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Question 1

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Considering the weldability concept which are the main features characterizing a welding application?

Weldability refers to the ability of a material to be welded under specific conditions without producing defects. When considering the weldability concept for a welding application, several key features characterize the process:

1. Type of Joints: it directly influences the strength, appearance, and functionality of the welded structure. The joint type must be chosen based on the intended application and loading conditions of the structure.
2. Type of edge shape for each component: The edge preparation or shape (e.g.,butt, tee, corner, lap, edge joint) affects the penetration of the weld [1], the amount of filler material required, and the quality of the weld. Proper edge preparation ensures better fusion, reduces the likelihood of defects, and enhances the mechanical properties of the weld.
3. Tolerances: it specifies the permissible limits of variation in the dimensions of the welded components. Tighter tolerances can lead to more consistent and higher-quality welds but may also increase the cost and complexity of fabrication.
4. The design criteria for joints depend on several factors: Welding Process, materials being welded, thickness of Components and joint accessibility

References:
[1] https://www.uti.edu/blog/welding/joint-types

Question 2

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Give 5 samples of welding processes and for each one identify its nature in terms of fusion welding

Fusion welding or simply metal welding, is a classification under homogeneous welding, that groups many processes that are defined as the method to heat two metals in higher temperatures until they melt, join or fuse each other [1]

The five types of welding processes with its basic form as fusion welding are [2]

1. Arc Welding
- Most popular type of fusion welding
- Relying on an electric arc to join two or more objects up to 6,000 degrees Fahrenheit
- highly capable of melting even the toughest metals.
- Can be performed underwater, which is ideal for offshore welding projects.

2. Laser Welding
- Involves the use of light radiation to produce heat.
- The laser welding rig blasts the surfaces with radiated light.
- With each blast, the surfaces become a little hotter and fuse together.

3. Induction Welding
- Distinguished from other types of fusion welding since there's no direct contact between an object's surface and the heat source.
- A wrapped coil is used to create a magnetic field that heats metal.
- The magnetic field quickly heats the metal, causing it to melt and fuse together.

4. Oxyfuel Welding
- Chemical-based fusion welding
- Using flame to heat and join surfaces, with oxygen as the fuel source.
- The oxygen fuels the fire to create a hot flame in excess of 4,500F

5. Solid Reactant Welding
- Relies on chemical reactions with certain materials to join them.
- There are compounds, for instance, that create heat when mixed together.

References:
[1] https://texfire.net/en/blog/60_types-of-fusion-welding-oxyacetilene-electric-and-laser.html#:~:text=Fusion%20welding%20or%20simply%20metal,a%20metal%20contribution%2C%20by%20general
[2] https://monroeengineering.com/blog/the-5-types-of-fusion-welding/

Question 3

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Give example of 3 techniques used as non-destructive testing (NDT)? and identify the main the physical operational fundaments for each one.

Definition: NDT is used to inspect and evaluate materials, components, or assemblies without destroying their serviceability [1]. There are many NDT techniques, but they are broadly categorized into 3 major physical principles: Electromagnetic radiation, Electromagnetism, and Ultrasonic techniques.

1. Electromagnetic radiation: Its techniques include X ray, Gamma ray, Microwaves, Thermography, Infrared flash thermography, and Holographic interferometry. It is a method of characterizing the thickness or internal structure of a test piece through the use of high frequency sound waves [2]. High frequency sound waves are directional, and they will travel through a medium (like a piece of steel or plastic) until they encounter a boundary with another medium (like air), at which point they reflect back. By analyzing these reflections it is possible to measure the thickness of a test piece, or find evidence of cracks or other hidden internal flaws.

2. Electromagnetism: Its techniques include Magnetic particles, Eddy currents and Eddy currents arrays. It is the process of inducing electric currents and magnetic fields inside a test object and observing the electromagnetic response. A defect inside a test object creates a measurable response that differs from background noise and allows us to detect and characterize surface and sub-surface flaws in conductive materials. [3]

3. Ultrasonic: Its techniques include Ultrasonic conventional, Laser ultrasonic, Termosonics, ToFD, Phased arrays, EMAT and Guided waves. It is used to locate internal and external product defects and measure wall thickness discontinuities in metal tubing, pipe, and other materials without damaging the item being inspected. Ultrasonic testing detects flaws deep within the items being inspected by transmitting short, high-frequency sound pulse waves into the inspection item. [4]

References:
[1] https://www.asnt.org/MajorSiteSections/About/Discover_Nondestructive_Testing.aspx#:~:text=What%20Is%20Nondestructive%20Testing%3F,assemblies%20without%20destroying%20their%20serviceability.
[2] https://www.wermac.org/others/ndt_ut.html
[3] https://www.nasa.gov/centers/wstf/supporting_capabilities/nondestructive_evaluation/electromagnetic_testing.html
[4] https://www.nasa.gov/centers/wstf/supporting_capabilities/nondestructive_evaluation/ultrasonic_testing.html

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