THE INDIAN INSTITUTE OF WELDING

Associate Membership Examination

Summer Session, July 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. a) State the characteristics of power sources with balance sine wave ac and square wave ac with unbalanced wave-forms and their influences on GTAW fusion behavior of aluminium.
   b) What is K-TIG welding process? How to achieve a keyhole in this process? State the advantages, limitations and applications of this process. 8+8

2. Explain how the peak current and it's duration as well as background current and it's duration affect pulse spray MIG welding process? What are the three essential criteria that must be satisfied to obtain a stable pulsed process? How the welding variables such as wire feed speed, welding voltage, rate of current increase and peak current control the spatters in pulse MIG welding-Explain. What is "synergic control" of pulse spray MIG welding? 6+2+6 + 2

3. a) Why is it necessary for real-time process monitoring and control? What is "process monitoring systems"? Discuss with suitable examples the difference between open-loop control and closed-loop control systems. 2 + 2 +4
   b) What are the basic differences among mechanized, automated and robotic welding? State the advantages, disadvantages and regime of applications in each category of welding. 2+6

4. a)What is the difference between twin-wire system and tandem-wire system? Discuss tandem SAW with cold wire addition with respect to technique of wire addition, wire feed speed and energy input. State the advantages of tandem cold wire over twin wire system. 2 +6+2
   b) What is narrow gap submerged arc welding? What problems may encounter in this process and how the problems could be minimized? 1 +5
5. Why hybrid laser-arc welding is sometimes preferred to either the laser or the arc in isolation? Explain why the distance between the arc and laser sources and laser beam focal position are considered as important process parameters. State the benefits derived from backhand and fore -hand welding and their applications. Why helium is required in the shielding gas for hybrid laser-arc welding -Explain. 4+ 6+ 4 + 2

6. Define "Additive Manufacturing (AM)". State the methods of wire arc additive manufacturing and powder added additive manufacturing and their respective advantages and limitations. How is it possible to enhance properties with AM that are not attainable by conventional manufacturing processes- Explain. State two typical applications of AM. 2+ 8+ 4 +2
7. Write short notes on (any four) : 4x4 = 16
   a) Strip cladding using submerged arc welding
   b) Principle of cold metal transfer and its applications
   c) Digital power source for arc welding
   d) Flexible Automation
   e) Defects in product formed by AM

THE INDIAN INSTITUTE OF WELDING

Associate Membership Examination

Summer Session, 2023-24

Economics of Welding and Fabrication (New Syllabus) (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 the concept of "Economies of Scale" with suitable example. Justify the need of enjoying economies of scale in a production house.

b. What does a Production Function represent? What are the probable consequences of changing the production function in a production house?

c. Explain the concepts of the output elasticities of the resources in consequence of a production function? Justify with proper examples. (3+3)+5+5

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

b. The following table shows the average sales of shops (in Rs. '000/day) in various locations of Mumbai and the corresponding rent of a shop in the same locality (in Rs. '000/month). Using trend analysis, determine the rent of the shop in three localities where the average sales of shops (in Rs. '000/day) is 110, 115, and 120 respectively.

Average sales of shops in a locality (in Rs. '000/day)	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105
Rent of the shop in the locality (in Rs. '000/ month)	5.4	7.1	9.6	10.7	15.3	13.5	15.1	16.7	19.8	21.3	21.2	24.8	35.9	27.2	28.8	30.7	31.6	43.2	35.4	47.9

3+5+8

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

b. How can the concept of Break Even Analysis be applied to Facility Location Planning? Justify your answer with a suitable case study. 6+10

4. a. Explain how does the Cost influence the Price and Revenue of any product? Justify your answer with case studies.

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

i. Sunk Cost

ii. Opportunity Cost

iii. Marginal Cost

iv. Variable Cost 4+(3×4)

5. a. What is Market?

b. What are the different types of Market? Explain with suitable example.

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

6. a. Explain the importance of NPV and IRR in analyzing different investment opportunities of a business with suitable example.

b. Calculate NPV, IRR and B-C Ratio from the following data. Assume rate of interest as 10% per annum.

Year	Cash Flow (Rs.)
0	(-)5,00,000
1	50,000
2	30,000
3	60,000
4	(-)3,00,000
5	80,000

4+(3×4)

7. a. Explain the objective of pricing.

b. Explain different pricing strategies of the products associated with Welding and Fabrication.

4+12

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

a. Inflation and its impacts on production houses.

b. Influences of technological developments in determination of pricing of a new product.

c. Risk of a business.

d. Investment opportunities.

THE INDIAN INSTITUTE OF WELDING

Associate Membership Examination
Sub: Materials 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. What is ionisation energy?
   b. Describe the difference between atomic mass and atomic weight.
   c. Explain briefly how substances with ionic bonding differ in properties from substances with covalent bonding.
   d. The radius of first Bohr orbit of electron in a hydrogen atom is 0.529 A°. calculate the radius of the second Bohr orbit in a singly ionized helium atom. 2+4+6+4

2. a. What are the Miller indices? How are they determined?
   b. Write a short note on Frenkel defect and Schottky defect in a crystal.
   c. Calculate the atomic packing factor for the BCC structure.
   d. Distinguish between slip and twin mechanism of plastic deformation in metals. 4+4+4+4

3. a. What is phase diagram? Explain lever rule.
   b. What do you understand by solid solution?
   c. Explain the following invariant reactions with reference to a phase diagram (i) eutectic reaction (ii) eutectoid reaction (iii) Peritectic reaction (iv) Peritectoid reaction.
   d. The complete solubility in liquid as well as solid state is possible only for substitutional type of binary alloys. Why? (2+2)+2+8+2

4. a. What is recrystallization? Define recrystallization temperature. Explain the factors affecting recrystallization process.
   b. "Maximum shear stress is observed, if the slip plane is at 45° in a single crystal" – Explain.
   c. What is work hardening? How does it occurs?
   d. What do you mean by "preferred orientation" ? Discuss the effect of preferred orientation upon elastic properties. 4+4+4+4

5. a. Explain the role of fatigue fracture behavior of materials? What are the different types of loadings available for fatigue testing?
   b. State and explain Griffith's theory of fracture.
   c. A steel bar 12.7 mm diameter breaks with a load of 14 kN. Its final diameter is 7.87 mm. What is (i) true breaking stress (ii) nominal breaking stress?
   d. Differentiate between Brittle fracture and ductile fracture. (2+2)+(2+2)+(2+2)+4

6. a. What do you mean by Engineering plastics? Give examples.
   b. Why is bakelite a thermosetting polymer? Write down the addition polymerization and condensation polymerization.
   c. Write down the characteristic property of a good plasticizer. Give examples of good plasticizer.
   d. How are polymers are classified on the basis of their structure? (2+2)+(1+3)+(2+2)+4

7. a. Define ceramic and refractoriness. Discuss properties of refractory materials.
   b. What is a glass? Define glass transition temperature.
   c. Which refractory oxide is inert to carbon and carbon monoxide? What are its limitations?
   d. What is the structure of silicon and silicates? (3+3)+(2+2)+(2+2)+2

8. a. Derive the equation for transverse and shear modulus for composites.
   b. Explain the composition, properties and applications of polyamide resin and phenolic resin.
   c. List the different fabrication methods of polymer matrix composites and explain any one.
   d. Discuss rule of mixture. 6+4+4+2

THE INDIAN INSTITUTE OF WELDING
Associate Membership Examination
Summer Session, 2023-24
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 are the different safety hazards in welding? What are the factors on which they depend? 8+8

2. What are the different health hazards in welding? Discuss how they vary with different welding processes. 8+8

3. a) What is occupational health? Differentiate between occupational and other diseases. Name any two welding related occupational diseases. 2+2+4

   b) Differentiate between welding gases and fumes, with two examples of each. 4+4

4. How are backfire and flashbacks caused? How to prevent flashback? What are the steps to be taken if flash back occurs? 6+6+4

5. Differentiate between hazard and risk. Describe a risk management strategy which will help to identify and manage welding health and safety risks at work. 4+12

6. What is ergonomics? What are the ergonomic factors that require consideration when analyzing and designing the welding equipment and environment? 4+ 12

7. Name the Indian Standard (IS) Code of Practice for Safety and Health Requirements in Electrical and Gas Welding and Cutting Operations? Briefly describe its salient features. 4+12

8. Write short notes on any 4 of the following:

   a) Phosgene
   b) Respirable particles
   c) Metal fume fever
   d) Arc eye
   e) TWA and STEL
   f) Material Safety Data Sheet
   g) Hierarchy of control measures
   h) Section 37 of The Factories Act, 1948

   4x4

THE INDIAN INSTITUTE OF WELDING

Associate Membership Examination

Summer Session, July 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) Explain with neat sketches different types of patterns used in casting.
   b) Explain briefly different types of furnaces used in casting.
   c) What is directional solidification and what are the ways and means to achieve it?

[6+6+4=16]

2. a) Explain Nitriding process and its applications.
   b) Differentiate between carburizing and cyaniding processes.
   c) Explain the different coating methods applied for surface modification.

[5+5+6=16]

3. a) Explain the terms TIME STUDY and MOTION STUDY with suitable examples.
   b) Explain the various costs associated with inventory and it's control.
   c) What do you mean by EOQ? How can it be determined? [6+5+5=16]

4. a) Tolerances for a hole and shaft assembly having a nominal size of 50 mm are as follows:

$$\text{Hole} = 50\,^{+0.02}_{+0.00}\ \text{mm and shaft} = 50\,^{-0.05}_{-0.08}\ \text{mm}$$

Determine the following:
(i) Maximum and minimum clearances
(ii) Tolerances on shaft and hole
(iii) Allowance
(iv) MML of hole and shaft
(v) Type of fit

b) Discuss about GO and NOT GO gauge with sketch. [10+6=16]

5. a) Explain briefly the needs of cutting fluid in machining.
   b) Write a brief note on advanced cutting tool materials.
   c) Draw and label Merchants circle diagram. State the assumptions made for drawing.
   d) Explain various taper turning methods that can be performed on a lathe.

[4+4+4+4=16]

6. a) With a neat sketch explain the basic Rolling process. What are the different Rolling mills?
   b) Differentiate clearly between drop forging and press forging.
   c) What is Spring Back effect in sheet metal operations? Differentiate between embossing and Coining. [6+5+5=16]

7. a) Explain TIG Welding process. Also state the advantages and limitations of the process.
   b) Explain any two solid welding processes with suitable figures.
   c) Differentiate between soldering and brazing.
   d) Explain three important defects in welding. [5+5+3+3=16]

8. Write short notes on <u>any four</u>: [4x4=16]
   i) Centrifugal casting
   ii) Twist drill
   iii) Hot working of metals
   iv) Precision Vs Accuracy
   v) Gantt Chart
   vi) Chills and chaplets

THE INDIAN INSTITUTE OF WELDING

Associate Membership Examination Winter Session, July 2023

Sub : Testing, Inspection and Quality Assurance (AME–201)

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

			Marks
1	a)	Describe Vickers, Brinell and Rockwell Hardness testing. If a 25Rc is the hardness measured for a steel weld metal what would be the approximate hardness of weld metal in Vickers and Brinell Hardness scales?	8
	b)	What information can we derive from measurement of hardness of the weld metal and HAZ with respect to weldability of the material, properties and heat treatment of the joint	4
	c)	What are the options available for in-situ hardness measurement in a component? What are the applications of microhardness testing in assessing the properties of the weld joints How hardness is related to yield strength of the material?	4
2	a)	Drawing a typical tensile test stress- strain curve for carbon steel, explain the information we can get from a tensile test. Does the ductility estimated from the tensile test depend on the specimen dimension? Justify.	4
	b)	Explain why longitudinal (all weld metal) tensile test is specified to qualify a welding consumable and transverse weld joint tension test is specified for welding procedure qualification?	4
	c)	Draw schematic of a standard Charpy V-notch impact specimen extracted from a butt weld joint for testing impact toughness of the weld metal. Mark dimensions of the specimen and the notch. Indicate the correct orientation of the notch with respect to weld metal (whether it is at root, top or side of the weld)	4
	d)	Show schematically how impact toughness a) carbon steel and b) austenitic stainless steel vary with temperature. What is ductile brittle transition temperature and how it is determined from impact test. How impact toughness for a weld metal is normally specified?	4
3	a)	What is cold cracking? What are the necessary conditions for a steel weld joint to be susceptible to cold cracking? How to predict susceptibility of a carbon steel to cold cracking from its composition? Give one example each of a self restraint test and externally restraint test employed to evaluate the susceptibility of a weld joint to cold cracking. What are options available to prevent cold cracking of carbon steel and alloy steel welds?	8
		What is hot cracking? Differentiate between different forms of hot cracking: a) solidification cracking, b) liquation cracking, c) Ductility dip cracking	4
		What is lamellar tearing? Which joints are more susceptible to this form of cracking than others? Which mechanical test is conducted on the base metal to evaluate its susceptibility to lamellar tearing? How material is graded based on the results of this test.	4
4)	a)	Describe steps involved in dye penetrant examination. Why DP check is often recommended after root pass welding?	4

	b)	What is the principle of Magnetic particle inspection? What is its advantage over DPI? Differentiate between continuous and residual method of magnetisation	4
	c)	Why hydrostatic test is called proof test? Why hydrostatic test is preferred over pneumatic test?	4
	d)	Give short note on He leak testing.	4
5		Write short notes on a) consumable qualification, b) welding procedure qualification, c) welder qualification List down the destructive and non-destructive tests required for each qualification. What is meant by essential, non-essential and supplementary essential variables in these qualification processes? Explain with examples	16
6	a)	Briefly explain the principle of Radiographic inspection. What is the difference between X-ray and gamma radiography?	4
	b)	What is meant by radiographic sensitivity and how it is ensured during inspection?	4
	c)	Briefly explain the principles of microfocal radiography and digital radiography?	4
	d)	A weld is having lack of side wall fusion defect. From the radiograph of that weld how one can identify this defect?	4
7	a)	Briefly explain the principle of ultrasonic inspection.	4
	b)	Discuss the importance of reference block in ultrasonic inspection.	4
	c)	What is meant by A-scan, B-Scan and C-Scan in ultrasonic inspection	4
	d)	Schematically show why angle probes are preferred for inspection of welds? Which type of probe is chosen to inspect bonding at the interface of a hard faced coating made on austenitic stainless steel	4
8		Write short notes on any four of the following	4x4
	a)	Eddy current testing	
	b)	Low cycle and high cycle fatigue tests	
	c)	Creep testing and creep curve	
	d)	Single and double sampling plan	
	e)	Quality control and Quality assurance	

THE INDIAN INSTITUTE OF WELDING

Associate Membership Examination

Summer Session, July 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**

a) How mechanical (micro-structural) properties are controlled in welding? 2 X 8=16

b) What is DCSP? What materials are suited for this?

c) What are the fluxes in submerged Arc Welding?

d) What is the main difference between MIG and MAG welding?

e) What is neutral dot?

f) What is solid state welding?

e) What is open circuit voltage?

g) When High penetration of metal occurs in arc welding?

h) Write four defects in welding?

i) Write name of welding with consumable and non-consumable electrodes.

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. **Write short notes on 4X4=16**

a) FCAW

b) Hazard associated with welding power sources

c) AC and DC in TIG welding

d) Defects in SMAW welding

4. 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. 4

b) State the conditions for satisfactory welds. 5

c) Discuss about solid phase welding. 7

5. 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

6. a) what are fluxed core and metal core arc welding? 2+ 2

b) What are the metal transfer modes GMAW? Explain. 5

c) What is effect of shielding gas in GMAW? 3

d) Write about voltage and current characteristics in GMAW. 4

7. a) Write the advantages and disadvantages of MMAW. 4

b) Write about the composition of coating materials in Electrode and their functions. 8

c) Write about AC and DC Arcs. 4

8. a) Write about mechanism of Arc Blow , its effect and remedies to overcome it. 3+2+2

b) Write about the choice of type of current, polarity, shielding gas and electrodes type according to application in TIG welding.

THE INDIAN INSTITUTE OF WELDING

Associate Membership Examination

Summer Session, 2023-24

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. What is a laser? Why gases are required for the laser welding process? Briefly describe the modes of laser welding. State the parameters which control the laser welding. 2+2+7+5 = 16
2. Write down the principle of electron beam welding. Why EBW process is preferred to perform in a vacuum? Briefly describe the beam characteristics of EBW. 6+4+6 = 16
3. How plasma keyhole welding is performed? Briefly describe the influence of the main control parameters on the process performance of plasma keyhole welding. When reverse polarity is used in plasma welding? 4+10+2 = 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 different welding and allied processes used for joining ceramics. 16
6. Write about hot gas welding and hot tool welding in connection with polymer joining.
7. 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
8. Write short notes on (*any four*) 4x4 = 16
   a) Electroslag welding
   b) Thermit welding
   c) Thermal spraying
   d) Braze welding
   e) Plasma-transferred arc surfacing

THE INDIAN INSTITUTE OF WELDING

Associate Membership Examination

Summer Session, 2023-24

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 in one place

1. Show the classification of crystalline defects in a chart. Briefly describe one defect from each classification. 8+8 = 16
2. Write about deoxidation, dephosphorisation and desulphurization with proper chemical equations related to Steel Making Processes. 16
3. Based on the chemical composition classify the steel. Make a table for different types of stainless steel with properties and uses. Write down the compositions of various kinds of tool steel. 4+12 = 16
4. Briefly explain how the property of steel is related to the microstructure. Draw the iron-carbon equilibrium diagram mentioning all salient points. 8+8 = 16
5. Give short notes on peritectic, eutectoid and eutectic transformation in steel. 16
6. What is a TTT diagram? How TTT diagram can be experimentally determined for a given steel? 4+12 = 16
7. Write down the properties of the following alloying elements of steel
   a) Manganese, b) Molybdenum, c) Chromium and d) Vanadium 4x4 = 16
8. Write short notes (any four) 4x4 = 16

   a) Recrystallisation

   b) Work hardening

   c) Strain ageing

   d) Cold and hot deformation

   e) Carbon equivalent of steel

THE INDIAN INSTITUTE OF WELDING

Associate Membership Examination

Summer Session, 2023-24

Sub : AME 20: Welding Metallurgy- II

Full Marks : 80

Pass Marks : 32 Time : 3 Hours

Answer any five

Parts of a question should be answered in one place

1. What are those factors that influence the microstructure of cast iron – briefly describe. Differentiate between white and grey cast iron. 12+4 = 16
2. What is season cracking of brasses? What do you mean by zinc equivalent in brasses? Write the uses of coinage bronze, gunmetal and phosphorus bronze. Why beryllium and silicon are added to copper? 2+4+6+4 = 16
3. Mentioning composition and properties enumerate briefly about at least 2 types of alloy of both aluminium and nickel. 4x4 = 16
4. Make a table showing the effect of nitrogen, oxygen and hydrogen on steels, austenitic stainless steel, aluminium and tungsten during welding. How to protect the weld from the chemical reaction of nitrogen, oxygen and hydrogen? 8+8 = 16
5. Why reheat cracking occurs in the weld zone? What is hydrogen cracking? What are those susceptibility tests carried out to detect both of these cracking? What measures should be taken to prevent such cracking? 4x4 = 16
6. What is corrosion? What is understood from Pilling and Bedworth ratio? What are the stages of formation and growth of corrosion film? Write down in short the mechanism of wet corrosion. 2+2+ 5+7 = 16
7. 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
8. a) What is weldability? Describe Cast Pin Tear Test (CPTT) or Hot Ductility Test. How distortion can be controlled in welding? 2+8+6 = 16

THE INDIAN INSTITUTE OF WELDING

Associate Membership Examination

Summer Session, July 2023

Sub: Welding Metallurgy of Ferrous Materials (AME-105)

Full Marks: 80 Time: 3 hours

Pass Marks: 32

(Answer any one from Q.1 & Q.2 and four from the rest)

1. a) Why most of the steels are now produced by continuous casting route rather than ingot route? What is mean by "quality steel"? How it can be produced?

   b) Draw a complete isothermal transformation/TTT diagram for a eutectoid steel. Assume austenized specimens are carried to room temperature. By using the TTT diagram show the time-temperature path in order to obtain 100% peralite, 100%bainite, 50% bainite and 50% martensite and martensite and austenite. Among the microstructures of pearlite, bainite and martensite, which one provides highest strength –explain why? 4 + 12

2. a) What is meant by "hardenability of steel"? Why addition of most alloying elements in steel increases hardenability-explain. Increasing hardenability of the steel is desirable or not- Explain with example for both cases.
   b) How Fe-C diagram is modified with the addition of Mn (say about 1.2% Mn) in low carbon steel? Draw the microstructures of the low carbon steel and Mn added low carbon steel. 8+8

3. a) Draw a typical thermal cycle developed in Gas Metal Arc welding process. How the thermal cycle is affected by heat input, preheat temperature and plate thickness of steel. How the thermal cycle is being represented as per IIW?

   b) Discuss the factors controlling the microstructures of a weld and HAZ for a given steel and a given process (say GMAW). Explain how interpass

temperature controls the microstructure and properties of low alloy steel weld metal in multi-pass welding? 6+ 10

4. a) What is “carbon equivalent”? Explain why it is important to the fabricators?

b) Discuss the relation between weldability and hardenability of steels?

c) Explain why only hydrogen , neither oxygen nor nitrogen, is mostly responsible for cracking in steel welded joints. State the four factors simultaneously present towards hydrogen induced cracking in steel weldments.

d) Discuss the purposes of post weld heat treatment (PWHT) with examples?

4+ 4 +4+4 = 16

5. Write short notes on: 4x4= 16

a) Solidification of weld fusion zone

b)Generation of residual stresses in the welds

c) Reheat Cracking in alloyed steel

d) Weldability of steels for high temperature applications

6. a) Explain why HSLA steels (often called micro alloyed steels)are provided higher strengths than those of carbon steels. Although weldability of most HSLA steels is similar to that of mild steel, better HAZ properties are observed in HSLA steels than mild steel-explain.

b) Why carbon content is restricted $<$ 0.25% in Q&T steels ? Too high a preheat or interpass temperature is undesirable during welding of this steel-explain.

c) How solidification cracking can be avoided in carbon steel containing $>$ 1.0% C ?.

d) Discuss different types of electrodes used in welding cast irons and their consequences. 6+4+2+4

7. a) Explain Why and how austenitic stainless steels(ASS) are stabilized ? The stabilized ASS can also be susceptible to intergranular corrosion attack. Explain the cause and remedies of such attack.

b) How does Schaeffler diagram become important to the fabricators? Explain how the diagram could be used? Give the steps in details.

c) What is “PREN”? 8+6+2

8. a) How the martensitic stainless steels(MSS) are classified? . When do you select MSS? Explain how filler wires are being selected for welding MSS . Explain how do you select preheat, interpass temperature and post weld heat treatment(PWHT) of high carbon MSS.

b) Welding of duplex stainless steels is more critical than either austenitic or ferritic stainless steels-Explain. 12+ 4

THE INDIAN INSTITUTE OF WELDING

Associate Membership Examination Winter Session, July 2023

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

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

			Marks
1	a)	Both Al-alloys and stainless steels have oxide films on the surface that give excellent corrosion resistance. However, oxide films present in Al-alloys adversely affect the weldability of these alloys, while this is not true in the case of stainless steel. Explain	4x4
	b)	What is done to overcome this in the welding of Al-alloys using GTAW process?	
	c)	What are the major alloying elements in 2xxx, 5xxxx, 6xxxx and 7xxx series of Al alloys	
	d)	Explain the possible reasons for wide acceptability of friction stir welding for welding of different type of Al alloys – both heat treatable and non-heat treatable.	
2	a)	How the groove design for butt welding of Ni base alloys should be different from that of steel or stainless steel welding? Why?	4x4
	b)	Briefly explain the issue of hot cracking in welding of Ni base alloys?	
	c)	Why Ni base welding consumables are often chosen for dissimilar welding applications involving steels and stainless steels?	
	d)	Which type of cracking/weld defect are likely to be formed during welding of the following Ni base alloys: a) Monel (Ni-Cu alloy), b) Alloy 600 (Ni-Cr-Fe alloy), c) Inconel X-750 (Ni-Cr-Mo-Ti-Nb-Al) Alloy) and d) Inconel 718 (Ni-Cr-Mo-Nb-Ti-Al)alloy	
3	a)	What are the favourable physical, chemical and mechanical properties of Ti and its alloys which make them ideal choice for very specific applications in aerospace, naval, chemical and bio medical engineering (prosthetic material) applications?	4x4
	b)	Why welding in an inert atmosphere or use of trailing shield is recommended for GTA Welding of Ti and its alloys? Why SMAW and SAW processes are not being used for welding Ti alloys? Why EB welding is preferred choice for welding Ti alloys?	
	c)	Briefly describe the effects of oxygen and hydrogen contamination in welding of Ti and Ti-alloys	
	d)	Describe how Ti cladded steel plates are produced. What are the options available for joining tubes/pipes with austenitic stainless steel tube/pipes. Explain the concerns	
4	a)	Briefly describe the physical, chemical and mechanical properties of the base materials and consumables to be considered in dissimilar materials welding	4x2+8

b) What consumable would be chosen for welding of carbon steel to austenitic stainless steel for room temperature applications? Justify your answer with the help of WRC 92 diagram.
c) What is meant by buttering in dissimilar welding. It is required to weld Cr-Mo steel pipe to austenitic stainless steel pipes for high temperature service. Explain the procedure involved executing this joint. Please note Cr-Mo has to be mandatorily post weld heat treated while no post weld heat treatment is recommended for austenitic stainless steel.

5 a) How the physical properties of copper and presence of oxygen in Cu affect its weldability? 4x4
b) Write brief notes on weldability of different Bronzes and Brass alloys
c) Discuss the thermite welding of Cu. What is the application?
d) Write a brief note on welding of Mg and its alloys

6 a) Describe the difference between surfacing and dissimilar welding. What is meant by dilution? How it is estimated? What is the purpose of buffer layer in surfacing? 4x4
b) What are the different welding processes available for surfacing? Which process give minimum dilution? What are the product forms in which consumables are available for surfacing?
c) Briefly describe the metallurgical, mechanical, NDT tests carried out to qualify the coating prepared by surfacing.
d) Describe a welding procedure for a) two carbon steel plates surfaced with austenitic stainless steel, b) Two Ti-cladded carbon steel plates

7 a) What is meant by hardfacing? How it is different from surfacing? 4x4
b) What are the processes available for hardfacing? List down the product forms available for hardfacing consumables and which welding processes are widely used for surfacing?
c) Give the major use of the following hardfacing alloys a) High Mn austenitic steels (Hadfield steel), b) AISI 410 steel, c) chromium carbide with Ni-Cr binder,d) Cobalt based hardfacing alloys (Stellites)
d) What is wear plate? How it is manufactured? Describe the situation a) in which cracks are not allowed in hardfaced coatings, b) cracks are permitted in hardfaced coating

8 a) Describe how repairing a crack observed in a service exposed component is different from a repairing an unacceptable defect detected during inspection of a newly fabricated component. 4X4
b) What are procedures available for repair of a component by welding when there is requirement of PWHT after welding; but PWHT is not possible after repair.
c) Why highly alloyed austenitic stainless steel and Ni base consumables are preferred for maintenance welding, especially when information on parent materials is unknown?
d) Describe the steps involved in taking up a repair of a crack by welding for a critical component that was in service for some time.

THE INDIAN INSTITUTE OF WELDING

Associate Membership Examination

Summer Session, July 2023

Sub: Weldment design welding Procedure and its applications (AME-204)

Full Marks: 80 Time: 3 hours

Pass Marks: 32

(Answer any five questions)

1.(a) Explain with examples how residual stresses are affected by the following factors :

i) Physical properties of the base metals

ii) Phase transformation of weld metal during welding

iii) Preheating of the base metals

(b) State the effects of residual stresses under the following conditions:

i) The level of applied stress on the welded joints increases.

ii) The welded structures under applied stresses beyond yielding.

iv) The welded structures under fatigue type of loading.

(c) Contrast mechanical vs thermal stress relief treatment of welded structure to relieve residual stresses. 6+4+6

2.a) How do you select the type of welded joint for a given application? State with reasons the applications (loading conditions)of the following types of joints :

i) Single fillet welded joint

ii) Double fillet welded joint

iii) Combined groove and fillet joint

b) Draw with a neat sketch single fillet weld joint showing leg lengths, throat thickness, penetration, convexity and concavity. A fillet weld of 20 mm leg is made with an electrode that deposits weld metals of 50 MPa minimum tensile

strength. Find out the allowable load per unit length of fillet weld for longitudinal and transverse loading. 6+4+6

3. a) State the loading and environmental conditions of the welded structures used in : i) Shafts, Propellers and Bridges

ii) Civil engineering construction

iii)Off-shore and chemical engineering plants

iv)Boilers and Superheaters

In addition to loading and environmental conditions, what are the two important considerations to be taken into account in the design of the joints-Explain

b) A disc is welded to a shaft of diameter 100 mm which is transmitting a torque 105 Kg-cm. There is a bearing of 200 mm from the disc which exerts a force of 3000Kg. Leg size of the weld is 12 mm. Calculate the bending stress and vertical shear stress at the bearing. 4+4+8

4. a) What do you mean by the term “Fitness-for-Purpose”? State the scope, application and limitation of such approach.

b) How the fracture mechanics based designed approach differs from conventional designed approach-Explain.

c) Consider high strength steel has been welded by fillet joint and the leg size is 20mm. The available NDT technique is able to detect defect of length 1 mm .If the fracture toughness of the weld is 105 MPa $m^{1/2}$, find out the safe allowable load considering factor of safety as 1.5. 6+4+6

5. Write short notes (any four): 4X4 = 16

a) Pressure vessel cladding

b) Distortion control in design

c) Failure criteria of tubular structure

d) Design based on hot spot stress

e) Welding Procedure for Pipe joning

6. a) Design a welded build-up column so that there is no problem in transferring tensile forces from the beam flange through the column. What precautions should be taken for very large column sections? What are the general requirements for the welds holding the plates of the columns together?

b) Two channels, each 150x50x12mm are welded so as to form (i) an I-type of section and (ii) a box section. Find out the torsional resistance of flanges and web (assume beta = 0.299). If the applied torque = 1000 Kg-mm, length of the beam =2500mm and shear modulus= 104 Kg/sqmm, compare the angular twist between box type and I-type construction. 8+ 8

7. a) What is mean by “Welding Symbol”? What are the advantages of symbols? Show the ISO and AWS reference lines and arrow lines. Draw the weld symbol for(i)a double fillet weld and (ii) an un-equal leg length of fillet weld as per ISO and AWS.

b) What is “stress concentration factor (SCF)”? What are the sources of stress concentration in a welded joint and welded structure? How the SCF is affected by toe angle, leg length and plate thickness in load and non-load carrying cruciform joints? 10+6