

**2. Versatility:** Suitable for a wide range of metals and alloys, including high-temperature and high-strength materials.

**3. Minimal Machining:** Parts often require less machining after casting due to the high precision of the process.

**Disadvantages:**

**1. Cost:** The initial setup, including pattern creation and shell building, can be expensive. This makes it less cost-effective for very large production runs.

**2. Time-Consuming:** The process can be relatively slow due to multiple steps, including shell building and curing.

**3. Fragility of Shell:** The ceramic shell can be brittle and may break or crack during handling or removal.

Shell casting is widely used in industries like aerospace, automotive, and jewelry for its ability to produce complex and high-precision components.

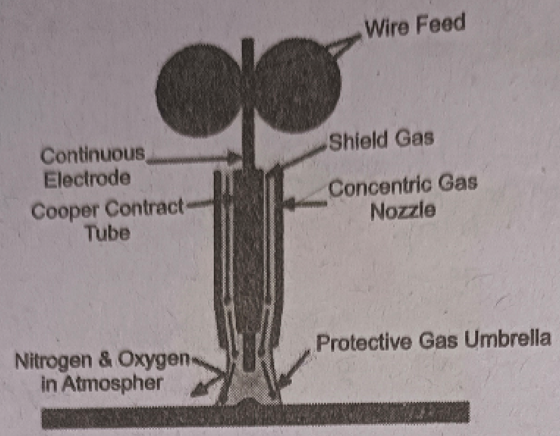


**Q.2. (b) Explain with help of neat sketch construction and working of metal inert gas (MIG) welding.** **(5)**

**Ans.** Metal Inert Gas (MIG) welding, also known as Gas Metal Arc Welding (GMAW), is a widely used welding process that employs a continuous wire feed as an electrode and an inert or semi-inert gas to shield the weld pool from contamination.

**Working**

• First, a high voltage current is change into DC current supply with high current at low voltage. This current passes though welding electrode. • A consumable wire is used as electrode. The electrode is connected to the negative terminal and work piece from positive terminal. • A fine intense arc will generate between electrode and work piece due to power supply. This arc used to produce heat which melts the electrode and the base metal. Mostly electrode is made by the base metal for making uniform joint. • This arc is well shielded by shielding gases. These gases protect the weld form other reactive gases which can damage the strength of welding joint. • This electrode travels continuously on welding area for making proper weld joint. The angle of the direction of travel should be kept between 10-15 degree. For fillet joints the angle should be 45 degree.




**Construction:**

The **construction** of a MIG welding system involves several key components, each playing a crucial role in the welding process. Here's a breakdown of the main elements:

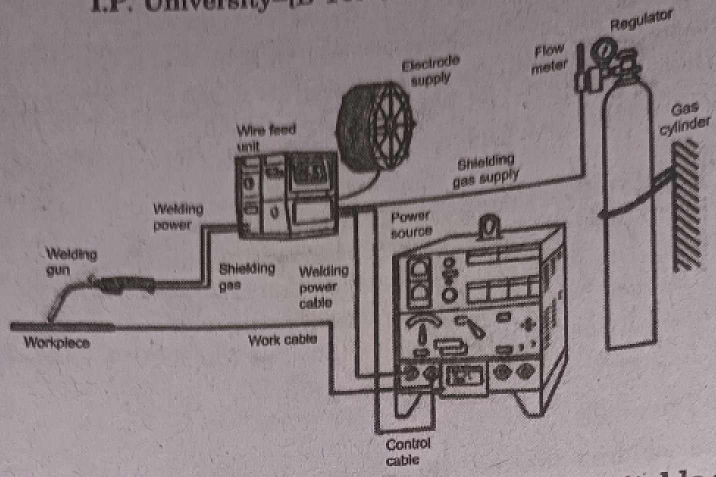
**Power Source:** In this type of welding process, a DC power supply is used with reverse polarity. Reverse polarity means the electrode or in case of MIG welding electrode wire is connected positive terminal and work piece to negetive terminal. The power source consist a power supply, a transformer, a rectifier which change AC into DC and some electronic controls which control the current supply according to weld requirement.

**Wire Feeder System:** MIG welding needs continuous consumable electrode supply for welding two plates. This consumable electrode used in form of wire. These wire is continuously supplied by wire feed mechanism or system. It controls the speed of the wire and also pushes the wire form welding torch to welding area. These are available in different shapes and sizes. It consist a wire pool holder, a driving motor, a set of driving rollers and wire feed controls. The wire feed speed is directly control the current supply through power supply.

**Welding Torch:** In this torch there is a mechanism which holds the wire and supplies it continuously with the help of wire feed. The front end of the torch is fitted with a nozzle. The nozzle is used to supply inert gases. These gases form a shielding area around the weld zone and protect it from oxidization. The welding torch is air cooled or water cooled according to the requirement. For high current supplied, the torch is water cooled and for low supply it is air cooled.

**Shielding Gases:** The primary function of shielding gases is to protect weld area from other reactive gases like oxygen etc. which can affect the strength of welding joint. These shielding gases are also form plasma which helps in welding. The choice of gas is depend on the welding material. Mostly argon, helium and other inert gases are used as shielding gases.

**Regulators:** As the name implies, they are used to regulate the flow of inert gases from the cylinder. The inert gases are filled into cylinder at high pressure. These gases cannot be used at this pressure so a regulator is used between the gases supply which lower down the gases pressure according to welding requirements.




**Q.3. (a) Explain different zones of Cupola furnace with suitable diagram. (5)**

**Ans.** A cupola furnace is a vertical cylindrical furnace used primarily for melting cast iron. It operates continuously and is widely used in foundries for producing molten metal. The furnace is divided into different zones, each with specific functions in the melting and refining process.

Here's an explanation of the various zones in a cupola furnace:

**Zones in a Cupola Furnace :** Refer to Q.2 Mid Term Examination Jan-2023 (Pg. No. 2–2022).

**Q.3. (b) Explain different welding defects with suitable diagrams. (5)**

**Ans. Types of Welding Defects:** Welding defects can be of different types based on various reasons for the irregularity. Some welding defects are following:-

**(A) Cracks:** The worst welding defect that is considered to be unacceptable without a second thought is the crack in the weld. These defects can progress rapidly affecting the whole weld and causing failure. Depending on how the cracks are formed in the weld, they are categorized into these types, and is also shown in the image.

**(a) Longitudinal Cracks:** They are formed parallel to the weld bead.

**(b) Transverse Cracks:** They are formed along the width of the weld bead.

**(c) Crater Cracks:** They are formed at the end of the bed.

**(d) Hot Cracks:** When the base metal is heated above 10,000°C °C, weld joints crystallise developing hot cracks. This can be due to incorrect filler metal usage and rapid cooling of metals.

**(e) Cold Cracks:** These can take hours to days to be visible, usually after the cooling of metal.

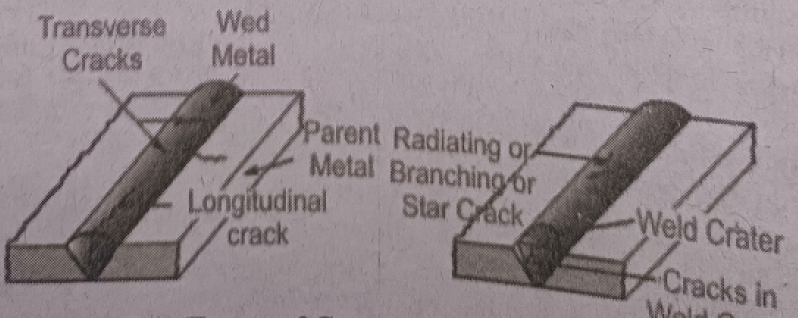



**Fig. Types of Cracks in a Welded Joint**

**(B) Porosity:** Holes are formed when the gas bubbles in the weld pool cannot escape causing the porous structure of the weld. This defect is called Porosity. These welding defects are most commonly found in processes such as TIG and stick welding.

These welding processes use a shielding gas, and using it beyond the permissible limit can lead to contamination of metal, reducing the strength of the weld. Conversely, porosity can be caused by gas bubbles trapped in the weld pool forming blow holes or pits as shown in the image below.

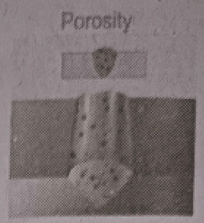



Fig. Porosity Defect

**(C) Burn-Through**

During the welding process, there are chances where it accidentally penetrates the thickness of the base metal exposing an open hole as shown in the image below. This creates a burn-through and makes one of the most common welding defects while operating with thinner metals in the industry.

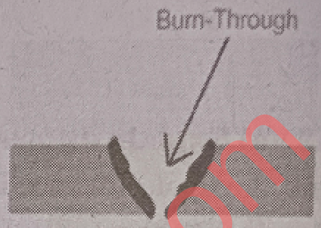



Fig. Burn-Through Defect

**(D) Underfill**

Welding too fast can cause only a little weld metal to be deposited in the weld joint as shown in the image below. Due to this, the base metals are not properly fused resulting in stress concentrated area.

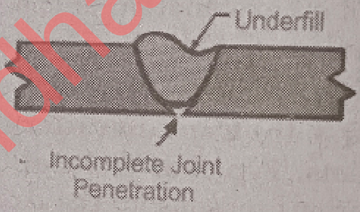



Fig. Underfill Defect

**(E) Excess Reinforcement:** In contrast to the underfill defect, the excess reinforcement is a defect that results in an extra build-up of the weld than required in the joint. The defect is also known as 'Overfill'. This defect induces maximum stress concentration towards the toes of the welds as shown in the image.

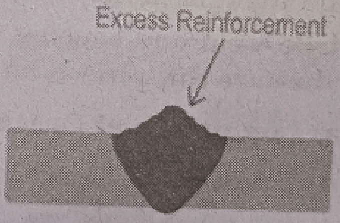



Fig. Overfill defect

**(F) Misalignment:** Any welding process requires proper alignment of base metals to weld properly. A slight misalignment can cause a misaligned weld as shown in the figure below. These defects are susceptible to fatigue stress in applications like pipe welding.


Fig. Misalignment Defect

**(G) Slag Inclusion:** Slag inclusion may occur on the surface of the welded metal or between welding cycles. A weld bead containing slag affects the metal's tensile strength and atomic structure as shown below.

This weld defect is typical of processes that utilise flux, including stick, flux-cored, submerged arc welding, and brazing.

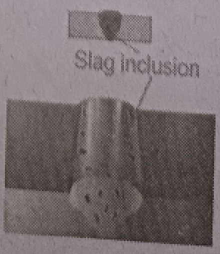



Fig. Slag Inclusion Defect

**(H) Incomplete Fusion:** When the metals solidify before the natural cooling and form gaps in the weld zone, an incomplete fusion of weld is caused as shown. There are several causes.

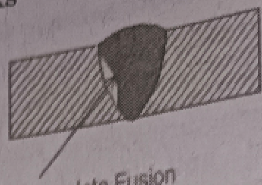



**Fig. Incomplete Fusion**

**(I) Incomplete Penetration:** During Butt welding, the gap is not filled throughout the thickness of the base metals. This welding defect makes either one side of the joint remain unfused with the root as shown.

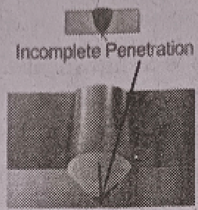



**Fig. Incomplete Penetration Defect**

**For More Welding Defects:** Refer Q.5 (b) End Term 2022 (Pg. No. 19-2022)

**Q.4. (a) Explain the importance of materials and manufacturing towards technological and social economic growth with suitable example. (5)**

**Ans.** Materials and manufacturing play crucial roles in both technological advancement and socio-economic growth. Here's a detailed look at their importance:

**1. Technological Advancement**

**(a) Materials:**

- **Innovation:** The development of new materials or the improvement of existing ones drives technological progress. For example, advancements in materials science have led to the creation of high-performance materials like carbon fiber and advanced composites, which are used in aerospace and sports equipment.
- **Applications:** High-tech industries rely on specialized materials. For instance, semiconductor materials such as silicon and gallium arsenide are essential for electronics and computer technology. Innovations in these materials enable the creation of faster, more efficient electronic devices.

**(b) Manufacturing:**

- **Precision and Efficiency:** Advances in manufacturing technologies, such as 3D printing and automated assembly, allow for the production of complex and precise components. This is critical for industries like aerospace, where precision is essential for safety and performance.
- **Prototyping and Innovation:** Modern manufacturing techniques enable rapid prototyping, allowing engineers and designers to test and refine new technologies quickly. This accelerates the innovation cycle and brings new products to market faster.

**Example:**

- **Smartphones:** The development of smartphones illustrates the impact of materials and manufacturing. Advanced materials like high-strength glass and lightweight metals, combined with precision manufacturing processes, have enabled the creation of powerful, compact devices. These advancements drive technological innovation and provide new capabilities, such as high-resolution cameras and advanced sensors.

**2. Socio-Economic Growth**

**(a) Materials:**

• **Infrastructure Development:** High-quality materials are essential for building infrastructure such as roads, bridges, and buildings. For example, the use of reinforced concrete and steel has revolutionized construction, allowing for the development of skyscrapers and modern urban infrastructure.• **Economic Value:** The availability and quality of materials impact economic development. Countries rich in natural resources can develop industries that capitalize on these materials, contributing to economic growth.

**(b) Manufacturing:**

• **Job Creation:** Manufacturing is a significant source of employment, providing jobs across a wide range of skill levels, from factory workers to engineers. This contributes to economic stability and growth. • **Economic Output:** A strong manufacturing sector boosts economic output and trade. Products manufactured in one country can be exported globally, generating revenue and improving the trade balance.

**Example:** • **Automotive Industry:** The automotive industry exemplifies the socio-economic impact of manufacturing. Car manufacturers create millions of jobs worldwide and contribute significantly to national economies through the production of vehicles, components, and related services. The industry also drives innovations in safety, fuel efficiency, and environmental sustainability.

**Q.4. (b) Explain with suitable sketch construction and working of resistance seam welding.** **(5)**

**Ans. Construction of Resistance Seam Welding:**

**1. Electrode Wheels:** • **Function:** These are the primary components that apply pressure and conduct current to the metal sheets. • **Design:** The electrodes are typically circular wheels that rotate to apply pressure across the seam. They are usually made of copper or copper alloys to handle the electrical and thermal loads.

**2. Electrode Holder:** • **Function:** Holds the electrode wheels in position and applies the necessary pressure during welding. • **Design:** It's a mechanical or hydraulic assembly that ensures the electrodes are aligned correctly and apply consistent pressure to the workpieces.

**3. Workpieces:** • **Function:** The metal sheets or plates that are to be welded. • **Design:** They are positioned between the electrode wheels. The workpieces are usually pre-aligned and clamped to ensure proper fit and contact during welding.

**4. Control System:** • **Function:** Regulates the welding parameters such as the amount of current, pressure, and welding time. • **Design:** Includes electrical controls and sensors to monitor and adjust the welding conditions to ensure consistent quality.

**5. Power Supply:** • **Function:** Provides the electrical current required for the welding process. • **Design:** Supplies a high current at a controlled voltage to the electrode wheels.

**Working Principle Seam Welding**

The welding process in which two similar or dissimilar materials are joined at the seam by the application of heat generated from electrical resistance is known as **seam**



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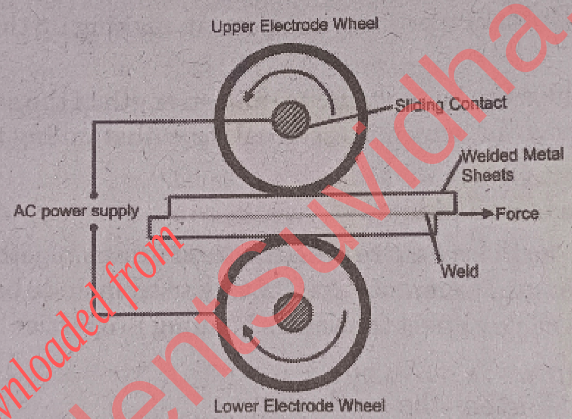
**welding**. The seam welding is a types of resistance welding, in which weld is produced by roller electrodes instead of tipped electrodes.

Most seam welding processes produce a continuous or intermittent seam weld near the edge of two overlapped metals by using two machine driven roller electrodes. As in the seam welding process, the roller electrodes move over the metal workpieces, the workpieces are under pressure and the current passing through them heats the two workpieces of the metal to the melting point. Thus, this process, sometimes, also called the seam **spot welding**.

Resistance seam welding is one of the most common welding process used to join metal sheets with a continuous weld. In seam welding process, when two similar or dissimilar materials are pressed together, there will be a small gap between them because of irregularities in the metal surface. This gap causes an electrical resistance between the two materials and results them to heat up at the seam.




**Resistance seam welding:** In seam welding process, the welding current is the main parameter, i.e., the amount of heat generated at the seams depends upon the magnitude of welding current flowing through it.