INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

AERONAUTICAL ENGINEERING

TUTORIAL QUESTION BANK

Course Name	**:**	AIRFRAME STRUCTURAL DESIGN
Course Code	**:**	R15-A72118
Class	**:**	IV B.Tech I Semester
Branch	**:**	Aeronautical Engineering
Year	**:**	2018 – 2019
Course Coordinator	**:**	Ms M.Mary Thraza, Assistant Professor, Department of Aeronautical Engineering
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OBJECTIVES

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited.

In line with this, Faculty of Institute of Aeronautical Engineering, Hyderabad has taken a lead in incorporating philosophy of outcome based education in the process of problem solving and career development. So, all students of the institute should understand the depth and approach of course to be taught through this question bank, which will enhance learner's learning process.

S No	Question	Blooms Taxonomy level	Course Outcomes
	UNIT - I **INTRODUCTION AIRWORTHINESS REQUIREMENTS**		
Part - A (Short Answer Questions)			
1	Explain structural sizing of an aircraft?	Understand	1
2	Give the engineering design parameters of an aircraft in cruise condition?	Remember	1
3	What is meant by structural integrity?	Understand	1
4	Describe the extension of life of an aircraft?	Remember	1
5	Explain the term damage tolerance of an aircraft.	Understand	2
6	List of the requirement of design durability and reliability?	Remember	2
7	What is structural modelling of an aircraft?	Understand	2
8	Explain design criteria for aircraft?	Remember	2
9	What are the phases involved in design.	Understand	2
10	What is meant by limit load in aviation industry?	Remember	2

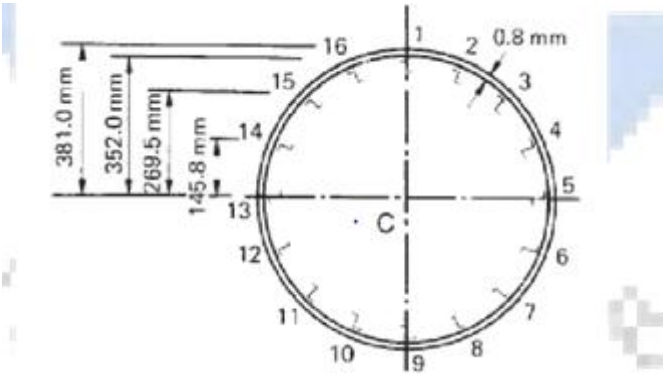
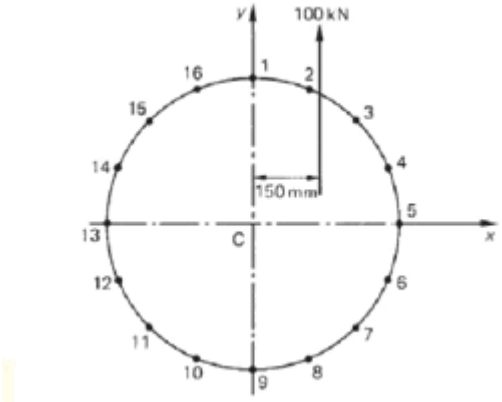
Part - B (Long Answer Questions)			
1	How is an airplane built? Explain with the help of a block diagram.	Understand	3
2	Discuss the design requirements of airframe structural design.	Remember	3
3	Explain Structural stiffness, aerodynamic characteristics in structural design criteria.	Understand	3
4	Discuss the sizing scenario in airframe structural design.	Remember	3
5	Explain any two principle structural components in brief.	Understand	3
6	Outline the sizing scenario in airframe structural design.	Remember	3
7	Discuss the mechanical properties and allowable bases of aircraft materials.	Understand	3
8	Differentiate the different loads acting on an aircraft and What are the basic parts of an airplane?	Remember	3
9	What is meant by airworthiness and how Certification of airworthiness is conferred?	Understand	3
10	Give some aircraft materials. what are frequently metal alloys, that have either been developed	Remember	3
Part - C (Problem Solving and Critical Thinking Questions)			
1	How is an airplane built? Explain with the help of a block diagram.	Understand	4
2	Explain structural stiffness, aerodynamic characteristics in structural design criteria.	Remember	4
3	Discuss the design requirements involved in the construction of an aircraft.	Understand	3
4	Explain briefly about structural components of aircraft.	Remember	3
5	Write a short note on a damage tolerance, stretching, design durability and extension of life.	Understand	4
6	Briefly explain about the base line aerodynamic configuration.	Remember	5
7	Explain the procedure of load estimation, stress analysis and choice of materials.	Understand	5
8	Explain the physical properties of the engineering materials.	Remember	5
9	Describe loads acting on flight?	Understand	5
10	Explain briefly about gust flight envelope.	Remember	5
UNIT - II EXTERNAL LOADS-ESTIMATION, FASTENERS AND STRUCTURAL JOINTS			
Part – A (Short Answer Questions)			
1	What the different types of fasteners which are basically represents and uses in aviation industry	Understand	6
2	Name the structural joints which are used in aviation industry	Remember	6
3	What the methods of joining process?	Understand	6
4	Explain the fatigue design considerations in aircraft design?	Remember	6
5	List out the causes of stress concentration while applying loads in airframe structure?	Understand	7
6	Define failure theory. Explain briefly	Remember	7
7	What the loads which are acting on fuselage?	Understand	7
8	Explain the external propulsion loads?	Understand	7
9	What is meant by proof load?	Remember	7

10	Define and explain the theories of failure for Maximum shear stress and Maximum strain energy theory	Understand	7
Part - B (Long Answer Questions)			
1	Explain different type of loads which are acting on aircraft when it is in flight condition?	Understand	6
2	Describe manoeuvre construction of flight envelope.	Remember	6
3	List out and explain the properties of engineering materials for use in the manufacture of an aircraft in detail.	Understand	6
4	What do you understand by the term Theories of failure"? Name and explain the important theories of failure.	Remember	6
5	Define and explain the following modes of failures in Maximum strain energy theorem	Understand	7
6	Explain critical load conditions when aircraft is stable?	Remember	7
7	Discuss Air worthiness requirements.	Understand	7
8	What do you understand by the term Theories of failure"? Name and explain the important theories of failure.	Remember	7
9	A thin cylindrical shell, 2.5 m in diameter is composed of plates 12.5 mm thick. The yield stress of for the material is 300 N/mm2. Calculate the internal pressure which would cause yielding according to the following theories of failure. a. Maximum shear stress, b. Maximum strain energy, c. Maximum shear strain energy. Poisson's ratio=0.25.	Understand	7
10	A shaft is subjected to a maximum allowable torque of 10kNm & maximum allowable bending moment of 7.5 kNm at a particular section. If the allowable equivalent stress in simple tension is 160 MN/m2 calculate the diameter of the shaft according to: a. Maximum shear stress theory, b. Strain energy theory and c. Shear strain energy theory. Poisson's ratio is 0.24	Remember	7
Part – C (Problem Solving and Critical Thinking)			
1	Explain flight load and its procedure and why it is essential as the dispatcher	Understand	7
	What are the advantages and disadvantages of riveted joints?	Remember	6
2	Write a short note on semi tubular rivets, blind rivets, hi-lok fastener and taper fasteners.	Understand	6
3	Explain briefly about fuselage load act on the aircraft.	Remember	6
4	Explain briefly about landing gear load act on the aircraft.	Understand	6
5	Explain buckling of a circular cylinder under pure torsion with Internal pressure & under Transverse shear and Internal pressure. A cylinder has length (L) 2000 mm, radius (r) 1400 mm and wall thickness (t) =1.3 mm, μ = 0.3. Find the geometrical parameter(z).	Remember	7
6	Describe the main features of a stressed skin structure.	Understand	7
7	Discuss the structural functions of the various components with particular reference to fuselage and wing of a medium size transport aircraft.	Remember	7

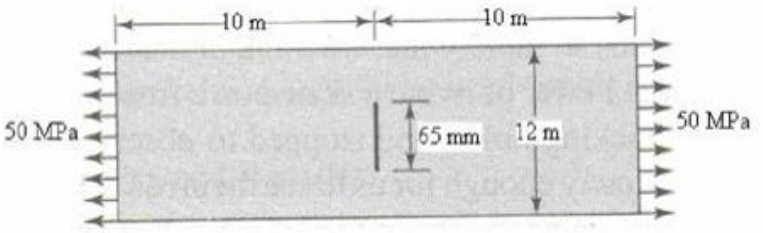
8	Write a short note on spliced joint, eccentric joint, gusset joint with determination n of forces in joints and distribution between components	Understand	7
9	What are fatigue design consideration and explain about stress consideration.	Remember	7
10	Write a short note on braced joint with a neat schematic diagram and also explain briefly about the welded joints in airframe applications?	Understand	7
11	Explain the difference between spliced joints and gusset joints in aircraft in detail?	Understand	6
UNIT-III DESIGN OF WING, TAIL UNIT STRUCTURES			
Part - A (Short Answer Questions)			
1	What is wing box? What is its application?	Understand	9
2	Differentiate ribs and bulkheads	Remember	9
3	Identify the general rules of spar design	Understand	9
4	Illustrate stiffeners and stingers	Remember	9
5	What is meant by safety of margin	Understand	9
6	Name the different control surfaces used in aircraft?	Remember	9
7	Define wing pod? Where it is attached?	Understand	10
8	What is nose pod? What are its applications?	Remember	10
9	Define wing box of an aircraft structure.	Understand	10
10	Define structural members of a wing	Remember	10
12	Briefly describe different loads acting on wing	Understand	9
13	Define longerons of wing structure.	Remember	9
14	State flaps and name types of flaps.	Understand	9
15	Define slats and its function.	Remember	9
16	Define slots with neat sketches.	Understand	9
17	State winglets and explain its importance.	Remember	9
18	Explain the general rules of spar design.	Understand	10
19	Interpret webs, flanges and its importance in wing.	Remember	10
20	Define wing boom? How it is categorised?	Understand	10
21	Write the different loads acting on wing	Remember	10
22	Define stringers in the wing structure	Understand	9
23	Write about air loads acting on wing	Remember	9
24	Define power plants loads acting on wing	Understand	9
1	Define manoeuvring loads acting on wing	Understand	9
2	Differentiate gust and dynamic loads acting on wing	Remember	9
3	Define inertial loads acting on wing	Understand	9
4	Explain briefly about Manoeuvre flight envelope	Understand	9
5	What are different aircraft materials and their properties? Explain briefly.	Remember	9
6	Write a short note on semi tubular rivets, Blind rivets, Hi-Lok fastener and taper fasteners.	Remember	9

7	Explain the concept of lug analysis.	Understand	10
8	Describe the role and significance of fasteners and fittings.	Remember	10
9	The spar of an aircraft is to be designed as an incomplete diagonal tension beam, the flanges being parallel. The stiffener spacing will be 250 mm, the effective depth of web will be 750 mm, and the depth between web–to-flange attachments is 725 mm.	Remember	10
10	Explain stowage and retraction of a landing gear.	Remember	10
11	Describe the general arrangements of a landing gear.	Understand	10
12	Explain Oleo strut with neat sketches	Remember	10
14	What is root rib bulkhead	Understand	11
15	How to estimate the loads on wing?	Remember	11
16	Find the stress analysis in wing?	Understand	11
17	What are the design parameters of fuselage?	Remember	12
18	Define optimisation and its techniques?	Remember	11
19	Explain Leading and trailing edge assembly?	Understand	11
20	What is the main advantage of the semi-monocoque construction?	Remember	11
21	Explain the purpose of spars?	Understand	12
22	What are the Axes and fundamental movements of the aircraft?	Remember	11
23	Mention the types of flaps with its advantages?	Understand	11
24	What are the factors depends on design of a wing?	Remember	11
Part – B (Long Answer Questions)			
1	Discuss wing layout of an aircraft is its arrangement of lifting and related surfaces.	Understand	13
2	Explain briefly ribs and bulkheads-rib spacing and arrangement.	Remember	13
3	Discuss the problems with swept wings in fighter wing design.	Understand	13
4	What are the advantages of single double and triple slotted flaps?	Remember	13
5	Draw and explain different types of wing leading and trailing edges used to increase the maximum lift at low speed flight.	Understand	13
6	Discuss mechanical design of wing and tail unit structures and its design considerations	Remember	10
7	Explain engine mounts.	Understand	10
8	Write about the selection criteria for wheels, brakes and tire.	Understand	10
9	Explain current Landing Gear Design of (a) Boeing B747 (b) Lockheed C-5 (c) C-141 (d) Fighter Airplane.	Understand	11
10	Explain the design considerations for a landing gear and loads acting on it.	Remember	11
Part – C (Problem Solving and Critical Thinking)			
1	Draw and explain different types of wing leading and trailing edges used to increase the maximum lift at low speed flight and also explain the advantages and disadvantages of different drive systems used in aircraft wings.	Understand	10
2	What are the advantages of single double and triple slotted flaps?	Remember	10
3	Explain the structural components–wing box, leading edge and trailing edge of a wing.	Understand	10

4	A round steel tube with 25 mm outer diameter (OD) 1.65mm thick resists a design torsional moment of 0.56kN-m. Find the margin of safety if the ultimate tensile stress σtu = 690 N/mm2.	Remember	11
5	Discuss procedure involved in the location of spar, aileron and flaps.	Understand	11
6	Explain the phenomenon of distribution of concentrated loads on thin webs in aircraft structure.	Remember	10
7	Explain about structural optimisation of wing box.	Understand	10
8	Explain structural layout and design consideration of tail unit.	Remember	10
9	Explain the phenomenon of calculating the bending moments in ribs of a wing.	Understand	11
10	The skin of the upper side of an airplane wing is made of 2024-T6 Al clad. The stringer spacing is 125 mm, and the rib spacing is 500 mm. Assuming the edges to be simply supported, find the compression buckling stress for skin gages of: i) 0.5, ii) 0.8, iii) 1and iv) 1.60mm.	Understand	11
UNIT-IV DESIGN OF FUSELAGE, LANDING GEAR, ENGINE MOUNTS			
Part – A (Short Answer Questions)			
1	What are the general requirements of fuselage design	Understand	10
2	What is stiffened cylindrical structure	Remember	10
3	List out the different principal structural components	Understand	10
4	Differentiate between forward and aft fuselage.	Remember	11
5	Name different types of landing gear.	Understand	11
6	Describe the general arrangement of landing gear	Remember	11
7	What are breaking systems of landing gear?	Understand	12
8	What is meant by stowage?	Remember	11
9	Define payment loading.	Understand	11
10	What is meant by retraction?	Remember	11
Part – B (Long Answer Questions)			
1	Discuss the functioning of a fuselage, its loading and its general requirements.	Understand	10
2	Explain briefly the ultimate strength of stiffened cylindrical structure.	Remember	10
3	Discuss fuselage openings and its design considerations	Understand	10
4	Describe the principal structural components of a fuselage.	Remember	11
5	Explain the wing and fuselage intersection with the help of a neat sketch	Understand	11
6	Briefly explain the assembly of leading and trailing edges.	Remember	11
7	Discuss about tail unit. Explain rudder and its configuration.	Understand	12
8	Explain the altitudes of the airplane that are specified by government aviation agencies for design of landing gear with neat sketches.	Remember	11
9	Give a brief summary of fuselage loads and explain fuselage configuration	Understand	11

10	Explain the construction of a Tricycle landing gear, with neat sketches.	Remember	11
Part – C (Problem Solving and Critical Thinking)			
1	A fuselage has circular cross section as shown in figure below the cross sectional area of each stringer is 100mm2 and the fuselage is subjected to bending moment of 200 KNm applied in the vertical plane of symmetry, at this section. Calculate the direct stress distribution. 	Understand	12
2	The load on a landing gear bolt consists of an axial pull of 8kN together with a transverse shear force of 4kN. Estimate the diameter of the bolt required according to (i) maximum shear stress theory (ii) shear energy theory and (iii) shear strain energy theory. Assume elastic limit in tension as 240N/mm2, poison's ratio = 0.3 and a factor of safety of 3.	Remember	12
3	The fuselage is subjected to a vertical shear load of 100 KN applied at a distance of 150mm from the vertical axis of symmetry as shown, for the idealized section, in Figure. Calculate the distribution of shear flow in the section. 	Understand	12
4	Explain briefly about wing and fuselage intersion layout with neat sketch.	Remember	13
5	Derive Compressive buckling stress (F_{cr}) and buckling coefficient (K_c) for Monocoque circular cylinder under axial compression.	Remember	13
6	Explain design landing gear structures with neat sketches.	Understand	13
7	Explain the working procedure of oleo strut? Explain construction detail with neat sketch.	Remember	13

8	Explain current Landing Gear Design of (a) Boeing B747 (b) Lockheed C-5 (c) C-141 (d) Fighter Airplane.	Remember	13
9	Explain the terms Ground Handling and take-off in order to understand the varied design considerations of landing gear.	Understand	13
10	Explain the altitudes of the airplane that are specified by government aviation agencies for design of landing gear with neat sketches.	Understand	12
UNIT-V FATIGUE LIFE, DAMAGE TOLERANCE, FAIL-SAFE DESIGN- WEIGHT CONTROAND BALANCE			
Part - A (Short Answer Questions)			
1	What is catastrophic effect of fatigue failure	Understand	15
2	Show S-N curve? Explain with neat sketch	Remember	15
3	Define fail safe design of an aircraft	Understand	14
4	What is scatter factor in the design of an aicraft?	Remember	15
5	Define damage tolerance and which property does it indicates	Understand	15
6	What is meant by factor of safety?	Remember	14
7	Define safe life. what are its design products	Understand	15
8	What is meant by ultimate load	Understand	15
9	Explain flight envelope with the range of combination for speed?	Remember	14
10	Define failure theory in theory of elasticity	Understand	15
Part - B (Long Answer Questions)			
1	Discuss the process of estimation of fatigue strength.	Understand	15
2	Describe the concept of fatigue crack propagation	Remember	15
3	What are the design strategies for improving system reliability? Explain in general and in the context of structures.	Understand	14
4	Explain the scatter factor and its significance	Remember	15
5	Explain the service behavior of aircraft structures and the effect of physical and load environment design	Understand	15
6	Explain modes of failure. Discuss catastrophic effects of fatigue failure.	Remember	14
7	Write short notes on Fatigue parameters like Fatigue stress, Fatigue performance and Fatigue life.	Understand	15
8	Explain fatigue design philosophy.	Remember	15
9	What is mean by S-N curve and explain its significance in fatigue failure with neat schematic?	Understand	15
10	Explain the engineer's responsibility in designing an aircraft?	Remember	15
Part – C (Problem Solving and Critical Thinking)			

1	A steel ship deck plate is 30mm thick, as shown in figure 4 loaded with a normal tensile stress of 50MPa. It is operated below its ductile to brittle transition temperature with KIC equal to 28.3MPa √ m. If a 65 mm long central hole transverse crack is present, estimate tensile stress at which catastrophic failure will occur. Compare this stress with the yield strength of 240 MPa for the steel. 	Understand	15
2	What is mean by S-N Curve and explain its significance in Fatigue failure.	Remember	15
3	Describe the concept of fatigue crack propagation.	Understand	14
4	A material has a fatigue limit of ±230N/mm2 and an ultimate tensile strength of 870N/mm2. If the safe range of stress is determined by the Goodman prediction calculate its value.	Remember	15
5	A more accurate estimate for the safe range of stress for the material of has a fatigue limit of ±230N/mm2 and an ultimate tensile strength of 870N/mm2 is given by the non-linear form of the Goodman prediction in which m = 2. Calculate its value.	Understand	15
6	A plate of width 1.4 mm and length 2.8m is required to support tensile force in the 2.8m direction 5.0MN. Inspection procedure will only detect through thicken edge cracks larger than 2.7mm. The two Ti-6Al- 4 V alloys in table are being considered for this application, for which the safety factor must be 1.3 and minimum weight is important. Which alloy should be used?	Remember	14
7	Explain why residual stress is important in failure analysis.	Understand	15
8	Discuss the theories of failure in structural design	Remember	15
9	What are the design strategies for improving system reliability? Explain in general and in the context of structures.	Understand	14
10	Explain the construction of Oleo strut with neat sketches.	Remember	15

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