

**Project Themes for PG & UG Students
at
Centre for Advanced Studies in Cryogenics (CASC)**

Prospective PG & UG project students (M.Tech / M.Sc (Phy) & B.Tech)

Any student with Zeal, Drive and Motivation, desirous of taking up challenging and emerging topics may approach. Grade no bar

Prospective Ph.D students

Meet personally or call for discussions

Various student project themes are proposed and being implemented in Centre for Advanced Studies in Cryogenics related to Analysis/design/modeling/simulation/CFD/coding/computer program package/prototyping/experimentation or its combinations (in collaboration and along with other departments of NIT and reputed institutes/organizations in India and abroad) which benefits advanced research, technology, scientific society and developing indigenous technologies and products.

1. Cryogenic and other coolers working on various cycles
 2. Refrigerators / Freezers / Ac / HVAC/ Liquefier using new technologies
 3. Specialty Compressors and Pressure wave generator (PWG) with free piston technology and gas bearings
 4. Cryogenic process plants
 5. Modelling, computer program dev., CFD and applied mathematics in Heat transfer Fluid flow for various applications
 6. Engineering for underdeveloped rural areas/ society
 7. Cryostats/ Devices/ Material/ Probes
 8. Special devices and phenomenon
 9. Medical & Bio Cryo applications
 10. Multi Physics
 11. Rocketry and Space propulsion
 12. Cryo engine, Turbo-Pumps, special engines and Turbines
 13. Aerial/ Space/ Satellite (Thermal & power management)
 14. Space instruments and devices
-

1. Cryogenic and other coolers working on various cycles

1. Micro miniature J-T coolers with high pressure stored gas
2. Compact J-T cooler for field and space applications
3. JT/ Kleemenko cycle coolers
4. 20K-100K Two stage and single stage Stirling/ Pulse tube coolers (working with free piston technology-moving magnet linear compressor)
5. 20K-100K Two stage and single stage Stirling/ Pulse tube coolers (working with free piston technology-moving coil linear compressor)
6. Long life free piston Cryocoolers with combined gas bearings/flexure bearings and gas springs
7. Large Stirling coolers with linear compressor for various applications
8. Scaling laws, dynamics and thermodynamics of miniature cryocooler

9. Staged vortex tube (Ranque-Hilsche) cooler
10. High efficiency Magnetic refrigerators (based on Ferro magnetic and para magnetic materials)
11. Acoustic coolers (standing wave and travelling wave based)
12. Anti-Stokes Optical cryocooler (Solid state)
13. Five stage cascade cooler to reach cryogenic temperatures

2. Refrigerators / Freezers / Ac / HVAC/ Liquefier using new technologies

1. Cryocoolers & refrigerators with Stirling, magnetic, Vuillimiuer, Pulse tube, anti-Stokes, JT & sorption cycles
2. Compact and large Magnetic refrigerators for near Carnot PI
3. Large magnetic refrigerator - system design for gas liquefaction
4. Active regenerative magnetic refrigerator
5. Concept development of new generation VCR systems with Gas bearings and Flexure springs
6. VCR system with new Refrigerant compressor handling hybrid refrigerants
7. Combined refrigeration cycle: VAR and VCR
8. Portable compact freezer
9. Pulse tube refrigerator
10. Thermo-acoustic refrigerator
11. Vuilleumier & Gifford McMahon refrigerators
12. Improved VCR system with nano additives and particles
13. Improved compact Electrolux system
14. Multi-pressure multi-evaporator VCR system for various applications
15. Simple Linde-Hampson, Claude/ Kapitza cycle scaled down refrigerator- liquefier
16. Mixed refrigerant Low pressure Kleemenko cycle Refrigerator / Liquefier
17. Four stage cascading refrigeration system/ Liquefier
18. HVAC system for green buildings
19. Combined cycle JT-VCR-Brayton for cooling
20. Turbine based Brayton expander cycle for cooling

3. Specialty Compressors and Pressure wave generator (PWG) with free piston technology and Gas bearings

1. Vibration free dual opposed linear compressor & Oil free resonating compressor
2. New generation gas compressors - Using flexure springs with one DOF to avoid wear and tear
3. Low pressure ratio clearance seal compressors
4. All metal to metal seal gas compressor with no lubricant
5. Long life Pressure wave generator (PWG)
6. Sensorless BLDC driven micro crank compressor with special non lubricated seals
7. Development of power piston /displacer piston with gas springs
8. Design of Pressure wave generator for a thermo-acoustic refrigerator
9. Flexure bearing for the use of a miniature compressor-Thermo structural
10. Miniature linear & rotary compressors and small motors
11. Miniature linear motor with moving magnet technology
12. Miniature linear motor with moving coil technology
13. Hermetically sealed BLDC

4. Cryogenic process plants

1. Natural gas separation from petroleum products

2. Liquid oxygen separation and liquid Hydrogen generation
3. Large cascading systems
4. Cryogenic Gas separation with waste heat energy

5. Modelling, computer program dev., CFD and applied mathematics in Heat transfer Fluid flow for various applications

1. Film cooling & Transpiration cooling in rocket engine combustion chamber
2. High speed compact Turbo-pumps
3. Ultra compact regenerators
4. Optimization of miniature Heat exchanger
5. Radiation heat transfer in Multilayer insulation with perforations, mirrors and carbon gettering
6. JT cooled Insulated jacket for cooling and heating for use in frontier areas
7. Cryogenic miniature Dewar for field use
8. Super insulated High pressure Large cryogenic Dewar
9. Interfacing heat transfer in compact Cryogenic Dewar
10. Flow oscillation and heat transfer in Stirling / Pulse tube coolers
11. Optimization of coolant channels in regenerative cooled engines
12. Modular engine design for study and performance prediction of test cryogenic engine
13. Code development for ignition, combustion and reaction
14. Combined heat transfers in any enclosure, space modules and air capsules
15. Study of carbon cocking problems in a semi-Cryogenic rocket engine
16. Co-axial Vs swirl injector for combustion chamber
17. Determination of economically viable high performance nozzle for future rocket engines
18. Combustion studies of LH₂ inducted spark ignition engine
19. Ignition & combustion studies in a Cryo/ semi-cryo rocket engine using NASA program
20. Stratification studies in Cryogenic LH₂ and LOX tanks
21. Cryogenic Two phase/multi-phase flow
22. Cryogen cooling for high performance robots to handle nuclear energy
23. Out gassing in materials with ultra-high vacuum
24. Flow and two dimensional / three dimensional heat transfer in coolant channels of cryogenic thrust chamber
25. Heat exchangers and heat transfer equipments- High effectiveness Miniature/ Special applications
26. Thermal energy storage (space application)
27. Model based thermal design
28. Heat transfer enhancement in air and space vehicle components
29. environmental control system(ECS) and Heat exchangers in aircrafts
30. Additive manufacture enabled conformal heat transfer
31. Air/oil coolers and Heat transfer in pre-coolers
32. Heat transfer enhancement - various
33. Boundary layer code development for subsonic and supersonic flows
34. Computer Program for determining Boundary layer effects, Chemical Equilibrium Compositions, Rocket Performance and C-J Detonation effects (for rocket engine fuels and oxidizers)
35. Radiation network matrix for combined heat transfer in Passive radiation cooler
36. Design code development for compact Stirling engine using radio isotope energy & Stirling cooler for long duration outer space mission

6. Engineering for underdeveloped rural areas/society

1. Portable Stirling engine-generator for un-electrified rural homes (Free piston/or Crank type)

2. Turbine-alternator with free stream water for remote places
3. Portable compact refrigerator with combined power from solar PV, wind energy sources
4. Micro CHP Stirling engine with tapped waste energy in urban homes

7. Cryostats/ Devices/ Probes / Materials

1. Cryogenic liquid level sensor
2. Cryogenic pump design
3. Space simulation chamber
4. Space Insulation blanket with heating and cooling
5. Cavitating venturi for LH₂ flow measurements
6. Cryo treatment of nonmetals and materials for improved thermo-structural properties
7. Characterization of special alloys and material with cryogenic temperature
8. Determination material properties of ferro-magnetic materials for use in near ambient magnetic refrigerator
9. Determination of material properties for carbon and other gettering substances at low temperature
10. Development of material properties for new vapor absorption system
11. Development of material for optical cooler using anti-Stokes fluorescence
12. Cryogenic medical probe
13. Production hardening with cryogens

8. Special devices and phenomenon

1. HTS-Superconducting devices: motor, bearing, magnetic levitation
2. Investigating special phenomenon with cryogenic fluids
3. Experimental investigation with cryogens
4. UHV space simulation chambers

9. Medical Cryo applications

1. Developing PSA and Kleemenko technologies
2. Cryogenic LN₂ probe for medical use
3. Miniature LN₂ liquefier for medical use with PSA technology
4. High purity O₂ production with Filtering/PSA/Distillation technology
5. Compact LO₂ Liquefier for Covid care Hospitals

10. Multi Physics

1. Modelling and optimization of parameters: all solid state fluorescent optical cooler based on anti-Stokes effect
2. Scaled mN thruster with electric/ion propulsion
3. Optimization of performance & staging parameters for thermo-electric cooler
4. Determination of magneto-caloric effect (MCE) in para-magnetic and ferro-magnetic materials
5. Ignition Instability problems in high pressure cryogenic engine combustion chamber
6. Modeling Radio-isotope (RI) energy sources for potential use in space application
7. Combined heat and power modeling and management in space use with PV, RI, Stirling, Fuel cell, Thermopile Seebeck, Brayton, Heat pipe and Passive radiation

11. Rocketry and Space propulsion

1. Mono propellant, Bi propellant, Tri-propellant rocket engines /and scaled down versions

2. solid & gel propelled rocket engines
3. Fully cryogenic, Semi cryogenic, Steering engines
4. Apogee motors and Vernier engines
5. Ascend and descend engines for outer space missions
6. Gimballed miniature engines
7. High speed Turbo-pumps and propellant feed systems
8. Gas pressurized Propellant feed systems
9. High speed centrifugal pumps & axial flow pumps
10. Turbine design: Design procedure, design of nozzle, rotor blades and roto-dynamics
11. Velocity compounded and pressure compounded turbines: single stage, two stage
12. Low mixture ratio Gas generator for initial powering of turbo-pump (rocketry)
13. GG, SC & Expander cycle Cryogenic engines analysis
14. High performance low mass Insulation-Cryogenic propellant tanks
15. Small engines and motors for powering, maneuvering, control and guidance
16. Micro propulsion systems & thrusters for strategic surveillance applications
17. Two phase heat transfer phenomenon in rocket engine ducts and coolant channels
18. Electric propulsion (Theoretical study and modeling & simulation only)
19. Nuclear propulsion (Theoretical study and modeling & simulation only)
20. Other advanced propulsion (Theoretical study and modeling & simulation only)
21. Operational efficiency of air space vehicles
22. Alternate rocket fuels
23. Extreme environment thermal management for air and space vehicle components
24. Modular engine design for liquid rocket engines with Optimization of parameters and

12. Cryo engine, Turbo-Pumps, special engines and Turbines

1. GH₂ operated Brayton cycle Turbine
2. Brayton cycle/ Expanding piston cooler for high cooling load HTS applications
3. LH₂ fired SI engines
4. High pressure LN₂ operated silent engines
5. Compressed air and LN₂ driven carts

13. Aerial/ Space/ Satellite (Thermal & power management)

1. Passive radiative cooler in satellite
2. Cryogenic heat pipe for satellite applications in high 'g' and low 'g' conditions
3. Bubble fin heat pipe with microgravity effects
4. High performance common bus multi staged heat pipe
5. Powering systems for micro-satellites-various
6. Reliable VCR system for cooling instruments room in combat UAV
7. Micro-propulsion system for Drone & UAV
8. Micro turbojet engine for UAV
9. Combined PV & thermoelectric solar power generation
10. Compact Stirling engine using solar energy for satellite applications
11. Electro-thermal analysis of space solar powering in satellite
12. Combined management for energy, solar, battery in micro satellite
13. RTG driven radio isotope based Stirling space engine-modeling and computer program
14. Oxygen provision systems for onboard crafts (liquid oxygen systems and on-board oxygen gas generation systems (OBOGGS))
15. High performance insulations for hazardous/extreme outer space conditions

14. Space instruments and devices

1. Qualified free piston Stirling and PTC coolers for various temp levels 10K to 250K
2. Qualified free piston Stirling engine 100-200W using solar power
3. Compatible integrated Dewar detector for Cryocoolers
4. Superconducting (S/c) motors and Magnetic bearings
5. Near no loss Multi-layer insulation technology with Gel
6. Cryogenic heat pipe
7. Combined power and energy devices
8. Space gyroscope (s/c)