



INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad-500043

AERONAUTICAL ENGINEERING TUTORIAL QUESTION BANK

Course Name	:	LAUNCH VEHICLE AND MISSILE TECHNOLOGY
Course Code	:	R15 – A82132
Class	:	B.Tech IV - II Semester
Branch	:	Aeronautical Engineering
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Course Coordinator	:	Mr. G S D Madhav, Assistant Professor, Dept. 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			
Part - A(Short Answer Questions)			
1	Describe briefly the role played by space launch vehicles.	Remember	1
2	Illuminate the mission requirements of space launch vehicles.	Understand	1
3	Enlighten briefly the typical mission profile of space launch vehicles with sketch.	Remember	1
4	Explain briefly the role played by a missile.	Understand	1
5	Detail about the mission requirements of a missile.	Understand	2
6	Describe briefly the typical mission profile of a space vehicle with sketch.	Remember	2
7	Discuss the preliminary concepts of missile interceptors with suitable sketch.	Remember	2
8	Draw design methodology/tree involved in accomplishing interplanetary space mission.	Remember	2
9	Enumerate briefly the role of multistage rockets.	Remember	2
10	Briefly address various internal ballistics involved with rockets with suitable correlations.	Remember	2

Part - B (Long Answer Questions)			
1	Discuss the importance of a) space launch vehicle in conjunction with their (i) Functions and (ii) types.	Remember	1
2	Enumerate importance of military missiles in conjunction with their (i) Functions and (ii) types.	Understand	1
3	Explain the role, mission and mission profile of space launch vehicles with sketch.	Understand	1
4	Detail the role, mission and mission profile of military missiles with sketch.	Remember	1
5	What is the physical meaning of thrust and classify thrust profile with sketch and relevant equations.	Understand	2
6	Outline the role of propulsion system in design of Space Launch Vehicles.	Remember	2
7	Describe role of propulsion system in the design of military missiles.	Remember	2
8	Classify various propulsion systems used for space launch vehicles.	Understand	1
9	Exemplify need of multi-staging in space launch vehicles and give preliminary weight estimation that contributes in realizing deep space mission.	Understand	1
10	Elaborate the functional aspects of i) control ii) guidance requirement for space launch vehicle.	Remember	2
Part – C(Critical Thinking Questions)			
1	Elaborate functional aspects of i) control ii) guidance requirement for military missiles.	Understand	1
2	Enumerate performance measures of space launch vehicles.	Understand	1
3	Estimate the performance measures of military missiles.	Understand	1
4	Highlight typical design methodology involved in realizing a space launch vehicle with sketch.	Understand	1
5	Explain in detail about team process flow chart involved within a space launch vehicle design program.	Remember	2
6	Consolidate various SLV programs of different nations and typical launch vehicle version/modes used in India; USA; USSR.	Understand	2
7	Present a study on various missile programs of different nations and typical launch vehicle version/modes used in India; USA; USSR.	Remember	2
8	Configure various SLV programs of different nations and typical launch vehicle version/modes used in China; Japan; Europe.	Understand	2
9	Discuss the various missile programs of different nations and typical launch vehicle version/modes used in China; Japan; Europe.	Remember	2
10	Detail the various ASLV programs of different nations and typical launch vehicle version/modes used in India.	Understand	3
UNIT - II SOLID & LIQUID PROPELLANT ROCKET MOTOR SYSTEMS			
Part – A (Short Answer Questions)			
1	List various hardware components of solid propellant rocket.	Remember	3
2	What is specific impulse of rocket?	Remember	3
3	Define specific consumption?	Remember	3
4	What is weight flow co-efficient?	Remember	3
5	Define propulsive efficiency?	Remember	3
6	What are the types of solid propellants?	Remember	4
7	What is monopropellant and bipropellant? Give one example for each.	Remember	4

8	Classify the rocket engines based on sources of energy employed?	Remember	4
9	Define solid propellant burn rate. Draw the typical variation of chamber pressure with burn time at a constant temperature	Remember	4
10	List various types of propellant grain with suitable sketches	Understand	4
Part - B (Long Answer Questions)			
1	Explain principles of solid propellant rocket systems involving primary hardware components.	Understand	3
2	Enumerate application aspects of rocket motor in launch vehicles and missiles.	Understand	3
3	Classify solid propellants according to various categories and elaborate on fuel and oxidizer matrix composition.	Remember	3
4	List and explain the physical properties evaluation of solid propellant matrix.	Understand	4
5	Describe the chemical properties evaluation of solid propellant matrix and list some propellants.	Understand	4
6	Discuss the performance characteristics associated with solid propellants.	Understand	4
7	Exemplify the importance of propellant grain and its desirable properties and nomenclature associated with it.	Remember	4
8	List various grain configurations widely used in rocket motors and explain their typical burn profiles with suitable sketches.	Remember	4
9	Give details of various types of loading experienced inside rocket motor.	Remember	4
10	Explain different types of burning a) progressive b) regressive and c) neutral with typical thrust –time profile.	Understand	4
Part - C (Critical Thinking Questions)			
1	Classify types of rocket motors loading and explain their typical hardware features with suitable sketches and (cartridges and case-bonded).	Remember	3
2	Explain critical issues involved in nozzle design for very large rocket motors touching.	Understand	3
3	Enumerate in detail thermal protection/shielding requirements for large rocket motor operation.	Understand	3
4	Explain importance of ignition in rocket motors and classify various types of ignition systems available.	Understand	4
5	Mention some oxidizers, fuel and binders of solid propellant with their advantages and drawbacks.	Remember	4
6	Discuss about Erosive burning and also explain about factors effecting erosive burning.	Understand	4
7	Detail about the star burning grain, rod and tube burning grain and Multi perforated grain.	Understand	4
8	Explain about regressive, neutral, and progressive burning modes.	Understand	4
9	Briefly explain about processing methodology of solid propellant.	Understand	5
10	Describe the advantages and disadvantages of a solid propellant rocket over liquid propellant rocket.	Remember	5
UNIT-III AERODYNAMICS OF ROCKETS AND MISSILES			
Part - A (Short Answer Questions)			
1	Classify the missile types briefly.	Remember	5
2	What are the different airframe components of a rocket?	Remember	5
3	Briefly explain about Air-to-Air missile.	Understand	6
4	Write a short notes on Surface-to-Air missile.	Remember	6
5	Write short notes on Air-to-Submarine missile.	Understand	6
6	Describe about the Submarine-to-Submarine missile.	Understand	6

7	Explain about wing control on missiles.	Remember	6
8	Detail about canard control on missiles.	Remember	6
9	Sketch the wingless tail control on missiles	Remember	6
10	Discuss about tailless wing control on missiles.	Understand	6
11	Define up wash for missiles	Remember	6
12	What is downwash for spacecraft	Remember	7
13	Detail about canard control on missiles.	Remember	7
14	Define lateral moment on missile.	Remember	7
15	Give an abbreviation PSLV?	Remember	7
16	What happens to heat load if we increase entry velocity for re-entry module?	Understand	7
17	Name the major force acting on the missile body	Remember	7
18	What happens if increase lift on rocket? Will it break or will it lift off?	Remember	7
19	Which is the major force for rocket lift or Thrust?	Remember	7
20	Define lateral moment on rocket.	Remember	7
21	Define the pitching moment on missile body	Remember	7
22	What happens if missile does not have an fins	Remember	7
23	What is the difference in thrust on and thrust off conditions	Understand	7
24	Define slenderness ratio	Remember	7
25	Write about rocket dispersion?	Remember	8
26	How lift can be defined on rocket?	Remember	8
27	What is damping moment?	Understand	8
28	Why re-entry vehicles are required?	Remember	8
29	What is the use of re-entry vehicles?	Remember	8
30	List two considerations for re-entry design.	Remember	8
31	What is lateral damping?	Understand	8
32	Write about longitudinal damping?	Understand	8
33	What are the classifications of the missiles?	Remember	8
34	How are missiles different from rockets?	Remember	8
35	Differentiate between missile and launch vehicle.	Remember	8
36	How does a lateral moment affect the lift on missile body?	Understand	8
37	What happens if increase lift on missile? Will it break or will it lift off?	Remember	8
38	Is an Aerodynamic force on missile and rocket are same, if so what are the forces?	Understand	8
39	What is damping?	Remember	8
40	Define dynamic stability.	Understand	8
41	What if static stability is lost on missile body?	Understand	8
42	If downwash is increased on fins which stability will be lost.	Understand	8
43	What are the methods of determining aerodynamic forces?	Remember	8
44	Define lateral aerodynamic moment.	Remember	8
45	Why drag estimation is required?	Understand	8

46	What is total drag?	Remember	8
47	Draw the boat tail configuration sketch.	Remember	8
48	Draw the view of tailless configuration of missile.	Remember	8
Part – B (Long Answer Questions)			
1	Give broad classification of missiles and explain them briefly based on i) Range ii) Usage/launch iii) Guidance systems iv) Control surfaces.	Remember	7
2	With a neat sketch list the airframe components of (a) rockets and (b) missiles.	Understand	7
3	Enumerate the forces and moments acting on a missile while passing through atmosphere with schematic diagram.	Understand	7
4	Describe methods of obtaining (a) aerodynamic forces and moments, (b) lateral aerodynamic moment of a rocket with necessary correlations.	Understand	8
5	Explain the methods of obtaining (a) damping moment, and (b) longitudinal moment of a rocket with necessary correlations.	Remember	8
6	Summarize advantages and disadvantages of (a) Wing- (b) Tail- and (c) Canard- control of missiles.	Understand	9
7	Define and signify (a) Monowing (b) Triform and (c) Cruciform-configuration in determining lateral stability of missiles.	Understand	9
8	Detail the concepts of body upwash and downwash over a missile configuration with a schematic diagram.	Remember	9
9	With a schematic diagram enumerate various longitudinal forces acting on a missile configuration.	Remember	9
10	Derive the lateral forces acting over a typical missile configuration with neat sketches.	Understand	
Part - C (Critical Thinking Questions)			
1	Give an estimate of lift and drag forces experienced by a rocket and also explain the drag estimation concept using suitable correlations.	Understand	8
2	Define drag coefficient. List various types of drag experienced over space launch vehicles/flight envelope of missile and deduce necessary equation for wave drag coefficient estimation for a) conical body b) rectangular wing.	Understand	8
3	Deduce necessary equations for estimating viscous drag coefficient for (a) laminar boundary layer (b) turbulent boundary layer.	Understand	8
4	Obtain the necessary equations for estimating i) induced drag coefficient for (a) subsonic case (b) supersonic speeds and ii) base drag for a) $M > 1$ b) $M = 1$.	Understand	9
5	Explain concepts of body upwash and downwash in missiles with neat sketches.	Remember	9
6	Discuss the concept of rocket dispersion considerations with neat sketch.	Remember	9
7	Detail concept of re-entry body design considerations with neat sketch.	Remember	9
8	With a schematic explain concepts of body upwash and downwash over a missile configuration.	Understand	9
9	Describe about the various longitudinal forces acting on a missile configuration with neat sketches.	Understand	9
10	With a schematic obtain and enumerate the forces and moments acting on a missile while passing through atmosphere.	Understand	9
UNIT-IV DYNAMICS & ATTITUDE CONTROL OF ROCKETS & MISSILES			
Part – A (Short Answer Questions)			
1	Define the need for thrust vector control in rocket.	Remember	9
2	Write short notes on the need for thrust vector control in missiles.	Remember	9
3	Discuss about one-dimensional thrust vector control in rocket with a pictorial representation.	Understand	9

4	Briefly explain about two-dimensional thrust vector control in rocket with a pictorial representation.	Understand	9
5	Write about three-dimensional thrust vector control in rocket with pictorial representation.	Understand	9
6	Detail about the thrust vector control using fluid bearing nozzle.	Remember	9
7	Explain role-played by range factor in the design of a projectile/flight envelope using Breguet range equation.	Understand	9
8	What is the influence of gravity on space launch vehicle dynamics with appropriate correlation?	Remember	10
9	Elaborate the primitive space mechanics concepts involved with satellite.	Understand	10
10	Give short description of various earth launch trajectories.	Remember	10
Part – B (Long Answer Questions)			
1	Derive Tsiolkovsky's rocket equation with sketch and obtain range estimation in the absence of gravity.	Understand	10
2	Obtain the rocket equation for a rocket launched in vertical motion inside the earth's gravitational field.	Understand	10
3	Deduce rocket equation for a rocket launched with an inclined motion and flight path at constant pitch angle.	Understand	10
4	Explain concept of multi-staging and give the preliminary weight estimation for a multi-stage rocket with necessary equations for velocity increment requirements with a net sketch.	Understand	10
5	Give brief introduction of space mechanics concepts involved in placing a satellite into its final orbit viz., lunar earth orbit with necessary definitions and figures.	Remember	10
6	List and explain conceptual basis for thrust vector control in rocket.	Understand	10
7	What are the types of TVC mechanisms and explain conceptual basis for thrust vector control in missiles.	Remember	10
8	Categorize different thrust vector control methods and explain in detail about hinge/gimbal scheme with a schematic.	Remember	10
9	Detail the thrust vector control mechanism with ball and socket type arrangement with suitable sketch.	Understand	10
10	Explain the conceptual working of (a) fluid bearing nozzle (b) flexible seal nozzle types of thrust vector control mechanisms with suitable sketches.	Understand	10
Part - C (Critical Thinking Questions)			
1	Explain the conceptual working of (a) flexible seal nozzle (b) flexible exit types of thrust vector control mechanisms with suitable sketches.	Understand	11
2	Discuss the conceptual working principles of (a) Jet vanes (b) Jet tabs (c) Jetavators with necessary schematics.	Understand	11
3	Enumerate the concepts of secondary fluid injection in a nozzle used for thrust vector control of rocket.	Remember	11
4	Enumerate the need of thrust termination in rockets and brief about various thrust termination mechanisms involved.	Remember	11
5	Emphasize on the various stage separation events involved with space launch vehicles.	Understand	11
6	Classify various earth launch trajectories with respect to a) vertical segment b) gravity turn c) constant pitch or vacuum trajectory and d) orbital injection.	Remember	11
7	With neat sketch explain general launch orbit and de-orbit profile of falcon-space launch vehicle mentioning burn time; jettisoning; stage altitude; coast altitude.	Understand	11
8	List various types of actual launch vehicle trajectories and explain them suitably for (a) Mu-3-S-II launcher.	Understand	11
9	Explain in detail different types of orbital injection (a) Direct (b) Hohmann using sketches.	Understand	11
10	Detail the various types of actual launch vehicle trajectories and detail them suitably for (a) Mu-3-S-II launcher.	Understand	11

UNIT-V
ROCKET TESTING

Part - A (Short Answer Questions)

1	Write short notes on Manufacturing inspection with respect to rocket propulsion systems.	Remember	11
2	Briefly explain the following with respect to rocket propulsion systems: (a) Component tests (b) Static tests.	Remember	11
3	Enumerate the following with respect to rocket propulsion systems: (a) Static vehicle tests (b) Flight tests.	Understand	11
4	Mention at least three basic types of programs upon which rocket propulsion systems tests are conducted.	Remember	11
5	Write short notes on associated with rocket testing (a) qualification test (b) preliminary flight rating tests.	Remember	12
6	What are the important considerations in the selection of materials used for rocket /missiles?	Understand	12
7	Discuss about the selection of materials for rocket nozzles.	Understand	12
8	List different types of materials and their associated mechanical properties involved in fabrication of rocket motor pressure vessels.	Remember	12
9	Explain briefly different types of materials and their associated physical properties involved in fabrication of liquid engine storage tanks.	Understand	12
10	Describe about the different types of materials and their associated chemical properties involved in fabrication of liquid engine storage tanks.	Understand	12

Part – B (Long Answer Questions)

1	Enumerate working architecture followed for ground testing sequence of launch vehicles/rockets/missiles.	Remember	11
2	Detail the working architecture followed for flight-testing sequence of launch vehicles/rockets/missiles.	Remember	11
3	List five types of tests conducted on launch vehicles/rockets and explain any one sequence with suitable example.	Understand	11
4	Describe about the water testing of liquid rocket injectors? How is it done? What is its application?	Understand	11
5	Explain various test facilities requirements to be implemented for smooth functional aspect of rockets.	Remember	11
6	What are the steps involved in selection of materials for rockets and missiles.	Remember	12
7	Describe the importance of materials for designing propellant tanks.	Understand	12
8	Discuss the choice of materials for designing liners at cryogenic temperature.	Understand	12
9	What is the importance of selection of materials for insulators and inhibitors at cryogenic temperature?	Remember	12
10	Discuss the requirements of materials subjected to extremely high temperatures in the case of re-entry vehicles.	Understand	12

Part - C (Critical Thinking Questions)

1	Enumerate requirements of materials supporting thermal shielding of space shuttles.	Understand	11
2	Present the state-of-the-art involved with materials to support large pressure vessels of space launch vehicles.	Remember	11
3	Emphasize need of lubricant materials in the field of aerospace engineering and list their selection criteria.	Remember	11
4	Detail the different types of materials, their associated physical, chemical and mechanical properties involved in fabrication of rocket motor pressure vessels.	Remember	11
5	Describe the in detail different types of materials, their associated physical, chemical and mechanical properties involved in fabrication of liquid engine storage tanks.	Remember	12
6	List and explain various safe guards' requirements to be implemented for smooth functional aspect of rockets.	Remember	12

7	Exemplify need for monitoring and control of toxic materials during rocket testing and mention some strategies in accomplishing them.	Understand	12
8	Explain the criteria laid down for instrumentation and data management involved in testing facilities of rockets/launch vehicles.	Understand	12
9	Give the sequential event topology for a typical space launch vehicle.	Remember	12
10	Detail the importance of following procedures a) Ground testing b) Flight testing.	Understand	12

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