THE INDIAN INSTITUTE OF WELDING

Associate Membership Examination

Winter Session, January 2023

Sub: Advanced Welding Technology (AME-206)

Full Marks: 80 Time: 3 hours

Pass Marks: 32

Answer any FIVE Questions
All Question carry Equal Marks
Parts of a Question should be answered at ONE PLACE

1. What are the drawbacks in conventional TIG welding process? Explain the various advancements of TIG welding process to overcome those drawbacks. Draw a typical variable square AC wave form and state its characteristics. Mention the range of applications with such pulse current in TIG welding process. 2+ 7 + 5 +2

2. a) How peak current and its duration affect the droplet transfer in pulse MIG welding? Why one droplet transfer per pulse is normally desired? How does pulsed-spray arc MIG welding process make possible for welding thin sheet and thick metals in all positions? 4+2+3

   b) Explain the transfer of so called "cold metal" in MIG welding process and state the typical applications. 4

   c) What is twin arc/tandem MIG? Mention the advantages over conventional MIG welding process. 3

3. a) Explain the operational features of narrow gap submerged arc welding (SAW) and tandem arc SAW.

   b) Discuss the suitability of the strip electrode and twin wire SAW for cladding of vessel equipment for nuclear power engineering industries. 10+ 6

4. a) what are the basic limitations of autogenous Laser welding and how laser-MIG hybrid welding overcomes those . Explain the effect of MIG torch direction (leading and trailing torch) and separate distance between laser and MIG on weld bead shape and weld quality of laser-MIG hybrid welding. 2+6

   b) Explain the mechanism of ultrasonic welding. Why and how do you make the surface of "welding tip" rough in UW? Give the range in welding timings in UW and Justify. 4+2 +2

5. a) What are the decisive factors to automate welding? Mention two key concept of automation. State the level of automation and corresponding machine function. Define "Flexable automation". 2+ 1+ 3 + 2

   b) Fundamentally a robot attempts to simulate the action of a skill welder- Explain how? What is "seam tracking"?State the basic types of seam-tracking systems and their sensing mechanisms. 4+ 1 +3

6. Write short notes on the following: 4x4=16

   a)Digital Power source for arc welding

   b) Adaptive Process control

   c) Principle and application of Magnetic Pulse welding.

   d) Industrial Applications of Additive Manufacturing

7. What is Additive Manufacturing(AM)? Mention the advantages of AM. Describe the two AM processes- (a) Power bed fusion(PBF) and Wire and arc AM(WAAM) vis-à-vis their merits and demerits. Discuss the various problems of product quality in AM and any post processing operations to resolve the problems. 2+ 2 +6 + 6

THE INDIAN INSTITUTE OF WELDING

Associate Membership Examination

Winter Session, January 2023

Sub: Computational Methods & Computer Programming (AME-18)

Full Marks: 80 Time: 3 hours

Pass Marks: 32

Read the questions carefully and answer any five questions to the point

1) a) Find the sum of first n terms of the series:
$1 + 2^2 + 3^2 + \ldots\ldots\ldots$ $n>0$ [8]
b) Write a C program to find number of words in a statement. [8]

2) a) Write a short note on Bitwise operator in C language. [4]
b) What is multidimensional array in C? [2]
c) Write a C program to sort an array of integer using pointer. [10]

3) a) Convert the following:
i) $(A1.8)_H$ to decimal
ii) $(138.5)_O$ to binary
iii) $(80)_{10}$ to octal
iv) $(A03.92)_H$ to binary [4x3=12]
b) Write a C program to determine whether a given number is prime or not. [4]

4) a) What is void data type? [3]
b) What are the differences between ASCII and UNICODE. [3]
c) Briefly describe various input-output devices of computer. [10]

5) a) Write short notes on:
i) OR Gate
ii) AND Gate
iii) XOR Gate [3x4=12]
b) How a computer is different from a calculator [4]

6) a) Write a C program to calculate GCD and LCM of given numbers. [10]
b) Give an example of using #define in a C program. [6]

7) a) Write a C program to add two matrices. [8]
b) Write a C program to print a lower diagonal matrix. [6]
c) What is the use of 'for' loop? [2]

8) a) Differentiate between system software and application software. [6]
b) Write a C program to find the factorial of a given number using recursion. [6]
c) Write a short note on DOS. [4]

THE INDIAN INSTITUTE OF WELDING

Associate Membership Examination

Winter Session, January 2023

Sub: Economics of Welding & Fabrication (AME-106)

Full Marks: 80 Time: 3 hours

Pass Marks: 32

Answer any five (5) questions from the followings.

Parts of a question should be answered at one place

Answer any 5 (Five) questions 5×16=80

1. a. Explain Price Elasticity of Demand with suitable example.

b. Consider the demand for a good. At price Rs 4, the demand for the good is 25 units. Suppose price of the good increases to Rs 5, and as a result, the demand for the good falls to 20 units. Calculate the price elasticity.

c. Suppose the price elasticity of demand for a good is -0.2. If there is a 5% increase in the price of the good, by what percentage will the demand for the good go down? 4+6+6

2. a. What is Demand Forecasting? Explain the importance of Demand Forecasting in the world of Industrial Engineering with suitable case study.

b. A pharmaceutical production house has used 9-month moving average forecasting method to prepare a drug. The actual demand is shown in the table. Using the previous moving average data, construct an exponential smoothing forecast for the month 33.

Month	24	25	26	27	28	29	30	31	32
Demand	78	65	90	71	80	101	84	60	73

4+6+6

3. a. Represent the concept of Break Even Point graphically.

b. Explain the importance of Break Even Analysis to evaluate the business health. Justify your answer with a suitable case study. 10+6

4. a. Define Market.

b. What is Product Differentiation? Explain it with suitable example.

c. Describe the features of market structure that supports Product Differentiation. Illustrate your answer with example. 4+6+6

5. a. Explain the concepts of Cost, Price and Revenue and justify your answer with case studies.

b. Discuss the following types of Costs with suitable examples from Welding and Fabrication jobs:

i. Fixed Cost

ii. Marginal Cost

iii. Recurring Cost

iv. Average Cost 4+(3×4)

6. a. Explain the importance of NPV and IRR with suitable example.

b. Calculate NPV, IRR and B-C Ratio from the following data. Assume rate of interest as 12% per annum.

Year	Cash Flow (Rs.)
0	(-)1,00,000
1	20,000
2	30,000
3	40,000
4	50,000
5	30,000

4+(3×4)

7. a. Explain the objective of pricing.

b. Discuss the concepts behind fixing of a pricing strategy of a product.

c. Explain any method that may be used to formulate a pricing strategy of a new product. 4+6+6

8. Write short notes on any 2 (two) of the following: 8+8

a. Economies of Scale and its importance in production house

b. Cobb-Douglas Production function in determination of Welding and Fabrication Cost

c. Working Capital Management

d. Capital Market.

THE INDIAN INSTITUTE OF WELDING

Associate Membership Examination
Sub: Materials Science (AME-101)

Full Marks : 80

Answer any 5 questions. Answer must be brief and to the point.
Parts of question (a, b, c etc.) should be answered at one place.

1. a. Describe the two major factors that must be taken into account in the packing of ions in an ionic crystal.
   b. Describe the Bohr model of the hydrogen atom. What are the major shortcomings of Bohr model?
   c. Describe the covalent bonding process between a pair of hydrogen atoms. What is driving energy for the formation of a diatomic molecule?
   d. A hydrogen atom exists with its electron in the n=3 state. The electron undergoes a transition to the n=2 state. Calculate (i) the energy of the photon emitted, (ii) its frequency, and (iii) its wavelength. Where 1 eV = 1.60×10^{-19} J, h=6.63×10^{-34} Js, 1nm = 10^{-9}

   2+4+4+6

2. a. What are the 14 Bravais unit cells?
   b. A sample of BCC iron was placed in an x-ray diffractometer using incoming x-rays with a wavelength $\lambda = 0.1541$ nm. Diffraction from {110} planes was obtained at $2\theta = 44.704^{\circ}$, calculate a value for the lattice constant a of BCC iron. (Assume firstorder diffraction with n =1).
   c. Calculate the atomic packing factor for the FCC structure.
   d. Distinguish between Crystalline and Amorphous solids.

   4+4+4+4

3. a. How are defects and impurities in a solid related? Can a pure, crystalline compound be free of defects? How can a substitutional impurity produce a vacancy?
   b. The ionic radius of K+ is 133 pm, whereas that of Na+ is 98 pm. Do you expect K+ to be a common substitutional impurity in compounds containing Na+? Why or why not?
   c. Define (i) a phase in a material and (ii) phase diagram.
   d. How point defects affect the properties of materials?

   (2+2+2)+4+(2+2)+2

4. a. State the phase rule, and its significance with respect to phase transformation.
   b. Write down short notes on (i) Eutectoid Reaction & (ii) Peritectoid Reaction
   c. Explain the difference between a solidus line and a solvus line.
   d. How would a difference in grain size affect the change in mechanical properties on plastic deformation.

   2+(3+3)+4+4

5. a. What is creep? In which application it should be considered? How is the creep resistance improved?
   b. A tensile specimen of aluminum alloy rod having 5 cm length and 1.5 cm diameter is subjected to maximum load 0f 37000 N. if diameter at facture was 1.2 cm, calculate the following (i) Tensile strength (ii) True stress (iii) True strain
   c. Give reason why – Specimens are notched in impact test.
   d. Draw a typical engineering and true stress-strain curve for mild steel. Comment on the nature of the curve.

(1+1+2)+(2+2+2)+2+(2+2)

6. a. What are some of the advantages of plastics for use in mechanical engineering designs?
   b. What are the three major reactions that occur during chain polymerization?
   c. What is the functionality of a polymer? Distinguish between a bifunctional and trifunctional monomer.
   d. What are the major processing methods used for thermosets?

3+3+(3+3)+4

7. a. What are the functions of matrix and fiber in composite materials?
   b. What are two of the most important matrix plastics for fiber-reinforced plastics? What are some advantages of each type?
   c. A unidirectional Kevlar 49 fiber-epoxy composite contains 60 percent by volume of Kevlar 49 fiber and 40 percent epoxy resign. The density of the Kvlar 49 fibers is 1.48 Mg/m^3 and that of the epoxy resin is 1.20 Mg/m^3. (i) What are the weight percentages of Kevlar 49 and epoxy resin in the composite material, and (ii) What is the average density of the composite?
   d. A metal matrix composite is made with 80 percent by volume of aluminium alloy 2124-T6 and 20 percent by volume of Sic whiskers. The density of the 2124-T6 alloy is 2.77 g/cm^3 and that of the whiskers is 3.10 g/cm^3, calculate the average density of the composite material.

4+(2+2)+(3+3)+2

8. a. What are refractories? What are two main types of ceramic refractory materials?
   b. Give the composition and several applications for the following refractories: (i) Silica (ii) Fireclay (iii) high-alumina
   c. What are the advantages of hot-pressing ceramic materials?
   d. What is tempered glass? How is it produced?

(2+2)+(2+2+2)+2+(2+2)

THE INDIAN INSTITUTE OF WELDING

Associate Membership Examination

Winter Session, January 2023

Sub: Production Engineering (AME-103)

Full Marks: 80 Time: 3 hours

Pass Marks: 32

Answer any five

Parts of a question should be answered at one place

1. a) Define Casting? Briefly explain the steps involved in making a sand casting.
   b) Explain with neat sketches various allowances given to pattern and reasons to provide the allowances.
   c) Explain how the shape and size of risers are determined in casting. What are risering aids?
   d) With a neat sketch, describe the shell moulding process. List the advantages of the process. [4x4=16]

2. a) Differentiate between Case Carburizing and Carbonitriding.
   b) State the need for coating and explain the different CVD processes employed.
   c) Explain briefly the process of thermal spraying. [5+6+5=16]

3. a) Explain the terms WORK STUDY and THERBLIGS.
   b) Explain briefly the different steps involved in production planning.
   c) Explain with a suitable example the merits and shortfalls of Gantt Chart. [5+6+5=16]

4. a) Describe with a neat sketch the measurement of pitch of internal and external screw threads using a pitch measuring machine.
   b) Explain how surface roughness of a flat surface can be measured. [10+6=16]

5. a) Explain how chips are formed in metal cutting.
   b) Differentiate between orthogonal and oblique cutting with neat labeled sketches.
   c) Discuss the friction process on rake surface.
   d) Why cutting edge angles are provided on single point tools. [4x4=16]

6. a) Differentiate between drop forging and press forging operations.
   b) Explain with neat sketches and make a comparison between Direct and indirect extrusion processes.
   c) Explain with neat sketches the Rolling mechanism. Sketch different Roll Stand arrangements.
   d) Define hot working. Differentiate between punching and blanking with neat sketches. [4x4=16]

7. a) What do you mean by Solid state welding? Explain with suitable sketches,i) spot welding and ii) Projection welding.
   b) Explain the mechanism of formation of arc in welding. Sketch a neat set up of Electron Beam Welding and state it's limitations.

c) What do you mean by Explosive welding? Explain with suitable sketches how the process is accomplished.

d) Sketch a neat set up of Submerged Arc Welding and state it's limitations. [4x4=16]

8. Write short notes on **any four:** [4x4=16]

i) Talysurf
ii) Tool geometry of SPTT
iii) Centrifugal casting
iv) Deep drawing
v) Inventory contrl
vi) Sprue design

THE INDIAN INSTITUTE OF WELDING

Associate Membership Examination

Winter Session, January 2023

Sub: Strength of Materials (AME-102)

Full Marks: 80 Time: 3 hours

Pass Marks: 32

Answer question Number 1 and four from the rest. Question number 1 is compulsory.

1. Answer any eight questions 2x8 = 16

i) Write the combined relation among elastic constant E, G and K.
ii) How principal planes are defined?
iii) A Shaft transmits 10kW at 1000rpm. Taking maximum shear stress of material of shaft 150MPa, determine the safest diameter of the shaft.
iv) Euler theory is applicable for what type of column? What is slenderness ratio?
v) What is Factor of Safety? Why this is important?
vi) Find the value of elastic modulus of material if its Shear modulus and Poisson's ratio are 80GPa and 0.25 respectively.
ii) What is neutral axis of a beam? Does neutral axis always pass through centroid?
viii) Why hollow shafts are preferred over solid shafts in engineering applications?
ix) Derive the hoop stress of a thin spherical vessel of thickness t, internal pressure p and diameter d respectively.
x) Give one physical example of plane stress and plane strain.

2. a) The two dimensional stress situation is expressed by a compressive stress of 50MPa in X-direction, a tensile stress of 100MPa in Y-direction and a shear stress of 30MPa. Find the following quantities:

i)	Principal stresses and principal angle.	4
ii)	The normal and shear stresses at an angle 30^O to X-axis.	4
iii)	Show the above determined stresses in Mohr's circle.	4

b) What are Von Mises and Tresca's criteria of failure? 4

3. a) Draw the shear force and bending moment diagram of a cantilever beam of length L and carrying a distributed load of w_oN/m. 6
b) Find the expression for maximum deflection of a simply supported beam of length L and carrying a distributed load of w_oN/m. 6
c) Deduce the deflection curve equation for a beam. 4

4. A simply supported beam (rail), made of steel is of dimension 10cm (width) X 20cm (depth). The beam is 5m long. Two such beams are kept apart 100cm to pass an automated guided vehicle (AGV), of mass 1ton and of length 50cm, is to be passed over the rail by four rollers. Find the bending stresses when the centroid of AGV is at 1.25m and 2.5m from one end of the beam. The elastic modulus value, the permissible stress and the maximum permissible deflection are 200GPa, 350MPa and 1.5mm respectively. Is the beam is safe for this AGV? If safe, is the beam cross section is over-sized or under-sized. Find proper and cost effective dimensions of the beam. 16

5. a) Deduce the torsion formula. 4

b) Two circular shafts made of copper and steel are joined together end to end. The copper shaft is of bigger dimension, and of diameter 100mm and 100cm long, is kept on left side of the assembly. The steel shaft is of 50mm diameter and 200cm long. An anticlockwise twisting moment 100KN-m is given to steel shaft from one fixed end of 150cm from right. Find the deflection at 50cm from left in the copper shaft. Find also the fixing moments at two end supports. The shear modulus of steel and copper are 100GPa and 50GPa respectively. 12

6. a) Find the elongation of a conical bar due to its self weight. 7

b) A compound bar consists of a circular rod of steel with diameter 20mm rigidly fitted into a copper tube of internal diameter 20mm and thickness 5mm as shown in Figure 1. If the bar is subjected to a load of 100kN, find the stresses developed in two materials. E_s=2 x10^5 N/mm^2 and E_c=1.2 x 10^5 N/mm^2. 9

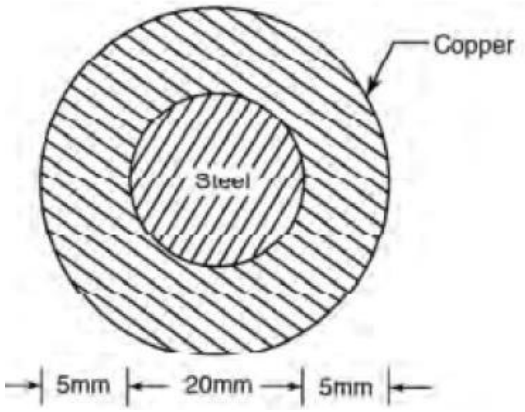

Figure 1

7. a) A cylindrical shell is of length 3m and having 1m internal diameter and 15mm thickness. Calculate the maximum intensity of shear stress induced and also the changes in dimension of the shell, if it is subjected to an internal pressure of 1.5N/mm^2. E=2 x10^5 N/mm^2 and Poisson's ratio=0.3. 8

b) Find the Euler's critical load for a coloumn with both end fixed. 8

8. a) Draw the shear force and bending moment of the beam as shown in Figure 2. 10

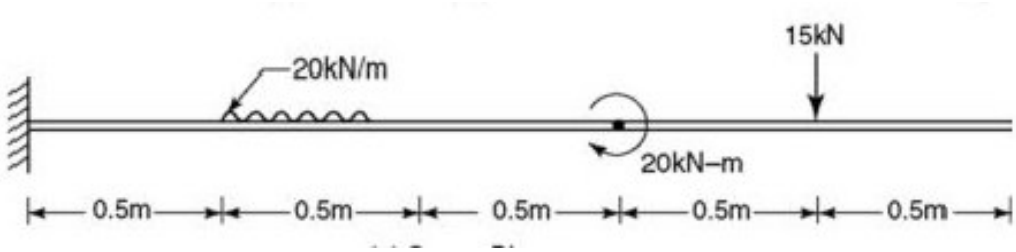

Figure 2

b) Prove the formula for beam, 6

$$\frac{\sigma}{y} = \frac{M}{I} = \frac{E}{R}$$

THE INDIAN INSTITUTE OF WELDING

Associate Membership Examination

Winter Session, January 2023

Sub: Welding & Allied Processes-I (AME-104)

Full Marks: 80 Time: 3 hours

Pass Marks: 32

Answer question Number 1 and four from the rest. Question number 1 is compulsory.

1. Answer any Eight **(8 X 2 = 16)**

i) What is DCSP? What materials are suited for this?
ii) What is the main difference between MIG and MAG welding?
iii) Write some alloying elements added to flux material of electrode to improve the strengths?
iv) What is HAZ? Clear with figure.
v) What types of welding come under Gas Metal Arc Welding?
vi) What is neutral dot?
vii) What is function of chipping hammer?
viii) What is short circuiting?
xi) Name the gas shielded arc welding process where 100% CO_2 is used as shielding gas.
x) What is solid state welding?

2. a) Define welding Process. 2
b) Write a short description on brief classification of welding process. 8
c) Write the combustion chemistry of Oxy-Acetylene gas. 3
d) Discuss about different Oxy-Acetylene flames. 3

3. **Write short notes on (any four)** **4x4 = 16**

a) FCAW
b) Hazard associated with welding power sources
c) AC and DC in TIG welding
d) Defects in SMAW welding
e) Diffusion bonding
f) Fluxes in SAW

4. a) Differentiate between fusion and solid state welding. 4
b) Explain role of AC and DC in TIG welding. 4
c) Discuss about oxidizing, Carburizing and neutral flames. 4
d) Write short note on arc blow and its prevention. 4

5. **Write short notes on (ANY FOUR)** **4x 4 =16**

a) Open circuit voltage
b) Welding hazards and their prevention
c) Electrode coating materials and their function in MMA welding.
d) AC and DC in TIG welding.
e) Principle of Submerged Arc Welding.

6. a) What is meant by DC SP and DC RP ? 6
b) Compare the application areas in DCSP, DCRP and AC with reasons. 4
c) Write a note on temperature distribution in arc. 6

7. a) Discuss the process variables in SAW.
(b) What are the advantages of SAW?
(c) Give the disadvantages and applications of SAW. 6+5+5=16

8. a) An arc weld process is made on steel under the following conditions:
E=20V, I= 200A, V=5mm/s, f1=0.9, f_2=0.3, Q=10J/mm^3.
Estimate the cross-sectional area of the weld pass.
b) State the conditions for satisfactory welds.
c) Discuss about solid phase welding. 4+5+7=16

THE INDIAN INSTITUTE OF WELDING

Associate Membership Examination

Winter Session, 2022-23

Sub : AME – 203: Welding and Allied Processes – II

Full Marks : 80

Pass Marks : 32 Time : 3 Hours

Answer any five

Parts of a question should be answered in one place

1. Write down the principles of resistance welding. Enumerate the salient features of any three types of resistance welding. 4x4 = 16
2. How laser is generated? With suitable figures briefly describe the working principle of CO_2 laser and Nd: YAG laser. 2+7+7 = 16
3. Explain with schematic sketches the basic working principles along with the key process variables the plasma arc welding and electron beam welding. 8+8 = 16
4. What are the differences between TIG and Plasma welding? What is the degree of ionization in forming plasma? What is the consequence of arc force in PAW? Write down the significance of plasma and inert gas in PAW. 4+2+5+5 = 16
5. Briefly describe the principle and application of electroslag and thermit welding. 7+1+7+1 = 16
6. What are those occasions you may choose Friction Stir Welding? Compare the microstructure changes between FSW and the fusion welding process. What are the differences between FSW and diffusion welding? With a neat sketch describe the principle of USW. 2+4+4+6 = 16
7. Specify the problems of joining ceramics with metal. With suitable examples briefly describe the joining of ceramics by fusion welding, friction welding and glaze bonding. 4x4 = 16
8. Write short notes on (*any four*) 4x4 = 16
   a) Magnetic pulse welding
   b) High-frequency welding
   c) Thermal spraying
   d) Braze welding
   e) Microplasma welding

THE INDIAN INSTITUTE OF WELDING

Associate Membership Examination

Winter Session, 2022-23

Sub : AME 16: Welding Metallurgy- I

Full Marks : 80

Pass Marks : 32 Time : 3 Hours

Answer any five

Parts of a question should be answered at one place

1. Enumerate the types of imperfections found on lattices in crystals. What is the atomic packing factor? Compare the FCC and BCC structures.
   9+2+5 = 16
2. Define critical cooling rate. Draw the CCT diagram of eutectoid iron-carbon alloy and name the different phases. 4+12 = 16
3. What is a TTT diagram? How TTT diagram can be experimentally determined for a given steel?
   4+12 = 16
4. Write the various basis for the classification of steel. Explain the various types of steel based on carbon content. 4+12 = 16
5. What is cold working? Depending upon the solid solution how steels can be hardened? 7+9
6. Write down the properties of the following alloying elements of steel
   a) Tungsten, b) Nickel, c) Chromium and d) vanadium 4x4 = 16
7. Write short notes (any four) 4x4 = 16

   a) Recrystallisation

   b) Work hardening

   c) Strain ageing

   d) Crystal lattice structure

   e) Carbon equivalent of steel

THE INDIAN INSTITUTE OF WELDING

Associate Membership Examination

Winter Session, 2022-23

Sub : AME 20E: Welding Metallurgy- II

Full Marks : 80

Pass Marks : 32 Time : 3 Hours

Answer any five

Parts of a question should be answered at one place

1. What is residual stress? How it can be minimised in welding? What are the causes of thermal stress? 2+10+4 = 16
2. a) Write the relation between residual stress and distortion in welding. 6
   b) What is reheat cracking? How it can be controlled? How to identify reheat cracking? 2+4+4
3. Briefly describe the influence of the following as alloying elements in steel. 4x4 = 16
   a) Carbon and nickel
   b) Silicon
   c) Chromium
   d) Molybdenum
4. a) What is the principle of hardfacing? Name the nominal compositions of three industrial hardfacing alloys. 10
   b) How to carry out hardfacing? What are its advantages? 10
5. Why corrosion rate is higher in welds than the base metal? Briefly describe the various forms of corrosion in welding joints. 2+ 14 = 16
6. a) What is weldability? Describe Cast Pin Tear Test (CPTT) or Hot Ductility Test. 2+8

   b) Compare strain-age cracking and lamellar cracking. 6
7. Write short notes (any four) 4x4 = 16

   a) Cladding

   b) Weldability of cast iron

   c) Hydrogen-induced cracking

   d) Recrystallization and grain growth in HAZ

   e) Effect of post-weld heat treatment in steel

THE INDIAN INSTITUTE OF WELDING

Associate Membership Examination

Winter Session, January 2023

Sub: Welding Metallurgy of Steels (AME-105)

Full Marks: 80 Time: 3 hours

Pass Marks: 32

Read the questions carefully and answer any five questions to the point

1. State the phase rule and apply it in the eutectoid reaction of Fe-Fe_3C equilibrium diagram. State the microstructures of annealed, normalized and quenched of 0.8% C steel and justify the differences. Explain why tempering is generally carried out after quenching . How do you select the temperature and time in case of tempering? 4+ 6 +4 + 2
2. Draw CCT diagram 0f 0.8 % C steel and superimpose the critical cooling rate(CCR). Explain the microstructures form at room temperature for faster and slower than CCR. Show how does the CCT diagram is being modified with addition of alloying elements? State the importance for such modification. 6+4+4+2

3. Draw and explain the Ingot solidification structure and weld solidification structure. Explain why segregation takes place during solidification of weld pool. Explain the problems that may arise during solidification of weld pool in case of carbon steel welding and how these problems can be overcome. 6+4+4+2

4. What is heat affected zone (HAZ)? Is it a single zone like fusion zone-Comment. How the size and microstructure of HAZ of plain carbon steel and austenitic stainless are affected by heat input-Discuss. Why HAZ is generally considered more critical in welded joints? 2+2+8+4

5. Why the presence of 5-8% delta ferrite prevents hot cracking in austenitic stainless steel? Draw Schaeffler diagram and explain how it can be used to find out required delta ferrite. What are the drawbacks of Schaeffler diagram. 2+12+2

6. a)Explain why there could be intergranular corrosion in HAZ of AISI 304 type austenitic stainless steel. Discuss the various methods to overcome it.
   b) How is the phase balance of duplex stainless steel altered during welding and how can it be restored. 10+6

7. a) Explain why hydrogen assisted cracking is more pronounced in HAZ of high strength steel . Discuss the methods to overcome it.

b) Explain why reheat cracking generally takes place in Cr, Mo, V etc. containing steel weldment ? Discuss how to overcome it. 8+8

8. Write brief note on the following: 4x4=16

a) Procedure and Selection of electrodes for welding cast iron.

b) Carbon equivalent and its usefulness.

c) Weld metal microstructure for good strength and toughness

d)Generation of residual stresses in the welds

THE INDIAN INSTITUTE OF WELDING

Associate Membership Examination
Winter Session, January 2023
Sub: Weldment design welding Procedure and its applications (AME-204)

Full Marks: 80 Time: 3 hours
Pass Marks: 32

Read the questions carefully and answer **any five questions** to the point**.**

1. Draw a single V-groove butt joint of 15 mm thick mild steel and state the function of each region. How does the groove design being modified by the processes, materials and their thickness- Discuss with suitable examples. What are the main disadvantages of butt joints? When does the designer recommend full or partial penetration of butt and fillet joints-Discuss. 4+ 6 +2 + 4
2. State the main applications of tubular joints and justify for such applications. Draw K type tubular joint and show the nodes. Define "hot spot stress" and state the factors influencing hot spot stress. How the stress concentration factor (SCF)is expressed in case of tubular joint? Which welding processes are currently used to construct both land and marine pipelines and justify such preference? 2 + 5 +4 +2 +3

3. a) What are the factors to be considered for the design of a joint? When the designers prefer butt joint or fillet joint? Give reasons.
   b) Consider a thin hollow circular tube welded on a plate at one end by butt weld and subjected to the twisting moment. Find the safe torque that can be applied when the diameter of the tube =100mm, wall thickness= 6 mm, length of the tube =500mm and allowable shear stress in the weld is 1.5 kg/ sq. mm.

c) A fillet weld of 12 mm leg is made with an electrode that deposits weld metals of 50 MPa minimum tensile strength. Find out allowable shear stress , unit load and bending stress. 4+6+6

4. a) What information are required in designing a pressure vessels? What are the basic criteria needed to be satisfied in service? What is the minimum design stresses considered in pressure vessel?

b) A pressure vessel is to be designed for an internal pressure of 2MPa using butt joint. The internal radious is 1250 mm and the thickness of the plate is 24.5 mm. Find out the allowable stress.(Assume thickness of the plate is the size of butt weld)

c) Why the pressure vessels are sometimes necessary for cladding? What are the materials used for cladding and how they are selected? Under what conditions PWHT is to be performed. 5+5+6

5. Write brief Notes on the following: 4x4=16

a) Weld symbols of brazed and soldered joints

b) Leak before break

c) Cruciform Joints and their applications

d) Distortion control in design and fabrication

6. a) What is “Residual stress”? How is it formed during fusion welding? What is the effect of residual stress in welded structure? How residual stress in weldment is being measured?

b) Which of the following material is expected to be more distortion under similar conditions of welding? Give reasons for each case. 10 + 6

i) Austenitic Stainless steel versus mild steel

ii) Aluminium versus mild steel

iii) High strength steel versus mild steel

7. a)What is fracture toughness? How does it differ from notch toughness? Why fracture mechanic based design provide more confidence to the designer so far as the life of the welded structure is concerned?

b) Consider two thick aluminium plates have been welded by butt joint. The width of the plate is 200mm. The fracture toughness of the joint is 30 MNm $^{-3/2}$. The maximum load of the joint will experience in the service is 200MPa. Find out the permitted crack length. 10 + 6