J.J COLLEGE OF ENGINEERING AND TECHNOLOGY

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SOWDAMBIKAA GROUP OF INSTITUTIONS

ESTD. 1994

DEPARTMENT OF AERONAUTICAL ENGINEERING

OAS353 – SPACE VEHICLE

QUESTION BANK

R-2021

INSTITUTE VISION & MISSION

VISION:

To become a globally recognized "Centre of Academic Excellence" providing Quality Education to all students.

MISSION:

To provide Quality Education in the fields of Engineering, Management, Information, Technology and other Engineering areas.

DEPARTMENT VISION & MISSION

VISION:

To prepare technically skilled and competent intellectual professional graduates to meet the challenges in the Aerospace industry.

MISSION:

M1: To produce technologically competent graduates to be front-runner in their profession.

M2: To provide state-of-the-art facilities and laboratories so as to enhance excellence in teaching and learning process.

M3: To provide need-based quality training programmes in the field of the Aerospace industry.

M4: Enhance the students sound knowledge in the latest technologies by organizing technical programs and encouraging students to make them present papers and participate in technical events.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1	To employ comprehensive knowledge in Aeronautical Engineering and analytical skills to work towards solving complex problems to excel in the professional career.
PEO2	To design, analyze and produce cutting edge engineering solutions by employing modern techniques and adhering to moral values for sustainable development.
PEO3	To assume global careers and leadership responsibilities through consistent learning with idealistic managerial practices.

PROGRAM OUTCOMES (POs)

PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions Using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including the design of experiments, Analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex Engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply to reason in formed by the contextual Knowledge to assess societal, health, safety, legal and cultural issues and the Consequent responsibilities relevant to the professional engineering practice.

PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and Responsibilities and norms of the engineering practice.
PO9	**Individual and team work:** Function effectively as an individual, and as a Member or leader in Diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able To comprehend And write effective reports and design documentation, make effective presentations, and give and Receive clear instructions.
PO11	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply These to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to Engage in in dependent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1	To gather data using modern tools and apply design techniques to develop solutions for challenges in the domain of Aerodynamics, Propulsion, Aircraft Structures and Aircraft Maintenance with professional ethics.
PSO2	To function as engineering solution providers or entrepreneurs, who are able to manage, innovate, communicate, train and lead a team for continuous improvement.
PSO3	Graduate will be able to work as a team member which will be a main requirement in industry or research organization or in any business enterprise. This will pave the way for successful career for the graduate and also play a role for the success of the organization in which the graduate is employed.

OAS353	SPACE VEHICLES	L T P C 3 1 0 4

COURSE OBJECTIVES:

To interpret the missile space stations, space vs earth environment. explain the life support systems, mission logistics and planning. Deploy the skills effectively in the understanding of space vehicle configuration design. explain Engine system and support of space vehicle interpret nose cone configuration of space vehicle.

UNIT I FUNDAMENTAL ASPECTS 9

Energy and Efficiencies of power plants for space vehicles – Typical Performance Values – Mission design – Structural design aspects during launch - role of launch environment on launch vehicleintegrity.

UNIT II SELECTION OF ROCKET PROPULSION SYSTEMS 9

Ascent flight mechanics – Launch vehicle selection process – Criteria for Selection for different missions – selection of subsystems – types of staging – Interfaces – selection and criteria for stages and their role in launch vehicle configuration design.

UNIT III ENGINE SYSTEMS, CONTROLS, AND INTEGRATION 9

Propellant Budget – Performance of Complete or Multiple Rocket Propulsion Systems – Engine Design — Engine Controls — Engine System Calibration — System Integration and Engine Optimization.

UNIT IV THRUST VECTOR CONTROL 9

TVC Mechanisms with a Single Nozzle – TVC with Multiple Thrust Chambers or Nozzles – Testing - Integration with Vehicle – SITVC method – other jet control methods - exhaust plume problems in space environment

UNIT V NOSE CONE CONFIGURATION 9

Aerodynamic aspects on the selection of nose shape of a launch vehicle - design factors in the finalization of nose configuration with respect to payload - nose cone thermal protection system - separation of fairings - payload injection mechanism

TOTAL:45 PERIODS

COURSE OUTCOMES (COs)

On completion of the course, the student is expected :	
CO1	To be able to apply control volume and momentum equation to estimate the forces produced by aircraft propulsion systems
CO2	To be able to describe the principal figures of merit for aircraft engine
CO3	To be able to describe the principal design parameters and constraints that set the performance of gas turbine engines.
CO4	To apply ideal and actual cycle analysis to a gas turbine engine to relate thrust and fuel burn to component performance parameters.
CO5	Understanding the workings of multistage compressor or turbine, and to be able to use velocity triangles and the Euler Turbine Equation to estimate the performance of a compressor or turbine stage.

CO's – PO's & PSO's MAPPING

Correlation of COs with POs / PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	1	2	3	1	1	1	2	3	1	1	3	1	1
CO2	3	2	2	3	3	2	3	2	2	3	1	1	3	1	1
CO3	3	3	3	3	2	1	2	1	3	2	1	1	3	1	1
CO4	3	3	3	2	3	2	2	1	2	1	2	1	3	1	1
CO5	3	3	2	2	3	1	1	1	1	1	1	1	3	1	1
AVG	**3**	**2.4**	**2.2**	**2.4**	**2.8**	**1.4**	**1.8**	**1.2**	**2**	**2**	**1.2**	**1**	**3**	**1**	**1**
3 – High; 2 – Medium; 1 - Low; - - No correlation															

TEXT BOOK

1. Hill, P.G. & Peterson, C.R. "Mechanics & Thermodynamics of Propulsion" Pearson Education (2009)

REFERENCE BOOKS

1. Cohen, H. Rogers, G.F.C. and Saravanamutto, H.I.H. "Gas Turbine Theory", Pearson Education Canada; 6th edition, 2008.
2. Mathur, M.L. and Sharma, R.P., "Gas Turbine, Jet and Rocket Propulsion", Standard Publishers & Distributors, Delhi, 2nd edition 2014.
3. Oates, G.C., "Aero thermodynamics of Aircraft Engine Components", AIAA Education Series, New York, 1985.
4. "Rolls Royce Jet Engine", Rolls Royce; 4th revised edition, 1986

UNIT– I

FUNDAMENTAL ASPECTS

PART–A				
Q. No	**Questions**	**CO Mapping**	**BT Level**	**Complexity**
1	What are the main power sources used in space vehicles?	CO1	Understand	Low
2	Define the term "mission design" in space vehicles.	CO1	Remember	Low
3	What is the role of structural design in space vehicle integrity?	CO1	Understand	Low
4	What are the importance of energy efficiency in space vehicles.	CO1	Understand	Low
5	What are the typical performance values for power plants in space vehicles?	CO1	Understand	Low
6	State that the launch environment affect vehicle integrity.	CO1	Remember	Low
7	Differentiate between space and earth environments for space vehicles.	CO1	Understand	Low
8	What are the major structural loads experienced by a launch vehicle?	CO1	Understand	Low
9	Define the term "payload" in space missions.	CO1	Remember	Low
10	Mention the challenges in space vehicle power management.	CO1	Remember	Low

PART–B				
Q. No	**Questions**	**CO Mapping**	**BT Level**	**Complexity**
1	Explain the different power plant systems used in space vehicles with their efficiencies.	CO1	Understand	Medium
2	Describe the structural design aspects of a launch vehicle and their importance.	CO1	Understand	Medium
3	Discuss the various energy sources used in space missions and their performance characteristics.	CO1	Understand	Medium
4	Explain the impact of launch environment conditions on the integrity of a space vehicle.	CO1	Understand	Medium
5	Discuss the role of mission design in the development of a space vehicle.	CO1	Understand	Medium
6	Explain the importance of thermal protection in space vehicle structural design.	CO1	Understand	Medium
7	Describe the energy conservation techniques used in space vehicles.	CO1	Understand	Medium
8	Explain the aerodynamic and structural considerations in launch vehicle design.	CO1	Understand	Medium
9	Compare and contrast the energy efficiency of chemical and nuclear propulsion systems.	CO1	Evaluate	High
10	Analysis the importance of material selection in space vehicle structural integrity.	CO1	Analyzes	Medium

UNIT – II

SELECTION OF ROCKET PROPULSION SYSTEMS

PART–A				
Q. No	**Questions**	**CO Mapping**	**BT Level**	**Complexity**
1	Define ascent flight mechanics.	CO2	Remember	Low
2	What are the major factors considered in launch vehicle selection?	CO2	Understand	Low
3	Differentiate between solid and liquid propulsion systems.	CO2	Understand	Low
4	What is staging in rocket propulsion?	CO2	Understand	Low
5	List any two criteria for selecting a propulsion system for different missions.	CO2	Remember	Low
6	What is the significance of subsystem selection in space vehicles?	CO2	Understand	Low
7	Define thrust-to-weight ratio in rocket propulsion.	CO2	Remember	Low
8	What are the major types of interfaces in launch vehicle design?	CO2	Understand	Low
9	What is the role of propulsion staging in launch vehicle performance?	CO2	Understand	Low
10	Mention the advantages of multi-stage rockets.	CO2	Remember	Low

PART–B				
Q.No	**Questions**	**CO Mapping**	**BT Level**	**Complexity**
1	Explain the different types of staging used in space vehicles with suitable diagrams.	CO2	Understand	Medium
2	Describe the process of launch vehicle selection for different space missions.	CO2	Understand	Medium
3	Discuss the criteria for selecting a suitable propulsion system for a space vehicle.	CO2	Understand	Medium
4	Explain the importance of subsystem selection in rocket propulsion.	CO2	Understand	Medium
5	Compare the performance characteristics of solid, liquid, and hybrid propulsion systems.	CO2	Evaluate	High
6	Describe the role of ascent flight mechanics in launch vehicle design.	CO2	Understand	Medium
7	Explain how staging affects the efficiency of a launch vehicle.	CO2	Understand	Medium
8	Discuss the different interfaces involved in launch vehicle configuration design.	CO2	Understand	Medium
9	Explain the working principles and advantages of multi-stage rockets.	CO2	Understand	Medium
10	Describe the selection process of different stages in a launch vehicle configuration.	CO2	Understand	Medium

UNIT – III

ENGINE SYSTEMS, CONTROLS, AND INTEGRATION

PART–A				
Q. No	**Questions**	**CO Mapping**	**BT Level**	**Complexity**
1	What is a propellant budget?	CO3	Understand	Low
2	Define specific impulse in rocket propulsion.	CO3	Remember	Low
3	What are the main functions of an engine control system?	CO3	Understand	Low
4	Differentiate between a single and multiple propulsion system.	CO3	Understand	Low
5	What is meant by engine system calibration?	CO3	Understand	Low
6	What are the major steps in engine system optimization?	CO3	Understand	Low
7	Write the importance of system integration in space vehicles.	CO3	Understand	Low
8	Define the term engine performance curve.	CO3	Remember	Low
9	What are the key components of a rocket engine control system?	CO3	Understand	Low
10	Mention the challenges in integrating propulsion systems.	CO3	Remember	Low

PART–B				
Q. No	**Questions**	**CO Mapping**	**BT Level**	**Complexity**
1	Explain the concept of propellant budgeting and its significance in rocket design.	CO3	Understand	Medium
2	Describe the design and working of multiple rocket propulsion systems.	CO3	Understand	Medium
3	Explain the engine control mechanisms used in space vehicles.	CO3	Understand	Medium
4	Discuss the role of engine system calibration in improving propulsion efficiency.	CO3	Understand	Medium
5	Explain the methods used for system integration and engine optimization.	CO3	Understand	Medium
6	Describe the factors affecting the performance of a rocket engine.	CO3	Understand	Medium
7	Discuss the importance of thermal management in rocket engines.	CO3	Understand	Medium
8	Compare the advantages and disadvantages of different engine control systems.	CO3	Evaluate	High
9	Explain how advanced computational methods help in optimizing engine performance.	CO3	Understand	Medium
10	Describe the various techniques used in thrust regulation of rocket engines.	CO3	Understand	Medium

UNIT – IV

THRUST VECTOR CONTROL

PART–A				
Q. No	**Questions**	**CO Mapping**	**BT Level**	**Complexity**
1	What is Thrust Vector Control (TVC)?	CO4	Understand	Low
2	Differentiate between SITVC and jet control methods.	CO4	Understand	Low
3	What is the role of TVC in launch vehicle stability?	CO4	Understand	Low
4	Define "exhaust plume" and its effect in space environment.	CO4	Remember	Low
5	List the different types of TVC mechanisms.	CO4	Remember	Low
6	What are the advantages of TVC with multiple nozzles?	CO4	Understand	Low
7	Define jet vanes in TVC systems.	CO4	Remember	Low
8	What is the impact of TVC on the guidance system?	CO4	Understand	Low
9	List out the challenges in TVC implementation.	CO4	Remember	Low
10	What is a gimbaled thrust system?	CO4	Understand	Low

PART–B				
Q. No	**Questions**	**CO Mapping**	**BT Level**	**Complexity**
1	Explain the working principle of thrust vector control (TVC) with neat diagrams.	CO4	Understand	Medium
2	Compare the different types of TVC mechanisms used in rockets.	CO4	Evaluate	High
3	Discuss the significance of SITVC and other jet control methods.	CO4	Understand	Medium
4	Explain the impact of exhaust plumes on space vehicle performance.	CO4	Understand	Medium
5	Describe the integration process of TVC mechanisms with a launch vehicle.	CO4	Understand	Medium
6	Explain the importance of TVC in space vehicle guidance and control.	CO4	Understand	Medium
7	Discuss the various testing methods for TVC systems.	CO4	Understand	Medium
8	Explain the role of fluid injection in thrust vectoring.	CO4	Understand	Medium
9	Describe the advantages of multiple thrust chambers in TVC design.	CO4	Understand	Medium
10	Discuss the challenges faced in exhaust plume management in space propulsion.	CO4	Understand	Medium

UNIT – V
NOSE CONE CONFIGURATION

PART–A				
Q. No	**Questions**	**CO Mapping**	**BT Level**	**Complexity**
1	What is the function of a nose cone in a launch vehicle?	CO5	Understand	Low
2	Define payload injection mechanism.	CO5	Remember	Low
3	What are the design considerations for nose cone configuration?	CO5	Understand	Low
4	Write the importance of aerodynamic shaping in nose cones.	CO5	Understand	Low
5	What is the effect of nose cone shape on vehicle stability?	CO5	Understand	Low
6	Mention two thermal protection strategies for nose cones.	CO5	Remember	Low
7	What is fairing separation in launch vehicles?	CO5	Understand	Low
8	Define the term "payload integration" in space vehicles.	CO5	Remember	Low
9	What are the main materials used in nose cone fabrication?	CO5	Understand	Low
10	What is the significance of weight optimization in nose cone design?	CO5	Understand	Low

PART–B				
Q. No	**Questions**	**CO Mapping**	**BT Level**	**Complexity**
1	Explain the aerodynamic design considerations for nose cone configuration.	CO5	Understand	Medium
2	Discuss the factors influencing the selection of a nose cone shape.	CO5	Understand	Medium
3	Describe the thermal protection methods used for nose cones.	CO5	Understand	Medium
4	Explain the process of finalizing the nose cone configuration for a payload.	CO5	Understand	Medium
5	Discuss the separation mechanisms used in payload fairings.	CO5	Understand	Medium
6	Explain the role of payload integration in nose cone design.	CO5	Understand	Medium
7	Compare different types of nose cone geometries and their applications.	CO5	Evaluate	High
8	Describe the effect of aerodynamic heating on nose cone materials.	CO5	Understand	Medium
9	Discuss the importance of weight reduction in nose cone design.	CO5	Understand	Medium
10	Explain the impact of payload protection on nose cone selection.	CO5	Understand	Medium

THANK YOU

ALL THE BEST