THE INDIAN INSTITUTE OF WELDING

Associate Membership Examination
Summer Session, July 2022
Sub: Material Science (AME-09)

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

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. Draw the following plane and direction in a cubic system, (321) plane and [101] direction. 2+2
b. Explain Schottky defect in a lattice. 4
c. For the HCP crystal structure, show that the ideal c/a ratio is 1.633. 4
d. Calculate the atomic Packing factor of BCC Crystal. 4

2. a. The average density of a carbon-fiber-epoxy composite is 1.615 g/cm³. The density of the epoxy resin is 1.21 g/cm³ and that of the carbon fibers is 1. 74 g/cm³. (a) What is the volume percentage of carbon fibers in the composite? (b) What are the weight percentage of epoxy resin and carbon fibers in the composite? 4+4
b. Derive an equation relating the elastic modulus of a layered composite of unidirectional fibers and a plastic matrix that is loaded under isostrain conditions. 8

3. a. A 0.8% C eutectoid plain carbon steel is slowly cooled from 750ºC to a temperature just slightly below 723ºC. Assuming that the austenite is completely transformed to a ferrite and cementite FeJC, Calculate the weight per cent of eutectoid ferrite formed. 4
b. Calculate the X-ray density of iron (BCC).
Given: Atomic radius= 1.24 A°, atomic weight= 55.85 gm/mole. 4
c. Estimate the surface energy of a surface etched sodium glass, which has fracture strength of 100MN/m2 and a young's modulus of 70GN/m2.Assume that the etching has removed all the surface cracks. A number of cracks are present inside the glass sample and they vary in length 1μm to 5 μm. 5
d. Calculate the linear atomic density p in the [110] direction in the copper crystal lattice in atoms per millimeter. Copper is FCC and has a lattice constant of 0.361 nm. 3

4. a .Calculate the energy in joules and electron volts of the photon whose wavelength is 303.4 nm. 4
b. Describe the covalent bonding process between a pair of hydrogen atoms. What is the driving energy for the formation of a diatomic molecule? 3+3
c. Explain with the help of suitable sketches the various types of bonding in crystal. 6

5. a. Draw the stress-strain diagram for a ductile material and show the salient points on it. 6
b. Sketch a typical creep curve and level its important areas. 5
c. Explain the terms percentage elongation and proof stress. 5

6. a. What is the functionality of a polymer? Distinguish between a bifunctional and trifunctional monomer. 3+4
b. Define the average molecular weight of a thermoplastics. 4
c. Distinguish between traditional and engineering ceramic materials and give example of each. 5

7. a. Calculate the fraction of atom sites that are vacant for copper at its melting temperature of 1084ºC (1357 K). Assume an energy for vacancy formation of 0.90 eV/atom. 4

b. Cite the relative Burger vector-dislocation line orientations for edge, screw and mixed dislocations. 6

c. Would you expect Frenkel defects for anions to exist in inonic ceramics in relatively large concentrations? Why or Why not? 2+2

d. What is grain boundary. 2

8. a. Briefly explain why, upon solidification an alloy of eutectic composition forms a microstructure . consisting of alternating layers of the two solid phases. 4

b. What is the difference between a phase and a micro constituent? 4

c What is a binary isomorphous alloy system? 3

d. Distinguish between hot and cold working. 5

THE INDIAN INSTITUTE OF WELDING

Associate Membership Examination

Summer Session, July 2022

Sub: Fluid Mechanics (AME-13)

Full Marks: 80 Time: 3 hours

Pass Marks: 32

Answer any five

Parts of a question should be answered at one place

1. a. Explain the following with neat sketch: (i) Surface Tension (ii) capillarity

   b. A vertical gap of 3 cm wide of infinite extent contains a fluid having dynamic viscosity 2 Ns/m^2 and specific gravity 0.8. A plate 1.5 m x 1.5 m x 0.25 cm is to be lifted with a constant velocity of 0.2 m/s through the gap. If the plate is in the middle of the gap find the lifting force required. The weight of the plate is 50 N. (4+4+8=16)

2. a. Explain with neat sketch the working principle of a micro-manometer.

   b. An inverted U-tube manometer is connected to two horizontal pipes P and Q through which water is flowing. The vertical distance between the axes of these pipes is 30 cm. When an oil of specific gravity 0.9 is used as a gauge fluid, the vertical distances of water columns in the two limbs of the inverted manometer (when measured from the respective centre lines of the pipes) are found to be same and equal to 34 cm. Determine the difference of pressure between the pipes.

   (8+8 = 16)

3. a. Explain boundary layer phenomenon over the curved surface of a horizontal cylinder with neat sketch.

   b. Explain major and minor losses in a pipe. (8+8 = 16)

4. a. Write short notes on (Any Four) – a) Reynolds Number, b) Mach Number, c) Froude Number, d) Weber Number, e) Prandtl Number

   b. A solid cone floats in water with its apex down words. Determine the least apex angle of cone for stable equilibrium. The specific gravity of the material of the cone is given as 0.8. (8+8 = 16)

5. a. Derive continuity equation in three dimensions in cylindrical coordinate system.

   b. Explain Newton's law of viscosity.

   c. The velocity vector in a fluid flow is given by $V = 5x^2\,i - 9xy^2\,j - 6tz\,k$. Find the velocity and acceleration of a fluid particle at (3, 7, 3) and at time t = 4. (8+4+4 =16)

6. a. Explain with neat sketch turbulent flow over a flat plate.

   b Explain by giving example Buckingham-pi theorem. (8+8 =16)

7. a. Derive and explain Bernoulli's equation with neat sketch.

   b. At a point in a pipeline where the diameter is 25 cm, the velocity of water is 5 m/s and the pressure is 340 kN/m^2. At a point 15 m downstream the diameter reduced to 10 cm. Calculate the pressure at this point, if the pipe is a) horizontal b) vertical with flow upward c) vertical with flow downward. (8+8 = 16)

THE INDIAN INSTITUTE OF WELDING

Associate Membership Examination

Summer Session, July 2022

Sub: Heat and Mass Transfer (AME-14)

Full Marks: 80 Time: 3 hours

Pass Marks: 32

Answer any five questions.
Parts of a question should be answered at one place.

1. a. State and explain Fourier law of heat conduction.
   b. Define thermal conductivity.
   c. Water flows through a tube (k = 35 W/mK) with inner radius R_i = 20 mm and outer radius R_o = 30 mm. The temperature of the water at a particular location is 280 °C. The pipe is surrounded by air at 30 °C. The associated surface heat transfer coefficient on the inner and outer surface are h_i = 1500 W/m^2K and h_o = 10 W/m^2K. Determine i) the overall heat transfer coefficient based on outer surface area ii) the heat transfer rate per metre length of the tube. (3 + 3 + 10 = 16)
2. a. Derive continuity equation in 3 dimensional Cartesian coordinate system.
   b. Write short notes on – i0 Reynolds number, ii) Nusselt number, iii) Rayleigh number, **iv**) Peclet number (8 + 8 = 16)

3. a. Define – i) fin efficiency, ii) fin effectiveness
   b. Derive an expression of temperature distribution and heat flow rate through a fin of uniform cross section and insulated tip. (6 + 10 = 16)

4. a. Derive an expression for Logarithmic Temperature Difference (LMTD) for a parallel flow heat exchanger.
   b. A counter flow heat exchanger is used to cool 2000 kg/h of oil (c_p = 2.5 kJ/kgK) from 100 °C to 35 °C by the use of water entering at 15 °C. If the overall heat transfer coefficient is expected to be 1.6 kW/m^2K, make calculations for the water flow rate, the surface area required and the effectiveness of the heat exchanger. Assume that the exit temperature of water is not to exceed 85 °C. Use NTU – effectiveness method. (6 + 10 = 16)

5. a. Write short notes on – i) Stefan Boltzmann law, ii) Kirchhoff's law of radiation.
   b. Define – i) gray body, ii) black body, iii) emissivity, iv) transmissivity
   c. A furnace inside temperature of 2200 K has a glass circular viewing of 6 cm diameter. If the transmissivity of glass is 0.08, determine the heat loss from the glass window due to radiation. (4 + 8 + 4 = 16)

6. a. Show that in a laminar internal flow through a pipe – average linear velocity of fluid is half of maximum linear velocity of fluid along flow direction.

b. Explain Buckingham pi theorem of dimensional analysis by giving suitable example.

(8 + 8 = 16)

7. Briefly describe – i) Laminar boundary layer flow over a flat plate ii) Lumped parameter analysis iii) Newton's law of cooling iv) Grashof number and its importance.

(4 x 4 = 16)

THE INDIAN INSTITUTE OF WELDING

Associate Membership Examination

Summer Session, July 2022

Sub: Welding Metallurgy - I (AME-16)

Full Marks: 80 Time: 3 hours

Pass Marks: 32

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

1. a) Draw the crystal structures of Cr and Cu. Which one is more close packed and why?
b) What are the different types of imperfections in crystals? Presence of crystalline imperfections is desirable or not – explain.
c) State the merits and demerits of macro structure and micro structure. 5+8+3

2. a) Define cold and hot deformations and state their advantages and disadvantages.
b)What is work hardening ? Give examples of two metals having low and high work hardening. How does work hardening behavior affect the mechanical properties.
c) What are the defects usually present in steel? What treatments are being given to produce clean steel? 6+6+4

3. a) State the different strengthening mechanisms . Which one is generally most desirable and explain why. Discuss with examples the application of each mechanism.
b) What is recrystallisation? State the factors affecting recrystallisation and its importance towards the properties of steel.
c) State two types of solid solutions and their limitations. Which one attributes higher strength and explain why? 6+ 6+4

4. a) What is phase diagram? How is it useful to us? What is the difference between phase and inter-metallic compound?
b) Draw Fe – C equilibrium diagram and show how small addition of Mn modifies the diagram. State the consequences of such modification.
c) What is closed gamma loop and how it can be broadened gamma area? 4+8+4

5. a) What is the first step of heat treatment? How do you select austenizing temperature for hypo and hyper eutectoid steel-Explain
b) With the help of CCT diagram, show how the micro structure 0f 0.3 % carbon steel varies with quenching in air, oil and water.
C) With the help of CCT diagram, show how the alloying elements, prior austenite grain size and inclusion affect CCT diagram. 4+6+6

6. a) How does structure of weld differs from base metal. How does the solidification of weld differ from ingot solidification? What is the consequence for such difference? How multi-pass weld improve properties-Explain.
b) Draw a typical thermal cycle of welding and show how it is being characterized.
c) Define "HAZ". It is not a single zone –explain. How does it affected by multi-pass welding. 8+ 2+ 6

7. a) Define "weldability". State the factors affecting weldability. What is carbon equivalent (CE)? Why carbon is given more **weightage** in CE ? Why weldability is usually correlated with carbon equivalent-Explain.
b) What is the purpose of preheating- explain with example. How do you select preheat temperature ? What are the effects of low and high interpass temperature in multi-pass welding. 10 +6

8. Write short notes on the following : 4x4=16
a) Strain ageing
b) Micro – alloyed HSLA steel
c) Pearlitic phase transformation in steel
d) Hardenability

THE INDIAN INSTITUTE OF WELDING

Associate Membership Examination

Summer Session, July 2022

Sub: Welding Metallurgy II (AME-20)

Full Marks: 80 Time: 3 hours

Pass Marks: 32

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

1. a) State the sources of O2, H2 and N2 and discuss the consequences of gas-metal reaction during fusion welding and how to control those.
b) Oxygen and nitrogen contents in weld metals have both bad and good effects on weld metal properties- Discuss with suitable examples.
c) Is it possible to transfer alloying elements from electrode coating to weld deposit? If so, explain how? 8+ 5+ 3

2. What are the different types of stainless steels available commercially? Discuss in brief the problems faced by different types of stainless steels during arc welding and state the causes and the remedies. 2+ 14

3. State the mechanisms of (i) Hydrogen induced cracking, (ii) Hot cracking, (iii) Reheat cracking and (iv) Liquation cracking. Discuss in brief how to control the above cracking phenomenon. 16

4. a) Residual stress and distortion are interrelated phenomena-Explain. How do you measure and control residual stress.
b) State the basic types of distortion and the factors responsible for distortion. What are the different approaches to control distortion-discuss. 8+ 8

5. Define "weldability" and state the factors affecting weldability. Discuss in brief the weldability of Al and Ni based alloys. 1+3+12

6. a) What are the problems faced in joining two dissimilar materials- Explain with examples. What is the role of Schaeffler diagram towards dissimilar weld joint-Explain.
b) What are the problems in joining Ti alloys? How to control those problems? 12 +4

7. How is it possible to protect steel from Wear and Corrosion-Explain with examples. State different methods of protection and discuss their merits and demerits. State the different hard facing electrodes and how to develop weld procedure to combat wear . 4+7 + 5

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

a) Types of corrosion in weldment.

b) Weld-ability of cast iron.

c) Advantages of multi -pass welding

d) Reheat cracking

THE INDIAN INSTITUTE OF WELDING

Associate Membership Examination
Summer Session, July 2022
Sub: Material Science (AME-101)

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

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. A cubic plane has the following axial intercepts: a= -1/2, b= -1/2, c= 2/3. What are the Miller indices of this plane? 3

   b. calculate the atomic packing factor for the FCC structure. 5

   c. What is the relationship between the length of the side 'a' of the BCC unit cell and radius of its atom? What is the coordination number for the atoms in the BCC crystal structure? 5+3

2. a. Explain with the help of suitable sketches the various types of bonding in a crystals. 6
   b.Using neat sketches show i) vacancy defect b) interstitial defect crystal 3+3

   c. State and explain the Bragg's law of X-ray diffraction. 4

3. For a polymer matrix fiber-reinforced composite.
   a. List three functions of the matrix phase. Compare the desired mechanical characteristics of matrix and fiber phases. Cite two reasons why there must be a strong bond between fiber and matrix at their interface. 3+4+3
   b. What feature is necessary in a monomer for addition polymerization to be possible? Is this same feature a necessity for condensation polymerization? 3+3

4. a. State and explain Griffith's theory of facture. 6
   b.Explain the role of fatigue behavior of materials. 4
   c. The yield stress of a polycrystalline material increases from 120 MN/m^{-2} to 220 MN/m^{-2} on decreasing grain diameter from 0.04 mm to 0.01 mm. find the yield stress for a grain size of 0.025 mm 6

5. a. Distinguish between elastic and plastic deformation of a solid. 4
   b. Distinguish between recovery and recrystallization. 5
   c. What do you mean by 'preferred orientation'? Discuss the effect of preferred orientation upon elastic properties. 3+4

6. a. What is metal creep? For which environmental conditions is the creep of metals especially important industrially? 2+3
   b. Describe the three stages in the ductile fracture of a metal. What are the characteristics of the surface of a brittle fracture of a metal? 3+3

c. Calculate the engineering stress in SI units on a bar 25 cm long and having a cross section 9 mm x 4 mm that is subjected to a load of 3500 kg. 5

7. a. A cubic plane has the following axial intercepts: a= -1/2, b= -1/2, c= 2/3. What are the Miller indices of this plane? 3

b.calculate the atomic packing factor for the FCC structure. 5

c. What is the relationship between the length of the side 'a' of the BCC unit cell and radius of its atom? What is the coordination number for the atoms in the BCC crystal structure? 5+3

8. a. Define (i) a phase in a material and (ii) a phase diagram. 2+2

b. Write equations for the following invariant reactions: eutectic, eutectoid, peritectic and peritectiod. How many degrees of freedom exist at invariant reaction points in binary phase diagrams? 6+6

9. a. compare the tensile strength, tensile modulus of elasticity, elongation and density properties of glass, carbon and aramid fibers. 8

b.Derive an equation relating the elastic modulus of a layered composite of unidirectional fibers and a plastic matrix that is stressed under isostress conditions. 8

THE INDIAN INSTITUTE OF WELDING

Associate Membership Examination

Summer Session, July 2022

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: (8 X 2 =16)

a) Find the value of elastic modulus of material if its Shear modulus and Poisson's ratio are 80GPa and 0.25 respectively.

b) What is factor of safety and how is it important in design of a component?

c) Which failure criteria are suitable for brittle and ductile materials?

d) Find the slanderness ratio of a column above which Euler column theory is applicable? Given E=200GPa and permissible compressible stress 320MPa.

e) Derive the hoop stress of a thin spherical vessel of thickness t, internal pressure p and diameter d respectively.

f) Why hollow shafts are preferred over solid shafts in engineering applications?

g) How is the bending moment and shear force of a beam related?

h) What is neutral axis of a beam? Does neutral axis always pass through centroid?

i) In Hinge supports, how many unknowns are there? Show with figure.

j) What are plane stress and plane strain?

k) Give one physical example of plane stress and plane strain.

l) What is principal stress? How many principal stresses are there in two dimensional stress situation?

2. a) By applying Euler's column theory find out the critical load of a column that has both ends fixed. 6

b) In case of short column which theory are applicable. Give two such examples. 4

c) A beam of dimension 10cm x 10cm and 2m long is fixed at both ends. The temperature of the assembly was raised by 200^{o}C. Find the thermal stress in the beam if E=210GPa and coefficient of thermal expansion 1.6x 10^{-6}/K. 6

3. 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

4. a) Derive the relation between Elastic modulus and shear modulus of an isotropic material. 6

b) A cube of 100cm is dipped into a sea and is placed 10km below the upper surface of the sea. Find the change in the dimension of the cube in sea water. If the Elastic modulus of the material is 200GPa, Poisson's ratio is 0.25 and sea water density is 1050kg/ m^3. Take g=9.8 m/s^2 6

c) What do you mean by strain energy? Find the strain energy of a bar of length L, area A and density d and elastic modulus E deforming under self-weight. 1+3

5. a) Show 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

6. 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

7. State/ define/ explain the terms (Any eight): 8 X 2 =16

a) Draw the stress- strain diagram of Mild Steel.
b) Resilience
c) Modulus of toughness
d) Hooke's Law
e) Poisson's ratio
f) Stress concentration
g) Statically indeterminate problems
h) Equivalent stress
i) True stress and engineering stress
j) Plasticity with physical examples

8. 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

THE INDIAN INSTITUTE OF WELDING

Associate Membership Examination

Summer Session, July 2022

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) Discuss the following casting defects with causes and remedies:
   i) Scabs and buckles, ii) Drops, iii) Hot tears, and iv) Metal penetration
   b) How would you increase the efficiency of an open riser? Discuss ideal theoretical shape of riser and its drawbacks. What factors limit the use of blind risers?
   c) Discuss the different methods adopted for promoting directional solidification.
   [6+6+4=16]

2. a) Explain Carburizing and its applications.
   b) Differentiate between PVD and CVD processes.
   c) Explain the basic differences between cladding and welding. Also state the utility of cladding.
   [5+5+6=16]

3. a) State the objectives and benefits of production planning. Briefly explain the role of a production planner.
   b) Explain the various costs associated with inventory and it's control.
   c) Draw a sample Gantt Chart and explain it's significance. [6+5+5=16]

4. a) Define fit? With neat sketch describe three types of fits. Differentiate between tolerance and allowance.
   b) Describe the three-wire method to determine the effective diameter of screw threads.
   c) Describe a method to determine the flatness of a surface plate. [6+5+5=16]

5. a) Explain the various methods adopted for controlling temperature during machining.
   b) Make a comparative study of HSS, carbide and ceramic tool materials with respect to their composition and application.
   c) Explain with neat sketches four important machining operations performed on a lathe.
   d) Differentiate between i) shaping and planing, and ii) grinding and milling.
   [4+4+4+4=16]

6. a) With a neat sketch explain the wire drawing process.
   b) With neat sketches explain i) Two high rolling mill, ii) Planetary rolling mill.
   c) How the extrusion process is classified. Differentiate between direct and indirect extrusion. [5+5+6=16]

7. a) Explain GMAW process. State the role of filler metal in welding.
   b) What do you mean by resistance welding? Explain briefly any two such welding processes.
   c) What are the different types of soldering processes?
   d) Why heat treatment may be required after welding? [5+5+3+3=16]

8. Write short notes on <u>any four</u>: [4x4=16]
   i) Submerged arc welding
   ii) Tool nomenclature
   iii) Impact extrusion
   iv) Loam molding
   v) EOQ
   vi) Open riser vs Blind riser

THE INDIAN INSTITUTE OF WELDING

Associate Membership Examination

Summer Session, July 2022

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)

a) For TIG welding of Aluminium what current is used?
b) What types of welding come under Gas Metal Arc Welding?
c) What are the fluxes in submerged Arc Welding?
d) Which welding uses non-consumable electrode?
e) What is DCSP? What materials are suited for this?
f) What are the inert gases used in TIG?
g) What is the main difference between MIG and MAG welding?
h) Write some alloying elements added to flux material of electrode to improve the strengths?
i) What is HAZ? Clear with figure.
j) Give some application of welding in industries?
k) How mechanical (micro-structural) properties are controlled in welding?
l) What are the sources of energy in welding?

2. a) Define welding Process. 2
b) Write a short description on brief classification of welding process. 6
c) Write the combustion chemistry of Oxy-Acetylene gas. 3
d) Discuss about different Oxy-Acetylene flames and their applications in short. 2+3=5

3. a) Compare ohm law and arc characteristics in welding process. 3
b) What are welding parameters? Compare the welding parameters and their control in TIG, MIG and MMA welding. 3+6=9
c) What are heat transfer efficiency and melting efficiency? Explain with mathematical terms. 4

4. write short notes on:
a) Open circuit voltage 2
b) Welding hazards and their prevention 2
c) Electrode coating materials and their function in MMA welding. 5
d) AC and DC in TIG welding. 4

e) Principle of Submerged Arc Welding. 3

5. 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. 6
b) State the conditions for satisfactory welds. 4
c) Discuss about solid phase welding. 6

6. a) What forces function to detach the droplets of weld against the force of gravity in GMAW? 5
b) Write a short description of MIG welding with figure. 6
c) Write the mechanism of Arc Blow and its remedies. 5

7. a) Write about use of AC and Dc in TIG welding. 5
b) Write the effect of shielded gas on metal transfer in MIG/MAG welding. 5
c) What is orbital welding? 2
d) What are the consumables for MIG welding? 4

8. a) Write a short note on Power supply equipments in Arc Welding. 8
b) Describe how polarity affects the metal transfer in welding processes. 8

THE INDIAN INSTITUTE OF WELDING

Associate Membership Examination

Summer Session, July 2022

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. Draw steel portion of Fe-C equilibrium diagram showing the different microstructural features. State how microstructures are being changed with increasing carbon content both at room temperature and above A1 and justify such changes. Show how Fe-C diagram is being modified with addition ferrite stabilizing element like Cr and austenitizing element like Ni. 8 + 4+ 4

2. Explain why is it necessary to add alloying elements in steel? Do the alloying elements exert any effect on TTT or CCT diagram and if any, what is the consequence? What is the effect of carbon on TTT or CCT diagram and what conclusions can be drawn from this effect ? Explain what is the advantage of CCT diagram over Fe-C diagram as far as microstructures of weld metal is concerned? 2 + 5+ 4 + 5

3. a) Draw a typical weld thermal cycle for a point in HAZ. Discuss the significance of peak temperature and cooling rate obtained at different points in HAZ.
   b) Discuss how peak temperature attained at a location in HAZ is affected by (i) plate thickness (ii) heat input and (iii) preheat temperature.
   c) Calculate the peak temperature attained by a steel plate of 8 mm thickness at a distance of 2 mm from fusion zone, while welding at 30V,300 amps with a speed of 5 mm/s. 6 + 6 +4

4. a) How does weld solidification differ from ingot solidification and what is the consequence?
   b) "It is possible to control the microstructure of weld metal; but very little control can be made on mcrostructure of HAZ" – Explain.
   c) How does gas-metal and slag-metal reactions affect weld metal- discuss. 4+6+ 6

5. a) Define "weldability". Why Weldability varies inversely with hardenability. State the different factors affecting weldability - discuss with examples.
   b) State the mechanism of hot cracking. Explain how manganese influence porosity and hot cracking of steel welds.
   c) What is carbon equivalent? Where and how is it useful? Calculate carbon equivalent for AISI 4340 steel with the composition 0.4%C, 1% Ni, 0.5% Cr and 0.2% Mo. Suggest the weld procedure for plates of 25 mm thickness. 6+ 6 +4

6. a) Discuss critically the microstructure of C-Mn steel weld metal in a single pass. How is it altered during multi-pass welding .

b) Discuss how do you select welding consumables for austenitic stainless steels. Explain why the presence of 5-8% delta ferrite prevents hot cracking in austenitic stainless steel (ASS)weld metals. State the procedure for calculating the presence of delta ferrite content in ASS weld metal before welding.

c) Why intergranular corrosion takes place in HAZ of ASS ? Will increasing the heat input be beneficial to avoid intergranular corrosion, if so how ? If not Why?

d) Duplex stainless steel requires more rigid control of welding parameters than ASS-explain. 4+6+4+2

7. a) State the expectancy of residual stress of the following welds and Justify:

i) Austenitic stainless steel vs. mild steel,

ii) Aluminium vs. steel and

iii) High strength steel vs. mild steel

b) State the factors responsible for hydrogen induced cracking (HIC). Why the susceptibility of HIC increases with increasing strength of welded joint? Discuss the different ways to control HIC of high strength steel. Can HIC take place in HAZ? If so how? If not why?

c) Two steels with same carbon equivalent may have different weldability-Explain. 6+8 +2

8. Write short notes on the following: 4X4 =16

a) Weldability Test

b)Reheat Cracking

c) Post weld heat treatment

d) Weldability of steels used for high temperature appliications

THE INDIAN INSTITUTE OF WELDING
Associate Membership Examination
Summer Session, 2022
Sub : Testing & Quality Assurance (AME - 201)

Full Marks : 80 **Pass Marks : 32** **Time : 3 Hours**

Answer any 5 questions.
All questions carry equal marks. (16X5)

1. **What is Quality ? Define Inspection, Quality Control, Quality Assurance and Total Quality Management and state the differences between each with the other. (4+3+3+3+3)**

2. **State the Components of Quality Assurance to ensure the quality of a product and process. How can you ensure Quality in Process Specification and Welder Specification ? what are the Standards and Codes ? (4+8+4)**

3. **Define : Hardness, Toughness, Brittleness and Ductility of a metal ? How can you measure Hardness in a laboratory and at site ? Mention the instruments to be used and brief procedure to use them. (3+3+3+3+4)**

4. **State the Visual Welding Inspection stages in production welding. What are the different items to inspect in Different stages of welding inspection? (4+12)**

5. **What are the differences between NDT and DT ? State and explain briefly the different NDT methods normally used. (4+12)**

6. **Welding Cracks are common defects in welding. What are the different types of welding cracks ? Draw sketches to show different types of cracks, the causes of such cracks and the detection methods. (4+12)**

7. **What is DP test ? Explain with sketches the step by step procedure for a DP test. What is Fluorescent Penetration test ? Where is it applied ?**

   (2+12+2)

8. **Write Short Notes on (Any Four) (4+4+4+4)**
   a. **Magnetic Particle Inspection.**
   b. **Fatigue Strength Measurement.**
   c. **Acceptance Sampling.**

d. **Statistical Quality Control.**
e. **Weldability and Tests.**

THE INDIAN INSTITUTE OF WELDING

Associate Membership Examination

Summer Session, July 2022

Sub: Welding Metallurgy of Non Ferrous Alloys, Dissimilar Welding and Cladding (AME-202)

Full Marks: 80 Time: 3 hours

Pass Marks: 32

Answer any 5 questions.
All questions carry equal marks. (16X5)

1. **Compare the basic characteristics of Aluminium with Steel. State in brief the different alloys of Aluminium in use. (8+8)**

2. **All Aluminium Structural Members have a thick layer of Oxide on their surfaces. Can we weld without removing the layer / How? By which process ?**
   What are the standard methods of removal of the oxide layer before welding ? Explain trhe process step by step. (8+8)

3. **When welding Copper and Copper Base Alloys which are the specific properties that require special attention and why?**
   Magnesium can be welded by many welding processes – state the processes with special care taken for the characteristic properties of Magnesium. (8+8)

4. **State and explain the welding Processes, Consumables used and special precautions to be taken in welding Titanium and its alloys.**
   What are the effects of oxygen contamination during welding? How do you propose to prevent it on different grades of Titanium and its Alloys? (8+8)

5. **What is WEAR ? State the factors causing wear in metal parts. State the compositions and specific properties used as Wear Resistant Alloys in an environment of wear and abrasion. (4+6+6)**

6. **What is CLADDING ? What are the differences between Cladding and Hardfacing ? What are the materials used for Cladding? Which Consumables are used in Hardfacing? (4+4+4+4)**

7. **A part made of IS 2062 steel is to be welded with a ss 308L steel part. Explain the Welding Process, welding Consumables Welding Parameters and post weld heat treatment if necessary.**
   State in brief what may be the defects in such welding and how to prevent these. (12+4)

8. **Write Short Notes on (Any Four). (4+4+4+4)**
   a. **Effects of Nickel and Chromium in Steel.**
   b. **NDT methods in repaired Cast Iron part.**
   c. **Lamellar Tearing and HIC.**
   d. **Shielding Gas and Electrodes used in welding Mg-Al.**
   e. **Buttering – uses and materials.**

THE INDIAN INSTITUTE OF WELDING

Associate Membership Examination

Summer Session, July 2022

Sub: Welding & Allied Processes-II (AME-203)

Full Marks: 80 Time: 3 hours

Pass Marks: 32

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

1. Why resistance spot welding (RSW) is so popular in automotive sectors? How do you calculate heat input in RSW? Which parameter provides more uncertainty in calculating heat input and explain why? What is weldability lobe and how do you determine it? How do you select parameters for dissimilar thickness? How the Quality of RS Welds is being evaluated? How does the thermal cycle (Temperature-time curve) of RSW differ from arc welding and explain why? 2 + 2 + 2 + 4+ 3 +3

2. a) How does the plasma arc welding become a variant of TIG welding process and what is the consequence? What is micro plasma welding and where it is being used? How does the plasma arc serve for both cutting and surfacing? 3+ 2+3
   b) What is electro slag welding? Explain with a neat sketch the operation of the process. How do you control heat input in this process. State the advantages, disadvantages and typical application of the process. 1 + 3 + 2 + 2

3. State the principle of laser beam welding (LBW)? What is difference between conductive and key-hole mode operations of LBW? How the stability of key-hole mode operation is being established? What are the main LBW parameters to be adjusted for joining different thickness of same material? When conductive mode of operation is particularly desirable? Is there any influence on joint performance due to pulse laser welding- explain. What are the advantages of diode laser welding over conventional LBW? 2 +3+ 2 +2 +2 +2 +3

4. Why solid state welding is being preferred for dissimilar welding? What are the basic differences between friction welding and friction stir welding (FSW)? Show with a neat sketch the formation of different zones in FSW and explain the characteristics of each zone. What are the functions of the tool and shoulder? Does the ratio of shoulder diameter and tool diameter have an effect on the joint performance? Explain why is it necessary to optimize heat input in FSW? 3+2+ 4+2+ 2 + 3

5. What is Transient liquid phase (TLP) diffusion bonding? Discuss the mechanism of bonding in TLP and the role of interlayer. How does it differ from conventional diffusion bonding (DB) process? What are the advantages of TLP over DB? What is the main problem in joining metal matrix composites using TLP diffusion bonding and explain why? 2 + 6+ 2 + 2 + 4

6. a) What is the major problem in joining ceramic material? How this problem can be minimized- explain with two suitable processes of joining and their merits and demerits. 2 +6
   b) With a neat sketch describe explosive welding process. Explain the mechanism of boding and it's typical application. 5 +3

7. a) What are the different types of water-jet cutting? State their operations and field of applications. 1+ 3
   b) How the quality of cutting is defined. State the mechanism of cutting in oxy-fuel gas cutting and plasma cutting? Why is it difficult to cut stainless steel using oxy-fuel gas cutting? 2+ 3+2
   c) State the principle of laser cutting. When pulse laser cutting is being preferred over continuous laser and explain why? 2+ 3

8. Write Short notes on the following: 4x4=16

a) Laser Surfacing
b) Magnetic pulse welding
c) Vacuum brazing
d) Braze welding

THE INDIAN INSTITUTE OF WELDING

Associate Membership Examination

Summer Session, June 2022

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. With a neat sketch describe how residual stresses (RS) are being developed with the progress of fusion welding. Show the distribution of RS in longitudinal and transverse direction of weld. How the RS distribution is affected by external constrain? State the parameters characterizing RS distribution and discuss how these parameters vary with heat input and joint strength? Does RS affect the properties of welded joints-comments. 5 + 3 + 2 + 4 +2

2. How distortion takes place in welded joints? State in brief different types of distortion and their causes. Discuss the different approaches to solving distortion problem? How do you control angular distortion of butt and fillet welds? Justify why maximum angular distortion takes place when plate thickness is neither thinner nor thicker. How do you control buckling distortion of butt weld? 2 + 4 +4 +2 + 2 +2

3. Brief notes on the following (Any Four): 4x4 = 16
   a) Vibratory stress-relieving technique
   b) Stress Concentration Factor
   c) Hot Spot Stress
   d) Pressure vessel cladding
   e) leak before break

4. What is fracture? How does it differ from failure? What is fracture toughness? How does it differ from notch toughness? Explain how fracture mechanics approach based design differs from traditional approach to structural design? What does it mean by the term" Fitness for Purpose"- explain with example. 2+ 2+ 2 +3+ 3+ 4

5. What is the purpose of preparing WPS in manufacturing? What are 'P' and 'F' numbers? State the Essential and Non-essential variables required to prepare WPS as per ASME Section IX. Explain how you will prepare a WPS for radiographic quality butt weld of 30 mm thick HSLS 8O steel plate. 2+2+ 4+ 8

6. a) Discuss the limitations of certain types of welded joints such as square – groove, single V-groove, single – bevel groove, double – bevel groove, and fillet welds, under service stresses such as tension, shear , bending or torque and economy point of view. 8

   b) Rocket motor case has been fabricated from a thin wall tube made of maraging steel that has got YS of 1800MPa and fracture toughness 50 MPa $(m)^{1/2}$. Calculate the minimum size of the defect required to give brittle fracture in service. (Consider the design stress =YS/1.5 and Young's modulus =200 GPa) 8

7. What is purpose of welding symbols on drawing? State the elements of welding symbols. 4

   Draw the welding symbols as per ISO and AWS to specify the followings: 8 x1.5= 12

   a) A single –V butt weld with weld flash
   b) Partial penetration single –V butt weld
   c) Double fillet weld with 6 mm leg length
   d) Unequal leg length fillet weld
   e) Single side intermittent longitudinal fillet weld
   f) Single-V weld with removable backing strip
   g) Cruciform joint
   h) Location of butt weld

8. a) What are the critical dimensions of welded connection in case of groove and fillet welds?

   b) A single fillet weld joint was made of high strength steel plate using E7018 electr0de. Calculate the strength of transverse fillet welded joint and allowable unit load as per standard. (Assume any missing data)

   c) A circular fillet weld was made to join steel plate and circular object made of same steel using E6012 electrode. Calculate the stress (i) when the fillet weld is subjected to torsion and (i) subjected to bending. (Assume any missing data) 2 +4+10

THE INDIAN INSTITUTE OF WELDING
Associate Membership Examination
Summer Session, 2022
Sub : Occupational Health, Safety and Environmental Issues in Welding and Related Areas (AME - 205)

Full Marks : 80 **Pass Marks : 32** **Time : 3 Hours**

Answer any 5 questions.
All questions carry equal marks. (16X5)

1. **What is Safety? Why Safety is a must in Welding workshop ? What is a Hazard ? What are the Hazards in Welding and how can you protect workmen from these Hazards? 2+4+2+8**

2. **What are the health Hazards in Welding at Confined place? What precautions do you propose for the safety of the welder ? 8+8**

3. **List the sources of Gas and Fume Generation in Welding. Explain the nature of such fumes and the steps to be taken for the safety of the workmen. 8+8**

4. **What are the types of radiation given off by the welding arc? What are the effects of such radiation? What are the protective measures you can take against such Hazards ? 4+6+6**

5. **State the Hazards in the following ancillary work processes of welding and the protective measures to be taken against each : (1+1) X 8 = 16**

:

Sl. No.	PROCESS	HAZARDS	PROTECTIVE MEASURES
1	Gas Cutting		
2	Plasma cutting		
3	Grinding		
4	Chipping		
5	Handling Gas Cylinders		
6	Shearing		
7	DP Tests		
8	Radiographic Test		

6. Write Short Notes on (Any Four) 4 X 4

a) **Fire Extinguishers**
b) **International Standards in Health and Safety.**
c) **Ergonomics as applied for welding safety**
d) **Need for Welding Booths and Curtains**
e) **Methods of Fume Extraction from welding workstations.**

7. Answer all the following questions (Strike off the wrong one) 2 X 8

a) **Metal fume fever is a possibility after exposure to fumes from (Cobalt / Manganese)**

b) **A benign form of pneumoconiosis may be formed during welding (Steel / Chromium)**

c) **"Welders Flash" or "Arc Eye" is caused by (Infrared / Ultra Violet Radiation)**

d) **The Filter Lens Shade number 12 is used for (CAW / GMAW)**

e) **Heavy, leather gloves are worn to protect welder's hands from (Radiation Hazards / Heat and Shock Hazards)**

f) **The most common injury to the welder is (Arc Eye / Burns)**

g) **To protect the hands of welder from welding injuries use - (Rubber Gloves / Leather Gloves)**

h) **The level of NOISE potentially hazardous to a welder is over – (85 decibels / 95 decibels).**

8. Explain in brief – what would you do : 4+4+4+4

a) **In case of FIRE in the Electrical Switch Board ?**
b) **In case of a BURN on the leg of a welder ?**
c) **ARC EYE of a Welding Supervisor ?**
d) **LEAKAGE OF GAS from a Acetylene Cylinder ?**

THE INDIAN INSTITUTE OF WELDING

Associate Membership Examination

Summer Session, July 2022

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. **Explain Laser Welding and Electron Beam Welding processes, industrial applications and specific advantages and disadvantages of each. 16**

2. **What is a ROBOT ? Explain Robotic Welding as used and applied in different welding processes. State and explain the advantages and disadvantages of Robotic welding. 4+6+6**

3. **Describe the process of TANDEM GMAW with sketches. State the Characteristics and advantages of Tandem GMAW over the standard GMAW process. 6+5+5**

4. **What is CMT ? Describe the process in details with sketches and specific applications. Is it productive and useful in Manufacturing applications ? 4+8+4**

5. **In ADDITIVE Manufacturing different welding processes are used. Which process is most effective and why? What is meant by WAAM? Comment on the effect use of part size, utilization of materials and deposition rates as applicable in Additive Manufacturing. 4+4+8**

6. **Write short notes on (Any Four): 4X4=16**
   a) **CMT+P welding.**
   b) **Cold Wire Tandem Submerged Arc Welding**
   c) **Laser Hybrid Welding.**
   d) **Narrow Gap Welding**
   e) **Friction Stir Welding.**

7. **State and explain the essential characteristics of INTELLIGENT POWER SOURCE. Explain the terms : (a) IGC. (b) IAC. (c) DOC. (d) TIG-A-TACK.**

8+2+2+2+2

8. **Explain with sketches KEYHOLE WELDING. Make out a comparative benefits and problems list on LASER and TIG Keyhole welding processes.**

8+8

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