June 2025

Research Problems for DIA-CoEs

Directorate of Futuristic Technology Management

Research Problems for DIA-CoEs

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Introduction

DRDO is funding multi-institutional and multi-disciplinary directed research projects to Academia and National Research Institutes to develop cutting edge defence technologies. The funding is focused on translational research for developing the crucial and futuristic technologies in defined research domains through a network of DRDO Industry Academia – Centre of Excellences (DIA-CoEs) at premier and capable academic institutes and universities in the country.

To foster the research in academia, DFTM invites project proposals on problem statements in multiple areas, that will be taken up through DIA-CoEs for directed research. Received proposals will be scrutinized by DFTM and forwarded to respective DIA-CoEs as per research verticals for further evaluation.

Forms for submission are provided at ***drdo.gov.in/drdo/adv-tech-center***

Fully furnished project proposals shall be submitted to DFTM through ***techforesight.drdo@gov.in***

1. Development of Light Weight Technology for EW payloads

Technology Area
Materials

Technology Category
Composites

Brief of the Research Problem
The objective of this project is to develop an alternative to aluminum based alloy with a significantly lower density than conventional aluminum alloys to create lightweight enclosures for electronic warfare (EW) system intended for UAV (Unmanned Aerial Vehicle) and drone-based platforms.

Major Objectives
The objective of this project is to develop an alternative to aluminum based alloy with a significantly lower density than conventional aluminum alloys to create lightweight enclosures for electronic warfare (EW) system intended for UAV (Unmanned Aerial Vehicle) and drone-based platforms. Given the critical importance of minimizing the weight of EW payloads, particularly for future UAV-based electronic intelligence (ELINT) systems, an alternative to traditional aluminum alloys (density ~2700 kg/m^3) is required.

Expected Deliverables
- This proposed solution involves developing a lithium-magnesium-aluminum (Li-Mg-Al) based alloy or equivalent with a target density of 1200 to 1500 kg/m^3. The new alloy must ensure structural integrity, durability, and reliability under challenging environmental conditions while significantly reducing overall system weight.
- Deliverables:- As a case study a Antenna Panel within targeted weight (Hardware) as per the sketch attached.
- Documentation/Test Reports
  i. Strength and Elastic property of the developed alloy
  ii. Process details
  iii. Industry Partner
  iv. Effect on Environmental profile
  v. ESS reports

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Probable Applications

Electronic warfare (EW) system intended for UAV (Unmanned Aerial Vehicle) and drone-based platforms.

Figures of Merit

S no	Parameter	Value
1	Antenna Panel within targeted weight (Hardware)	-

2. Development of In-Channel Full Duplex Radio

Technology Area
Communication

Technology Category
Wireless

Brief of the Research Problem
Design, development and testing of In-Band Full Duplex (IBFD) Radio in the frequency band, 225-400MHz, for technology demonstration. The IBFD radio will cater for self interference cancellation component at hardware as well as in software/waveform. One of the most challenging technologies, Self interference cancellation will be handled at three domains of the radio, namely:
a. Antenna Feed Network b. Analog Domain c. Digital Domain

Major Objectives
To design and develop Self Interference Cancellation (SIC) techniques for voice and data communication in the frequency band of 225-400MHz.

Expected Deliverables
- Self Interference Cancellation (SIC) techniques-

a. At antenna feed network, b. In analog domain, c. In digital domain
- Prototype hardware in 19 inch rack and 3U form factor with above SIC techniques.

Probable Applications
- Simultaneous transmission and reception at the same frequency to enhance the spectral efficiency.
- Support relaying at same frequency.
- To provide protection from interception while receiving mission critical commands.
- To intercept adversary communication while transmitting mission critical commands.

Figures of Merit

S no	Parameter	Value
1	Self Interference Cancellation at antenna feed network	45 dB
2	Self Interference Cancellation at analog domain	55 dB
3	Self Interference Cancellation at digital domain	40 dB

3. Sensitivity / Survivability analysis of Stealth Unmanned Combat Aircraft under heavily contested airspace

Technology Area
Wargaming

Technology Category
Flight Simulation

Brief of the Research Problem
- Sensitivity / Survivability analysis of the High performance Unmanned Combat Aircraft is required to converge towards the missions which are survivable under different war gaming scenario. This analysis will also include the risk quantification and risk mitigation strategies with respect to change in scenarios.
- It is proposed that analysis to carried out through high fidelity mathematical modelling & simulation of adversaries' various assets like - Air defence radar network, Air defence Guns, Surface to Air missiles batteries etc.
- It is proposed to consider the stealth attributes of the Unmanned Combat Aircraft as per open literature data which will be refined with original inputs at appropriate stage of the study.
- A detailed analysis report along with the simulation model to be submitted.

Major Objectives
To refine the tactics of own ship operations in dynamics and contested airspace where probability of survival can be quantified

Expected Deliverables
Detailed technical report and developed software tool/s for analysis

Probable Applications
Futuristic Projects

4. Reinforced learning based trained AI solution for constructive simulation of aerial/ground/sea agents, deployed in tactical scenario (war/peace)

Technology Area
AI/ML Technology

Technology Category
Software Framework

Brief of the Research Problem
- Tactical Scenario Simulator (TSS) is the vital elements of full mission simulator for manned as well as unmanned class of fighter aircraft. TSS is used for painting the variety of tactical scenario as per mission evaluation needs. Missions are painted by selecting the gaming area, de-marking the borders with marking tools, deploying the Aerial entities, ground entities & Sea based assets as per mission evaluation requirements.
- After entities and assets deployment in the gaming area, entities are required to behave / react to the presence of own ship. It is proposed to provide AI based approach for behavior training of these entities or assets. AI based trained behavior simulation of entities is expected to provide realistic and nondeterministic simulation of tactical scenarios.

Major Objectives
To give high fidelity tactical scenario for mission training to the prospective users

Expected Deliverables
Trained AI solution (Software) tool, comprising of Mathematical models of various agents with varying attributes and real life behaviors along with their applicable databases

Probable Applications
Futuristic Projects

5. Thermal management of microwave electronics module housed in Titanium Shell for underwater application

Technology Area
Electronic Warfare

Technology Category
Thermal Management

Brief of the Research Problem
- Aim: To carryout thermal management of microwave electronics stack, packaged as conduction cooled chassis housed in the Titanium shell which dissipates 400W (PCB based modules). Card edge temperature of the modules to be maintained at 70 Deg C when the shell is exposed to 45 bar external hydrostatic pressure & 55 Deg C ambient temperature.
- Description: Antennas are mounted all around the Titanium shell. Structurally, Titanium shell should withstand 45 bar external hydrostatic pressure. There are 4 modules each dissipates 100W packaged in a enclosure and placed centrally in the Titanium shell. The Module edge temperature to be maintained at 70 Deg C in the ambient of 55 Deg C. This shell will be mounted on a submarine Mast for underwater application. Innovative cooling methods to be planned to maintain the inside electronic modules well within the safe temperature limits as the titanium shell is having low thermal conductivity. External effective conductive surface area of shell is limited due to placement of antennas and radomes.
- Constraints:

  i. System should work in -20 Deg C to 55 Deg C environmental conditions. ii. Noise level of the system should not cross 40 dB. iii. The maximum size of the Titanium shell is Ø 620 X 600 (H) mm X 10 (t) mm. iv. Shell is a sealed unit against 45 bar hydrostatic pressure.

Major Objectives
Development of ESS qualified Titanium shell hardware with cooling mechanism to transfer heat from the central core to the outer walls of the Titanium shell, maintaining required temperature at Card edges.

Expected Deliverables
- ESS qualified Titanium shell hardware with cooling mechanism
- Design & analysis report
- ESS reports

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Probable Applications

Underwater applications

Figures of Merit

S no	Parameter	Value
1	The Module edge temperature to be maintained in the ambient of 55 Deg C	70 Deg C

6. Improvised engine bay ventilation for stealth platform

Technology Area
Aerodynamics

Technology Category
Aircraft configuration

Brief of the Research Problem
To study and evolve improvised engine ventilation scheme by tapping air from air intake for futuristic unmanned stealth platform. In stealth aircraft, engine and nozzle are buried inside the fuselage in the compartment called engine bay. Engine requires ventilation to avoid fire as well as to maintain engine bay within permissible operating limits of temperature. The engine bay ventilation is presently achieved by providing inlet scoops for ram air which adversely affects performance and stealth. Use of secondary bleed from air intake for engine bay ventilation can eliminate scoops on the aircraft. Inlet air to be through secondary bleed from air intake and exhaust by nozzle ejection.

Major Objectives
- To estimate tapping location, type and sizing of secondary bleed in air intake by studying different configuration
- Analysis of engine bay ventilation using secondary bleed to meet engine bay ventilation requirements for ground and flight conditions
- Analysis of air intake for ground and flight conditions to assess the affect of secondary bleed on performance of air intake.
- To study the possible reduction of skin temperature around the nozzle as an input to IR studies
- To document on advances happening world wide in the field of engine bay ventilation

Expected Deliverables
- 3D models of secondary bleed duct
- Detailed report covering configuration studies towards estimation of tapping location, type and sizing of secondary bleed in air intake
- Detailed report covering analysis approach, results and compliance towards meeting engine bay ventilation requirement using secondary bleed for ground and flight conditions.
- Detailed report covering analysis approach, results and compliance towards meeting performance requirement of air intake for ground and flight conditions.
- CFD analysis files of engine bay and air intake

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Probable Applications

Engine bay ventilation of stealth platform

Figures of Merit

S no	Parameter	Value
1	Average temperature in engine bay	<120 deg C
2	Average velocity in engine bay for static condition	>1.5 m/s
3	Average velocity in engine bay for max speed condition	>4.5 m/s
4	Maximum distortion in the air intake	<0.1%

7. Development of Rare Earth free Permanent Magnets

Technology Area
Materials

Technology Category
Permanent Magnets

Brief of the Research Problem
Rare earth permanent magnets, such as Sm-Co and Nd-Fe-B, are widely used in both strategic and civilian sectors, including clean energy (electric vehicles, wind turbines), medical devices, consumer electronics, sensors etc. Ongoing supply challenges combined with the growing demand for rare earth magnets have necessitated the development of magnets with reduced reliance on critical materials. This has led to a growing interest in rare earth-free magnets that can offer comparable or near-comparable magnetic performance to conventional rare earth magnets. Innovative research proposals are invited in the area of rare earth-free permanent magnets that show the greatest promise in achieving performance levels on par with, or approaching, those of rare earth-based magnets.

Major Objectives
To develop rare earth-free permanent magnets with magnetic properties comparable to rare earth magnets

Expected Deliverables
Process and methodology, dataset

Probable Applications
Development of RE free permanent magnets as an alternative to RE magnets for BLDC motor

Figures of Merit

S no	Parameter	Value
1	Cost effective and RE free permanent magnets as an alternative to RE magnets	-

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