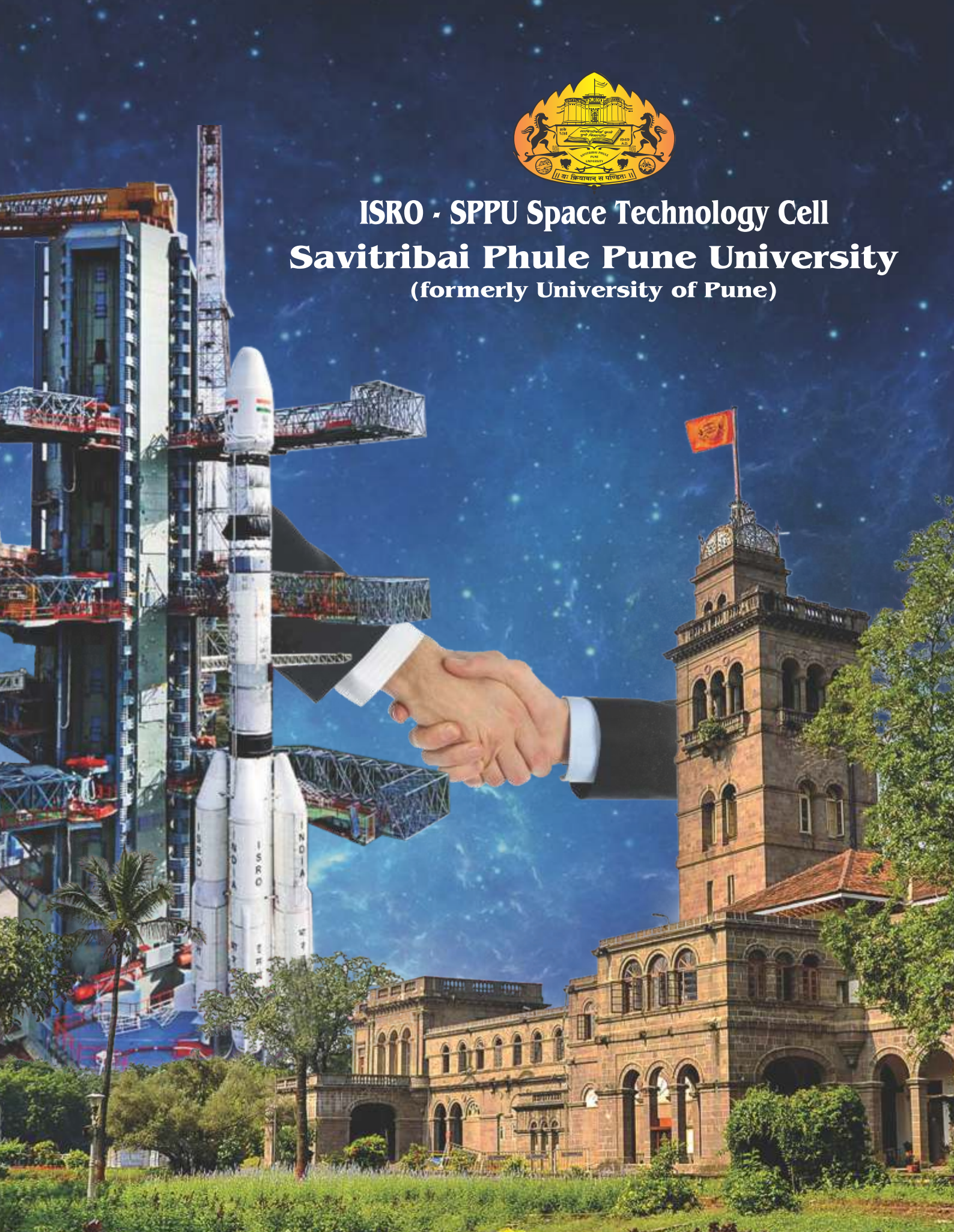


ISRO - SPPU Space Technology Cell

Savitribai Phule Pune University

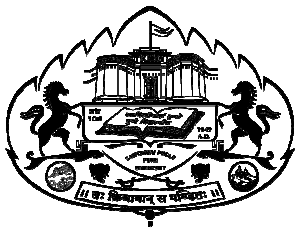
(formerly University of Pune)

Annual Report 2016-17

JPC Members in a discussion

ISRO-SPPU
Space Technology Cell

Savitribai Phule Pune University
(Formerly University of Pune)



ANNUAL REPORT
2016-17

SUMMARY

This document presents details of the activities of ISRO-SPPU Space Technology Cell (STC) at Savitribai Phule Pune University for the year 2016-17. Studies in respect of seven projects have been completed this year and final technical reports received from the Investigators. Summary of findings of these projects is presented in the Report. Presently there are 24 ongoing projects including eight projects initiated in June 2016. Progress of these projects is monitored through periodical progress reports and reviews by Preliminary Evaluation Committee (PEC) and Joint Policy Committee (JPC). Current status of these projects is given in the Report. In response to ISRO-SPPU STC's call for new research projects under ISRO-SPPU Joint Research Programme (JRP), 121 study proposals were received from various Departments and affiliated colleges of the University. These proposals were evaluated by Preliminary Evaluation Committee (PEC) for making recommendation to Joint Policy Committee (JPC). JPC interacted with the prospective investigators and approved 11 proposals for funding in the financial year 2017-18. In respect of other not-approved proposals, JPC suggested to communicate observations/comments to investigators for improvement/modifications. Technical summary of the approved proposals has been included in the Report. Major establishments of DOS and their areas of technical activities were highlighted in the Annual Report 2014-15. With a view to bring out the potential research areas for the benefit of prospective investigators from the University, salient features of technical activities of National Remote Sensing Centre (NRSC/ISRO), Hyderabad were added in the Annual Report 2015-16. Similar information on Satellite Application Center (SAC/ISRO) Ahmedabad has been included in the present Annual Report.

ISRO Proposal Format and thrust areas in the suggested research topics have been also included for the guidance of prospective Investigators.

Contents

1. Introduction

Having recognized the need to generate basic knowledge through advanced academic research enabling a self-reliant and self-generating space programme for the country, ISRO evolved a plan called RESPOND through which financial support is provided for conducting research and development activities related to Space Science, Space Technology and Space Application to academia in India. RESPOND plan has been effective in establishing strong links with academic institutions and in deriving useful outputs of such R&D to support ISRO programmes. Under this plan, a Memorandum of Understanding (MoU), initiating Joint Research Programme (JRP), was signed between ISRO and Savitribai Phule Pune University (SPPU) on 21 January 1998. Initially five broad disciplines were identified for carrying out research study under this JRP. Co-operation between the two organizations was found beneficial and as a result, while renewing the MoU on 24 February 2006, these areas were enlarged by identifying additional disciplines where more emphasis could be laid on. The areas currently recognized for development are:

- Origin of life
- Space Radiation
- Wind measurements and modeling
- Optical coatings and sensors
- Rural development and developmental communication
- Geo-informatics
- Remote sensing applications
- Material Sciences
- Biodiversity
- Instrumentation
- Image processing

With a view to strengthen the institutional interaction and thereby enhancing scope of the activities pursued under JRP commensurate with the programmatic goals of ISRO, Memorandum of Understanding was revisited and concluded afresh on 21 March 2017. It was agreed that Joint Research Programme should continue with special emphasis on advanced research in the areas of relevance to the future technological and programmatic needs of Indian Space Programme.

2. Management of Joint Research Programme

Under ISRO-SPPU Joint Research Programme, emphasis has been on pursuing advanced research in the areas of relevance to the future technological and programmatic needs of the Indian Space Programme. A Joint Policy Committee (JPC) chaired by Vice Chancellor, SPPU with members from both ISRO and SPPU has been constituted jointly by Vice Chancellor, SPPU and Chairman, ISRO to guide the JRP. JPC plans the research programmes of common interest and periodically reviews such research programmes and related activities. JPC is responsible for approving the budget of JRP. Honorary Director, ISRO-SPPU STC, is responsible for the administration, fund utilization and day-to-day functioning of the STC. Following were the JPC Members during the year 2016-17.

Joint Policy Committee (JPC)

Prof (Dr) W N Gade, Vice Chancellor, SPPU	Chairman
Dr MBN Murthy, Dy. Director, SDSC/ISRO	Member
Dr G Nagendra Rao, Director, LEOS/ISRO	Member
Dr S Aravamuthan, Dy Director, VSSC/ISRO	Member
Dr Rajeev Jyoti, Director, DECU/ISRO	Member
Dr P V N Rao**,** Group Director, NRSC/ISRO	Member
Shri MS Anurup, Dy Director, ISRO HQs	Member
Dr K Ganesh Raj, Dy Director, RESPOND, ISRO HQs	Member
Prof S Ananthakrishnan	Member
Shri P P Kale	Member
Dr V B Gaikwad, Director BCUD, SPPU	Member
Dr Shridhar Geji, Head, Dept of Chemistry, SPPU	Member
Dr P Pradeep Kumar, Head, Dept of Atm and Space Sciences, SPPU	Member
Prof Anjali Kshirsagar, Head, Dept of Physics, SPPU	Member
Prof P B Ahuja, Director, College of Engineering, Pune	Member
Smt Vidya K Gargote, Finance & Accounts Officer, SPPU	Member
Shri M C Uttam, Hon Director, ISRO- SPPU STC,SPPU	Member Secretary

Preliminary Evaluation Committee (PEC)

Preliminary Evaluation Committee (PEC) is a local Committee constituted to co-ordinate and assist in implementation of Joint Research Programme in Savitribai Phule Pune University. This Committee carries out preliminary evaluation of new research proposals and interacts with Investigators to make changes in the proposed study. The proposals recommended by the Committee are examined by the Joint Policy Committee for final approval. PEC also has the responsibility to periodically review the progress of the ongoing projects and take corrective measures. Following were the PEC Members during the year 2016-17.

Dr S Ananthakrishnan	Chairman
Shri PP Kale	Member
Dr (Mrs) Deepti Deobagkar	Member
Dr V B Gaikwad, Director BCUD, SPPU	Member
Prof Anjali Kshirsagar, Head, Dept of Physics, SPPU	Member
Dr P Pradeep Kumar, Head, Dept of Atmospheric and Space Sciences	Member
Dr Shridhar Geji, Head, Dept of Chemistry, SPPU	Member
Dr A D Shaligram, Head, Dept of Electronic Science, SPPU	Member
Dr Veena Joshi, Head, Dept of Geography, SPPU	Member
Dr D C Meharam, Head, Dept of Geology, SPPU	Member
Prof Sanjeev Sonawane, Head, Dept of Education and Extension	Member
Smt Vidya K Gargote, Finance & Accounts Officer	Member
Shri M C Uttam, Hon. Director, ISRO-SPPU STC,SPPU	Member Secretary

3. Completed research projects

Beginning in 1998-99, a total of 166 research projects were undertaken by the various departments of the University and its affiliated colleges under ISRO-SPPU Joint Research Programme and 135 of these projects were completed in the previous years ending in March 2016. During the year 2016-17 studies in respect of seven more projects have been completed and final technical reports received from the Investigators. In order to bring the results of the study to the notice of ISRO Scientists/Engineers, brief details along with summary of findings of the completed research projects are published from time to time. In addition, these details are put on the University's website for wider dissemination. Copies of full technical reports of the completed projects are also sent to concerned libraries of ISRO Centres.

List of Projects Completed During the Year 2016-2017

1. Naphthoquinone containing metal polypyridyl complexes for Solar Cells: Computational and Experimental Study (Project No.136)
2. Development of Microwave Excess Noise Generator Heads using Gas Discharge of Reactive and Non Reactive gases (Project No.138)
3. Development of transition metal oxide nanoparticle films for solar radiation protection and solar cells (Project No.139)
4. Halophilic bacterial diversity of marine ecosystems from West Coast of India (Project No.140)
5. Studies on nano-porous metal oxides via anodization and their applications in super capacitors (Project No.141)
6. The development of the F.C. Observatory - an autonomous robotic telescope (Project No.142)
7. Multifunctional conducting polymer transition metal nano structure based sensor device for detection of NO_2, H_2S and NH_3 (Project No.143)

Summary of findings and brief details of completed projects :

PROJECT NO	**136**
TITLE	Naphthoquinone containing metal polypyridyl complexes for solar cells: computational and experimental study
INVESTIGATORS	Dr Sunita A Salunke and Dr Subhash S Pingale (PIs) Dept of Chemistry, SPPU Dr H M Pathan (Co-PI), Dept of Physics, SPPU
CO-PI/FOCAL POINT/CONTACT SCIENTIST FROM ISRO/DOS	Dr C P Raghunadhan Nair VSSC/ISRO Thiruvananthapuram
DURATION	2 years (Started on: November 2013)
BUDGET (₹)	16,26,000

SUMMARY OF FINDINGS	Dye Sensitized Solar Cell (DSSC) is photovoltaic device which absorbs photons and convert them into electricity. Present project aims towards exploring naphthoquinone based dyes, as photosensitizers in DSSC. Naturally occurring dye henna, contains 2-hydroxy-1,4-naphthoquinone (lawsone), has good potential as dye in DSSCs. As a first step, experimental and theoretical studies were carried out to characterize lawsone. DSSC based on ZnO photoanode and lawsone is then made and tested. It shows 0.68 % power conversion efficiency. Quantitative structure property relationship (QSPR) analysis of derivatives of lawsone, substituted with electron withdrawing and donating groups is performed in order to improve absorption of light in the visible region. The theoretical study reveals the HOMO, LUMO band gap of naphthoquinone dyes. Chlorine (chlorolawsone; ClLw) and bromine (bromolawsone; BrLw) containing derivatives of lawsone were studied by single crystal X-ray diffraction as well as by DFT methods. Lawsone and its derivatives coordinate to metal ions via deprotonation as monodentate, bidentate as well as tridentate ligand. The synthesis and characterization of Zinc (II) complex of lawsone derivatives has been carried out. To enhance the visible absorptions, pyridine based naphthoquinone compounds (compound 1 [2-(2'-aminomethylpyridine)-3-chloro-1,4-naphthoquinone] and compound 2 [2-(2'-aminoethylpyridine)-3-chloro-1,4-naphthoquinone]) were synthesized and electronic transitions evaluated by TD-DFT studies. From the TD-DFT study of both compound 1 and compound 2, it is observed that both molecules absorbs in UV/Vis. region and are suitable for use in DSSC as dye sensitizer. Photosensitizer 6 – methyl – 5 H – benzo [α] phenothiazin -5 one (benzo [α] phenothiazine) has been successfully synthesized and characterized and fabricated DSSC. Test shows 1.64 % photo conversion efficiency, considerably higher compared to DSSC based on lawsone. Experimental work on Ruthenium polypyridyl complexes has been done and photo conversion efficiencies are being tested.

PROJECT NO	**138**
TITLE	Development of microwave excess noise generator heads using gas discharge of reactive and non reactive gases
INVESTIGATORS	Dr (Ms) S A Gangal (PI), ISRO Chair Professor, Dept of Electronic Science, SPPU Prof S V Ghaisas (Co-PI), Dept of Electronic Science, SPPU
CO-PI/FOCAL POINT/CONTACT SCIENTIST FROM ISRO/DOS	Dr Rajeev Jyoti SAC/ISRO Ahmedabad
DURATION	2 years (Started on: November 2013)
BUDGET (₹)	13,50,000
SUMMARY OF FINDINGS	Noise Source is required in communication field for calibrating the communication circuits especially receivers. Aim is to design, develop and

study an indigenous microwave Excess Noise Generator (ENR) based on gas discharge tubes using plasma of reactive and non reactive gases. Five different noise sources of following frequency bands were identified:

S band	2 to 4 GHz
C band (Lower)	4 to 6 GHz
C band(Higher)	6 to 8 GHz
X band	8 to 12 GHz
Ku Band	12 to 18 GHz

The output connector specified was N type connector. Focus was to develop the noise sources using indigenous materials and components. Gas tubes (Argon, Neon and Xenon) were purchased from the market and waveguide mounts designed and fabricated. Brass/copper was chosen for waveguide components and to improve its performance silver coating was given inside the waveguide mounts. Five different noise sources working in the above frequency bands have been successfully fabricated. Three different methods namely (i) Power meter method, (ii) Spectrum analyser method and (iii) Comparison method were set up for measurement and calibration of noise power. Three different power supplies - 5KV/200mA (variable) with trigger facility, 600V/600mA (Variable) and 80V/2Amp are fabricated and used to excite the gas tubes. ENR specifications of the fabricated Noise Sources are given below:

S band	14.5dB ±3.5%
C band (Lower)	14.95dB±3.5%
C band(Higher)	15.9dB± 3%
X band	15.4dB±3 %
Ku Band	13dB ±3%

VSWR of S-band noise source as measured is 1.45:1. VSWR for other ranges could not be measured since the network analyser and signal generator was not available in those ranges. But from the insertion loss values it can be judged that the VSWR will be within the expected values. All Noise Sources have been provided with co-axial N type (F) output port. Development of noise sources based on gas discharge arrestor for telephone and solid state (zener) devices (operated in avalanche mode) has also been done. It is planned to apply for a patent. The facility developed is made available for testing purposes to other Universities, Institutes, Research laboratories and industries.

PROJECT NO	**139**
TITLE	Development of graphite fiber reinforced Aluminium (7075) in the rolled sheet form
INVESTIGATORS	Prof Madhuri Deshpande (PI), Prof (Dr) Rahul Waikar (Co-PI) Vishwakarma Institute Of Technology, Pune SPPU
CO-PI/FOCAL POINT/CONTACT SCIENTIST FROM ISRO/DOS	Dr S C Sharma and Dr S V S Narayanmurty VSSC/ISRO Thiruvananthapuram
DURATION	2 years (Started on: December 2013)

BUDGET (₹)	20,05,000
SUMMARY OF FINDINGS	AA7075 (Aerospace material) is used as matrix and milled pitch based carbon fibers as reinforcing material. Aim is to increase thermal conductivity of AA7075 as this material is used as enclosuer for DC-DC converter to dissipate heat. Stir casting method was tried with coated fibers and using Electromagnetic stirring but carbon fibers could not be distributed uniformly. Solid state route was then adopted to make composite. Composite specimens were made with carbon fiber contents ranging from 5 to 50 vol% by Vacuum Hot Pressing. Single and double action compaction methods were used for compaction. T_7 treatment was given to study its effect on electrical conductivity. Hot rolling was done to find out formability. All the composites were characterized for mechanical and thermal properties. Density of the composites show decrease as amount of fibers / flakes increases. Better densification is observed in the specimens produced by double compaction. Composites with Nickel coated carbon fibers exhibited higher densities than composites containing uncoated fibers. Optical and SEM images show that carbon fibers in all the compositions were uniformly distributed. XRD analysis revealed that Aluminum Carbide did not form at the interface of fiber and matrix. Fibers show good bonding with the matrix. However, at some places debonding was also seen. Fibers and flakes align perpendicular to pressing direction confirming anisotropic properties. It was observed that as amount of carbon fibers increase, its density, hardness, compression strength decrease. Composites containing carbon fibers more than 30 vol%, could not be rolled due to brittleness. Due to increase in densification after T_7 treatment, electrical conductivity increased. Thermal conductivity (TC) increases as volume content of carbon fiber increases in parallel and perpendicular direction to fiber. TC values obtained by "Layers-in-series" and "Layers-in-parallel model" are higher than experimental values mainly because of not considering important effect of interfacial thermal resistance on TC and also theoretical values of TC have been calculated by considering graphite flake as reinforcement but in this work milled carbon fibers are used. Graphite flake composite shows better thermal properties than carbon fiber composite. Co-efficient of Thermal expansion (CTE) decreases with increase in carbon fiber content in parallel direction but shows increase in perpendicular direction. This higher CTE in perpendicular direction is attributed to the interfacial debonding of carbon fibers which is present in some of the composites.

PROJECT NO	**140**
TITLE	Halophilic bacterial diversity of marine ecosystems from West Coast of India
INVESTIGATORS	Prof Rebecca S Thombre (PI), Dr Pradnya P Kanekar, (Co-PI) P E Society's Modern College of Arts, Science and Commerce, Pune SPPU
CO-PI/FOCAL POINT/CONTAC	Dr C S Jha NRSC/ISRO

T SCIENTIST FROM ISRO/DOS	Hyderabad
DURATION	2 years (Started on: January 2014)
BUDGET (₹)	16,04,000
SUMMARY OF FINDINGS	Halophiles are salt loving organisms that belong to prokaryotic as well as archaeal group of phylogenetic tree. Haloarchea (halophilic archaea) are members of the archaeal branch of phylogenetic tree that appeared very early in evolution. Haloarchaea are ideal organisms for astrobiology related studies. In the present study, 120 halophiles were isolated including 81 bacterial isolates from low salinity environment like sea water, beach sand and rock pieces from the coast. Halophilic nature was studied and 58 % halotolerant, 33 % slight halophiles and 9 % moderately halophilic bacteria were observed. Moderately halophilic bacteria was identified by biochemical, physiological, phylogenetic analysis and 16S RNA gene sequencing method. Isolated Organisms belong to different genera namely *Halomonas, Salimicrobium, Alkalibacillus* and *Marinobacter.* Isolated Haloarchaea were *Haloferax prahovense*, *Haloarcula tradensis, Haloferax lucentense, Halovivax asiaticus, Haloarcula marismortui, Haloarcula argentinensis*and *Haloferax alexandrines* and *Natronococcus jeotgali*. Marine halophiles were screened for the production of industrially important metabolites. These halophiles produce enzymes like amylase, lipase, protease, antimicrobial compounds and carotenoids. Halophiles can be used to produce bioactive. Attempts were also made to investigate the survival of these organisms in microgravity, fluctuating temperature and high concentrations of acid. When *Haloarchaea* are exposed to acidic, microgravity or temperature stress, they predominantly respond by changes in cellular pigmentation and activation of 'salt-in' strategy with special reference to sodium ion. Changes in environmental conditions leading to stress is the factor for stress proteins like heat shock proteins (HSP), chaperonins, proteasomal proteins and small heat shock proteins (sHSP's) in haloarchaea. Haloarchaea demonstrated growth in high concentrations of acidic medium, suggesting the possibility of biodegradation of effluents contaminated with Ammonium Perchlorate. The study indicates that extremely halophilic archaea can be utilized as a model organism to study the adaptation strategies of organisms in altered gravity.

PROPOSAL NO	**141**
TITLE	Studies on nano-porous metal oxides via anodization and their applications in super capacitors
INVESTIGATORS	Dr Arif V Shaikh (PI), Poona College of Arts, Sci. and Comm, Pune Dr H M Pathan (Co-PI), Dept of Physics, SPPU
CO-PI/FOCAL POINT/CONTACT SCIENTIST FROM ISRO/DOS	Prof S Ananthakrishna Adjunct Professor / Shantanu Das (ex-BARC) as subject experts

DURATION	2 years (Started on: January 2014)
BUDGET (₹)	11,76,000
SUMMARY OF FINDINGS	Aim is to develop Anodization and other methods for deposition of metal oxide films, their characterization and fabrication of super-capacitor. Nano crystalline materials are promising candidates for developing super capacitors. In the present work, various metal oxides have been synthesized and assessed for their suitability in supercapacitor electrode. **Synthesis of Molybdenum oxide:** Synthesize by anodization, resulted in good morphology and uniform deposition of Mo_2O_3 films but showed poor charge storage characteristics. **Synthesis of Titanium dioxide:** Synthesize by anodization, Tetragonal phase of the crystal doesn't change in annealing up to 600˚C. Hollow microrods morphology of TiO_2 favorable for supercapacitor as it can have more capacity to store electric charge. **Synthesis of Copper oxide (Cu_2O) and Ruthenium oxide (RuO_2):** Cu_2O synthesis by anodization, and RuO_2 by electrodeposition. SEM shows flex like nanorod morphology for Cu_2O and spherical nano-aggregations of RuO_2. After annealing Cu_2O nanorod shows bending perhaps due to thermal stress. Annealed micrographs of RuO_2 do not show any change in morphology. Composite of RuO_2/ Cu_2O formed by the same technique, after annealing, morphology did not change. **Synthesis of Copper oxide (CuO):** Synthesize by anodization, formation confirmed by RAMAN Spectroscopy. UV spectrum shows 1.7 eV band gap, exhibits high specific capacitance of 339.82 F/g. **Synthesis of Ruthenium oxides and its composite with Carbon nanotube (CNT):** Synthesize by electrodeposition, composite formed using carbon nanotubes. UV-vis and XRD analysis shows good interfacing, formation of an infinite absorption band tending towards IR-range. **Synthesis of Aluminum oxides:** Synthesize by anodization formation of porous material, suitable for use in supercapacitor. Specific capacitance was 3.52 F/g. **Synthesis of Manganese oxides:** Synthesize by SILAR method, Specific capacitance of annealed sample measured 119F/g and without annealing 289.3 F/g. **Synthesis of Zinc Ferrite oxide and Cobalt oxide:** For deposition of Zinc Ferrite oxide SILAR method was used and Cobalt oxide was synthesized using chemical bath deposition method. Specific capacitance was calculated by CV curve.

PROPOSAL NO	**142**
TITLE	Development of the F C Observatory - an autonomous robotic telescope
INVESTIGATORS	Dr Ms Raka V Dabhade (PI), Fergusson College Prof Ananthakrishnan (Co-PI), Dept of Electronic Science, SPPU
CO-PI/FOCAL POINT/CONTAC	Prof Ranjan Gupta, Prof Rangarajan (Subject experts)

T SCIENTIST FROM ISRO/DOS	
DURATION	2 years (Started on: January 2014)
BUDGET (₹)	11,00,000
SUMMARY OF FINDINGS	Astro Club at Fergusson College is host to students who are keen to learn the skills required to be a good astronomer. ISRO project has taken this interest of students to the next level by giving them a chance to firsthand experience in operating telescope and recording observations. Aim of the present project was to establish a functional observatory at Fergusson College focusing on Solar and Stellar studies. This needed establishing Differential photometry facility comprising of Data Processing Lab, Dome/Shed, CCD and Photometer. Differential photometry is the simplest of the calibrations and most useful for time series observations. When using CCD photometry, both target and comparison objects are observed at the same time, with the same filters, using the same instrument and viewed through the same optical path. Most of the observation variables drop out and the differential magnitude is simply the difference between the instrument magnitude of the target object and the comparison object (ΔMag = C Mag – T Mag). This is very useful when plotting the change in magnitude over time of a target object and is usually compiled into a light curve. As part of automated observatory, tools like ACP, Maxim DL, DS9 and Stallarium were tested and used in automation. Successful completion of ISRO project has enhanced image of Astro Club at Fergusson College and as a result, a MOU is being signed with Cork Institute of Technology, Ireland for collaboration in a project named TARA.

PROJECT NO	**143**
TITLE	Multifunctional conducting polymer transition metal nano structure based sensor device for detection of NO_2, H_2S and NH_3
INVESTIGATORS	Dr Vasant Vidyadhar Chabukswar Nowrosjee Wadia College, Pune SPPU
CO-PI/FOCAL POINT/CONTACT SCIENTIST FROM ISRO/DOS	Prof SA Gangal (Subject expert) ISRO Chair Professor, SPPU, Pune
DURATION	2 years (Started on: January 2014)
BUDGET (₹)	15,82,000
SUMMARY OF FINDINGS	Aim is to synthesize conducting nano particles of Polyaniline and poly(N-ethyl aniline) using functional organic acids as dopants and study detection characteristics of hazardous chemical vapours like NO_2, H_2S and NH_3. **Polyaniline silver nanocomposite (PANI/Ag)**: Synthesized using aniline as both stabilizer and dispersing agent, acts as efficient sensor for monitoring ammonia gas with low concentration at room temperature, shows fast

response (57%) at 100ppm concentration, has short recovery time of 10 to 120 sec for 1ppm to 100ppm. Sensor shows reproducible sensing properties up to six months suggesting long term stability. **Hematite (α-Fe_2O_3)** synthesized by hydrothermal method and (PAni/α-Fe_2O_3) nano hybrids by in situ chemical oxidative polymerization of aniline. Hybrid nanocomposite has good environmental stability and sensitivity for low concentration of ammonia gas (1ppm) at room temperature and good sensitivity (51%response) for 300ppm concentration. It shows quick response and shorter recovery time of 60 sec. **PAni/ZnO** synthesized by *in situ* polymerisation using ammonium per sulphate (APS) as oxidizing agent, shows good response of 7% to 1ppm of and 43% for 100ppm of H_2S gas with quick response time of 60sec. response of the sensor is linear and increases with increasing concentration of H_2S gas. **PAni/Cu Nanocomposites** prepared through one step *in situ* chemical oxidative polymerization process, shows good response of 3.8% with 60 sec response and 120 sec recovery time with high selectivity for 1ppm NO_2 gas at room temperature.

4. Ongoing research projects

Presently there are 24 ongoing projects (listed below) including eight projects initiated in June 2016. Progress of these projects is monitored through periodical progress reports and reviews by Preliminary Evaluation Committee (PEC) and Joint Policy Committee (JPC). Investigators are invited to make detailed presentation highlighting the technical milestones achieved in their studies. Midcourse correction is suggested by PEC wherever necessary. Three PEC meetings chaired by Prof S Ananthakrishnan, were held to assess the progress of the ongoing projects and to make midcourse correction. JPC in its meeting held on 20 &21st March 2017, reviewed the progress of all ongoing projects and had detailed interaction with the investigators.

List of Ongoing projects

1. Feasibility study on indigenous development of electrochemical based gas sensors and transmitters (Project No.137)

2. Development of Flexible and high temperature aerogels (Project No.144)

3. Occurrence and distribution of fluoride in groundwater of Terekhol river basin, Sindhudurg district, Maharashtra: A Remote Sensing and GIS based study (Project No.145)

4. Remote sensing application in Coastal geomorphology, changes in morphology in parts of West coast of Maharashtra, (Project No.146)

5. Study of precipitation characteristics using disdrometer and satellite datasets over Pune (Project No.147)

6. Optimization of low voltage DC micro-grid with intelligent Solar PV Utilization for a Computer laboratory (Project No.148)

7. Processing of natural biopolymers – wild and Domestic silk varieties of northern western ghats: Fabrication of biopolymer film based technological substrate for advanced optical structures (Project No.149)

8. Stabilization of zirconia for electronic applications, in tetragonal and cubic structure using various dopants (Project No.150)

9. Interaction of plasma with Thermal Protecting System (TPS) material during Re-entry of Space Vehicle (Project No.151)

10. Development of Nuclear Batteries using Radioactive Sources (Project No.152)

11. Design, fabrication and testing of a compact and robust Monochromator (Project No.153)

12. Fabrication of Magnetoelectric Energy harvesters by Utilizing Piezoelectric-Macro fiber composite (MFC) and Magnetostrictive-Nickel/Metglas/ Magnetic oxide materials (Project No.154)

13. Design feasibility of PLL frequency synthesizer for Ku band (Project No.155)

14. Space Radiation from the Optically Transparent Planar Microstrip Antenna Integrated with the Solar panels of Small Satellites (Project No.156)

15. Development of coating/manufacturing technology for friction stir coating/welding tool for welding of 3 mm thick stainless steel sheets (Project No.157)

16. Studies on Biodiversity of poly-extremophilic bacteria for their probable use as test organisms in space research (Project No.158)

17. Development of Pre qual engineering model of "SEAPS" (300 KHz to 30 MHz) RF Front-End Electronics and Data Acquisition System for low frequency space science studies (Project No.159)

18. Converting energy derivable from low energy sources into electrical power for autonomous sensors applications (Project No.160)

19. Development of high current density thermal-field (T-f) cathodes (Project No.161)

20. Fabrication of a small satellite for monitoring radiations in different orbits of outer atmosphere where orbit maneuvering will be controlled by solar sail (Project No.162)

21. Studies on glare reduction techniques for indoor illumination systems (Project No.163)

22. Valve-less linear compressor driven stirling cycle cryocooler for space applications (Project No.164)

23. Drilling techniques/technology for drilling of miniature size holes of diameter less than 10 microns in super alloys for a depth of 1.0 mm (Project No.165)

24. Bioleaching of electronics wastes (E – wastes) (Project No.166)

Current status of ongoing projects :

Sr No.	Project title, Name of Investigator, Budget, Duration & Contact Scientist	Current status and observations
1.	Feasibility study on indigenous development of electrochemical based gas sensors and transmitters **(Project No.137)** PIs: A D Shaligram/ S Haram Budget: ₹ 29.60 lakhs Duration:2 years (Started on: November 2013) ISRO/DOS Contact Scientists: M B N Murthy/ R Senthil Kumar, SDSC Shriharikota	Feasibility study has been completed, but there is scope for improvement in the performance of the gas sensor system. Final Report to be submitted without further delay.
2.	Development of Flexible and High Temperature Aerogels **(Project No. 144)** PI: N B Chaure Budget: ₹ 15.99 lakhs Duration:2 years (Started on: August 2014) ISRO/DOS Contact Scientist: V Sekkar, VSSC Thiruvananthapuram	Committee appreciated successful completion of the project and suggested to contact VSSC and LEOS/ISRO engineers for possible application. Final Report to be submitted without further delay.
3.	Occurrence and distribution of fluoride in groundwater of Terekhol river basin, Sindhudurg district, Maharashtra: A remote sensing and GIS based study (Project No. 145) PI:S K Gaikwad Budget: ₹ 16.00 lakhs Duration:2 years (Started on: August 2014) ISRO/DOS Contact Scientists: K Ganesh Raj / MA Paul, ISRO Hq, Bengaluru	PI should attempt to develop mathematical model to reflect findings of the study and its utilization for other areas.
4.	Remote sensing application in coastal geomorphology, changes in morphology in parts of West coast of Maharashtra, India (Project No. 146) PI: Milind Herlekar Budget: ₹ 11.05 lakhs Duration:2 years (Started on: August 2014) ISRO/DOS Contact Scientist: A S Rajawat, SAC, Ahmedabad	Committee appreciated successful completion of the project and suggested to contact SAC and NRSC/ISRO engineers for possible application. Final Report to be submitted without further delay.

5.	Study of precipitation characteristics using disdrometer and satellite datasets over Pune (Project No. 147) PI: Rohini Bhawar Budget: ₹ 8.41 lakhs Duration:2 years (Started on: August 2014) ISRO/DOS Contact Scientist: N V P Kiran Kumar, NRSC Hyderabad	Committee appreciated successful completion of the project. Final Report to be submitted without further delay.
6.	Optimization of low voltage DC micro-grid with intelligent Solar PV Utilization for a Computer laboratory (Project No. 148) PI: Vivek Aranake Budget: ₹ 21.39 lakhs Duration:2 years (Started on: August 2014) ISRO/DOS Contact Scientist: S Ananthakrishnan, Adjunct Professor, SPPU	Committee appreciated successful completion of the project and suggested to contact SDSC and SAC/ISRO engineers for possible application. Final Report to be submitted without further delay.
7.	Processing of natural biopolymers – wild and domestic silk varieties of Northern Western Ghats: Fabrication of biopolymer film based technological substrate for advanced optical structures (Project No. 149) PI: R D Chaudhari Budget: ₹ 23.66 lakhs Duration:2 years (Started on: August 2014) ISRO/DOS Contact Scientist: S A Gangal, ISRO Chair Professor	Final Report to be submitted without further delay.
8.	Stabilization of ziroconia in tetragonal and cubic structure using various dopants for electronic application (Project No. 150) PI:M Y Khaladkar Budget: ₹ 15.02 lakhs Duration:2 years (Started on: August 2014) ISRO/DOS Contact Scientist: Surinder Singh, SAC, Ahmedabad	PI should bring out the utilization plan of the results of the study. Final report should be submitted without further delay.
9.	Interaction of plasma with Thermal Protecting System (TPS) material during Re-entry of Space vehicle (Project No. 151) PI:V L Mathe Budget: ₹ 12.56 lakhs Duration:2 years (Started on: August 2014) ISRO/DOS Contact Scientist: M R Ajith, VSSC, Thiruvananthapuram	Study is completed. Final Report to be submitted without further delay.

10.	Development of nuclear batteries using radioactive sources (Project No. 152) PI: Sanjay D Dhole Budget: ₹ 19.98 lakhs Duration: 2 years (Started on:June 2015) ISRO/DOS Contact Scientist: S A Ilangovan, VSSC, Thiruvananthapuram	Regular interaction with ISRO scientists needed.
11.	Design, fabrication and testing of a compact and robust Monochromator (Project No. 153) PI: Chandrashekhar S Garde Budget: ₹ 19.445 lakhs Duration: 2 years (Started on:June 2015) ISRO/DOS Contact Scientist: Saji Kuriokose, SAC, Ahmedabad	Satisfactory progress. PI to contact LEOS/ISRO engineers for possible application.
12.	Fabrication of magnetoelectric energy harvesters by utilizing piezoelectric-macro fiber composite (MFC) and magnetostrictive Nickel/Metglas/Magnetic oxide materials (Project No. 154) PI: Kambale R C Budget: ₹ 10.00 lakhs Duration:2 years (Started on:June 2015) ISRO/DOS Contact Scientist: Bhanu Pant / H Sreemulanadhan, VSSC, Thiruvananthapuram	Satisfactory progress. PI to improve interaction with identified ISRO experts for the Project.
13.	Design feasibility of PLL frequency synthesizer for Ku band (Project No. 155) PI: Mrs Shobha Sachin Nikam Budget: ₹ 8.60 lakhs Duration: 1 & 1/2 years (Started on:June 2015) ISRO/DOS Contact Scientists: D K Das, SAC, Ahmedabad / H S Jattana, SCL, Chandigarh	Study is nearing completion. Investigators to discuss Phase Noise performance with Prof Shaligram, before making Final Report.
14.	Space radiation from the optically transparent planar microstrip antenna integrated with the solar panels of small satellites (Project No. 156) PI: Jayashree Pratap Shinde Budget: ₹ 11.75 lakhs Duration: 1 year (Started on:June 2015) ISRO/DOS Contact Scientists: R Rama Subrahmanyam, ISAC, Bengaluru / M Viswanathan, LEOS, Bengaluru	This is a feasibility study. PI needs to bring out a plan to take up the study further. Final report should be submitted before March 2017.

15.	Development of coating/manufacturing technology for friction stir welding tool for welding of 3 mm thick stainless steel sheets (Project No. 157) PI: Rajesh Chaudhari Budget: ₹ 23.02 lakhs Duration: 2 years (Started on:June 2015) ISRO/DOS Contact Scientist: D Sivakumar, VSSC, Thiruvananthapuram	Progress is satisfactory. PI to have good interaction with ISRO expert identified for the Project.
16.	Studies on biodiversity of poly-extremophilic bacteria for their probable use as test organisms in space research (Project No. 158) PI: Neelima M Deshpande Budget: ₹ 9.00 lakhs Duration: 2 years (started on: July 2015) ISRO/DOS Contact Scientist: K R Manjunath, SAC, Ahmedabad	Progress is satisfactory. PI to have good interaction with ISRO expert identified for the Project.
17.	Development of Pre qual engineering model of "SEAPS" (300 KHz to 30 MHz) RF Front-End Electronics and Data Acquisition System for low frequency space science studies (Project No. 159) PI: Gharpure D C Budget: ₹ 28.22 lakhs Duration: 2 years (started on: June 2016) ISRO/DOS Contact Scientist:Rajeev Jyoti, SAC, Ahmedabad	Regular interaction with SAC engineers needed.
18.	Converting energy derivable from low energy sources into electrical power for autonomous sensors applications (Project No. 160) PI: Arvind D Shaligram/ Subhash V Ghaisas Budget: ₹ 8.08 lakhs Duration: 2 years (started on: June 2016) ISRO/DOS Contact Scientist: P P Kale	Progress is satisfactory.
19.	Development of high current density thermal-field (T-f) cathodes (Project No. 161) PI: M A More Budget: ₹ 13.31 lakhs Duration: 2 years (started on: June 2016) ISRO/DOS Contact Scientist:	Progress is satisfactory.
20.	Fabrication of a small satellite for monitoring radiations in different orbits of	Progress is satisfactory.

	outer atmosphere where orbit maneuvering will be controlled by solar sail (Project No. 162) PI: Rohini P Mudhalwadkar Budget: ₹ 20.60 lakhs Duration: 2 years (started on: June 2016) ISRO/DOS Contact Scientist:	
21.	Studies on glare reduction techniques for indoor illumination systems (Project No. 163) PI: Jayashri A Bangali Budget: ₹ 19.18 lakhs Duration: 2 years (started on: June 2016) ISRO/DOS Contact Scientist: Nagendra Rao, LEOS, Bengaluru	Model developed needs to be corrected for point source.
22.	Valve-less linear compressor driven stirling cycle cryocooler for space applications (Project No. 164) PI: Virendra K Bhojwani Budget: ₹ 22.10 lakhs Duration: 3 years (started on: July 2016) ISRO/DOS Contact Scientist: Alok Shrivastava, ISAC, Bengaluru	Progress satisfactory. Interaction with identified ISRO expert taking place.
23.	Drilling techniques/technology for drilling of miniature size holes of diameter less than 10 microns in super alloys for a depth of 1.0 mm (Project No. 165) PI: Ganesh G Dongre Budget: ₹ 38.20 lakhs Duration: 3 years (started on: July 2016) ISRO/DOS Contact Scientist: Jacob Philip, VSSC, Thiruvananthapuram	PI has interaction with ISRO experts and based on the discussion hole size is changed from 10 micron to 100 micron. PI to submit more details on this. Study on EDM micro drilling and laser micro drilling processes may be done before finalising setup for micro drilling work. Using electrodes of phosphor bronze and other conductive metals may be examined. Using guides for electrode support may be examined.
24.	Bioleaching of electronics wastes (E – wastes) (Project No. 166) PI: Ameeta Ravikumar Budget: ₹ 20.93 lakhs Duration: 2 years (started on: June 2016) ISRO/DOS Contact Scientist: T Saboo, VSSC, Thiruvananthapuram	Parallel attempts should be made to identify the industries to take up the process being formulated under this study. Regular interaction with ISRO scientists needed.

5. New research projects

In response to ISRO-SPPU STC's call for new projects, 121 study proposals were received from various Departments and affiliated colleges of the University. These proposals were evaluated by the Preliminary Evaluation Committee (PEC) for making recommendation to Joint Policy Committee (JPC). PEC examined the new proposals and noted that some of the proposed studies were very similar to the projects already completed under ISRO-SPPU Joint Research Programme and such studies need not be repeated. PEC scrutinized the new proposals and short listed 40 for further technical evaluation. Investigators of these proposals were invited to make a technical presentation to PEC on 30 and 31st January 2017. At the end of the exercise, Committee made an assessment and recommended 20 proposals for the consideration of JPC. Investigators of these 20 proposals were then invited to highlight the merits of the proposed study to JPC on 20 March 2017. JPC interacted with the prospective investigators and approved 11 proposals for funding in the financial year 2017-18. In respect of other not-approved proposals, JPC suggested to communicate observations/comments made by JPC Members to investigators for improvement/modifications. Technical summary of each of the approved proposals is given below:

Project No.	**167**
Title	Study of cloud parameters observed by Ceilometer with the Satellite retrieved and Mesoscale Model generated, cloud parameters
Investigators	P Pradeep Kumar (PI), D. Rohini Bhawar, (Co-PI) Dept of Atmospheric & Space Sciences SPPU, Pune
Co-PI/Focal Point/Contact Scientist from ISRO/DOS	Amit Kesarkar National Atmospheric Research Laboratory (NARL) Gadanki
Duration	2 years
Budget (₹)	9,30,000
Summary of the proposed study	A Laser Ceilometer is being installed in the University which will give continuous observation of Height of Cloud Base (3 layers), depth of the cloud and cloud fraction. The vertical range of the Ceilometer is 7.5 km. Laser Ceilometers are more accurate in directly detecting the cloud base as it is sensitive to small cloud droplets. The seasonal and diurnal cycle of cloud base and cloud depth can be studied to estimate the contribution from the boundary layer clouds towards radiation budget. INSAT-3D gives the temperature and humidity profiles every 1 hour. From these profiles the Lifting Condensation Level (LCL) and Convective Condensation Level (LFC) can be computed. If the air is forcibly lifted then Cloud Base can be expected to form at LCL and if the air is lifted due to surface heating then the cloud base will form at CCL. Depending upon the lower tropospheric conditions the cloud base can form in between LCL and CCL levels. The actual cloud base observed by the Ceilometer will be compared with the cloud base from CCL and LCL levels computed from INSAT observations. How much

overestimation or underestimation is there in different seasons by the INSAT derived cloud bases can be determined. The Ceilometer observations will be compared with the Cloud Base and depth computed by Mesocale Model. The observations can be made use of to fine tune the model. The INSAT-3D gives layer precipitation for three layers every 1 hour. The fluctuations in cloud base observed by the Ceilometer will help to understand the consequences in vertical motions on the INSAT derived precipitation in the lowest two layers.

Objectives:

1. To find the diurnal cycle of cloud base during different seasons
2. To compare the cloud base observed by Ceilometer with the INSAT derived Lifting Condensation Level (LCL) and Convective Condensation Level (CCL) estimated from Temperature and Humidity profiles
3. To compare the cloud base and depth computed by Mesoscale Models with the Ceilometer observations
4. To look at the vertical motions of cloud base height and understand how it affects the INSAT

Project No.	**168**
Title	Astrobiology experiments on effect of impact and space related stress on micro-organisms isolated from rocks: Implications for origin of life and Lithopanspermia
Investigators	Rebecca S Thombre P E Society's Modern College of Arts, Science and Commerce, Pune, SPPU
Co-PI/Focal Point/Contact Scientist from ISRO/DOS	Bhalamurugan Sivaram Physical Research Laboratory (PRL) Ahmedabad
Duration	2 years
Budget (₹)	14,50,000
Summary of the proposed study	In the present investigation, we intend to explore Indian rocks, fossils and halite crystals for isolation of micro-organisms and study the effect of space related stresses on extremophiles. The studies related to proliferation of microbial life at space like conditions are useful in understanding the fundamental questions pertaining to physical limits of survival of life. With the exploration of extra terrestrial life and habitability of other planets and exoplanets, the survival in altered gravity becomes an indispensable requirement for living cells. Similarly, if micro-organism needs to endure inter planetary transport in asteroids or rocks, which is the fundamental basis of theory of panspermia, their survival in hypergravity, hyperacceleration in a rocky substrate is cardinal requirement to survive stress during interplanetary transport. As survival of organismic life in rocks and hypergravity is

mandatory for substantiating theories of panspermia and inter planetary travel, this study aims at isolation of an extreme haloarchaeon/micro-organisms from rock and exposure to stress.

Objectives:

1. Isolation of micro-organisms (Bacteria/archaea/algae) from rocks/ stromatolites/fossils/halites
2. Identification of isolates using biochemicals, polyphasic approach and 16 S rRNA gene sequencing
3. Study of survival of endoliths in rocks in the presence of space related stresses like desiccation, radiation
4. Effect of impact and space related stress on biomolecules and/or micro-organisms isolated from rocks: Implications of origin of life and Lithopanspermia

Project No.	**169**
Title	Wear behavior of the high nitrogen martensitic stainless steel (Fe-17Cr-0.25N-0.45C-1.7Mo-0.12Nb-0.20V in wt %)
Investigators	N B Dhokhe College of Engineering Pune (COEP) SPPU
Co-PI/Focal Point/Contact Scientist from ISRO/DOS	Thomas Tharian K Liquid Propulsion System Centre (LPSC) Thiruvananthapuram
Duration	2 years
Budget (₹)	15,00,000
Summary of the proposed study	A martensitic stainless steel developed by VSSC will be cut into suitable specimen typically used for wear test and material characterization. Solutionizing treatment at 1100^{o}C will be conducted in muffle furnace followed by tempering at varying temperatures 200 to 550^{o}C. Applications of cryogenic treatment before or after tempering will be carried out. Optimization of cryogenic soaking period will be studied. A dry sliding Pin-On-Disc test will be conducted for varying speeds and loads. The 3D surface response and 2 D contour plot will be analyzed for construction of wear maps and corresponding wear modes will be delineated with prevailing wear mechanism. Worn surface analysis by SEM will be useful in identifying wear regimes and thus subsurface deformation pattern will be analyzed. **Objectives:** 1. Optimization of tempering cycle 2. Selection of cryogenic treatment (before or after tempering) 3. Optimization cryogenic soaking period 4. Characterization: hardness, microstructures using optical/ SEM 5. Effect of load and sliding speed on wear behavior 6. Wear mechanism, subsurface deformation pattern and wear maps

Project No.	**170**
Title	Miniaturized Microstrip Antenna design for 3U CubeSat covering UHF, L- and S- Band Frequency Spectrum and their Interference Study for Earth Observations
Investigators	Pratap N Shinde (PI), Mrs Jayashree P Shinde (Co-PI) Sinhgad Academy of Engineering, Pune SPPU
Co-PI/Focal Point/Contact Scientist from ISRO/DOS	V Senthil kumar Isro Satellite Centre (ISAC) Bengaluru
Duration	2 years
Budget (₹)	16,66,000
Summary of the proposed study	The research will investigate design of miniaturized microstrip antennas covering UHF ultrawide band (UWB), L- and, S-band, medium gain and circular polarization characteristics suitable for small satellites (3U CubeSat). The electromagnetic scattering of spacecraft can interfere with antennas radiation pattern, which degrades antennas gain. These antenna structures must possess very less mutual coupling in between them and negligible interference with the satellite's metallic chassis structure. The proposed research work would be the good solution for next CARTOSAT small satellite series stabilized into 505 Km polar sun synchronous orbit (SSPO) for environment and earth observation mission by ISRO. **Objectives:** 1. To design and develop miniaturized electrically small UHF microstrip antennas for two different orientations of 3U CubeSat 2. To present the technique for enhancement in gain and bandwidth of circularly polarized UHF antennas to cover spectrum from 500 MHz - 1.15 GHz 3. To develop physically small dual band antenna prototype for covering S-band (2 GHz-4 GHz) and L-band for earth observation 3U CubeSat 4. Design of CAD model of 3U CubeSat system and integration of miniaturized UHF antennas

Project No.	**171**
Title	Design and development of work function measurement set up and its use to measure work function of thrusters
Investigators	V L Mathe (PI), Mrs S V Bhoraskar (Co-PI) Dept of Physics SPPU
Co-PI/Focal Point/Contact	M R Ajith Vikram Sarabhai Space Centre (VSSC)

Scientist from ISRO/DOS	Thiruvananthapuram
Duration	2 years
Budget (₹)	18,70,000
Summary of the proposed study	In electrical propulsion, Electrostatic Ion Propulsion (EIP) is one of the popular means to provide required propulsion. The EIP drive is one of several different types of electric rocket engines, and in fact is not the first type to be used in space. However, it is conceptually one of the simplest and best-known. The basic idea is to accelerate ions of a relatively heavy propellant, such as xenon, to high velocities, through grids charged to high voltages. The thrust is very low, but the efficiency is very high, with sufficiently high specific impulse. Xenon atoms are usually fed from a propellant tank into an ionizing chamber, where an electron emitter ionizes them, producing positive xenon ions. These xenon ions are then accelerated by suitable grids with a potential higher than 1000 V, driving the ions out the exhaust at over 30 kilometers per second. Electrons are injected into the external exhaust flow to neutralize the positive ions; this prevents the spacecraft from building up a negative charge, which would otherwise attract exhaust ions back to the grid and possibly disrupt the operation of spacecraft instruments. The electron generator consists of thermionic emission/field emission cathode made up of oxides of BaO-CaO-Al_2O_3-W. It is of interest to ISRO scientists to systematically investigate properties related to electron emission of cathode material before and after its use in space launch vehicle. It is planned to investigate work function, structural properties, morphological properties and electron emission behavior of the cathode material with and without use during electrical propulsion. **Objectives:** 1. To design and develop work function measurement set up using retarding field diode geometry 2. To design and develop work function measurement set up using thermionic emission 3. To compare the results obtained from above two set ups 4. Carry out pre and post investigation of cathode material using X-ray diffraction

Project No.	**172**
Title	Development of solders for use in cryogenic applications
Investigators	Mrs Madhuri C Deshpande (PI), Dr Kedar D Sant (Co-PI) Vishwakarma Institute of Technology, Pune, SPPU
Co-PI/Focal Point/Contact Scientist from ISRO/DOS	Ramesh Narayanan P Vikram Sarabhai Space Centre (VSSC) Thiruvananthapuram

Duration	2 years
Budget (₹)	24,46,000
Summary of the proposed study	Harmful effects of Lead (Pb) have encouraged using Pb free solders, a challenge to electronic industries. Researchers have worked on Tin base solders with alloying elements as Ga, In, Bi & Cd. These alloying elements reduce melting point of Tin. Cd, due to its toxicity is not commonly considered. Bi & In are potential candidates for alloying with Tin. But most of Tin based solders become brittle at cryogenic temperatures. Most commercial solders are Tin based, which undergo ductile to brittle transition resulting in developing cracks. Indium based solders remain ductile even at cryogenic temperatures. In the present plan, Indium based solders of different compositions such as Indium + Silver, Indium + Bismuth will be studied. Alloys like In+Ag+Sn & In+Bi+Sn will also be examined. These solders would be characterized for mechanical properties, Wettability & compatibility with base metals. Metallographic examination would be carried out with Optical & Scanning electron microscope. Testing would also be carried out at cryogenic temperatures to find out their suitability for cryogenic applications. **Objectives:** 1. To prepare solders of different compositions such as In-Bi, In-Ag ,In +Ag +Sn & In+ Bi+ Sn 2. To ensure compatibility of the solders to the substrate 3. To characterize these solders at cryogenic temperatures

Project No.	**173**
Title	Selective capture and conversion of CO_2 to methanol from direct air using MOFs supported polyamines
Investigators	Mrs Waghmode Shobha Ajeet Abasaheb Garware College, Pune SPPU
Co-PI/Focal Point/Contact Scientist from ISRO/DOS	Benny K George Vikram Sarabhai Space Centre (VSSC) Thiruvananthapuram
Duration	2 years
Budget (₹)	15,00,000
Summary of the proposed study	MOFs with polyamines act as robust cure for CO_2 conversion to products such as methanol, methane and formic acid. This process is mediated through polyamine adsorption of CO_2 and is made available for catalysis with MOFs. Proposed study includes (i) Synthesis of polyamines and MOFs using ditopic ligands, (ii) Synthesis of MOFs decorated with polyamines and (iii) Polyamines on different supports such as graphene3, aminated silica, alumina etc. Screening of MOFs will be done by using molecular modelling. Actual capture and

conversion of CO_2 to methanol will be carried with above prepared material with concentrated CO_2 or synthetic air in PARR reactor, followed by optimization of reaction conditions. CO_2 capture quantization will be planned with VSSC using temperature pressure desorption studies (TPD). To enhance efficiency and reduce reaction conditions, these will be worked with phosphene based aminated silane supports.

Objectives :

1. To prepare supported polyamines and ditopic ligands
2. To prepare selective MOFs using transition metals like Ru, Re, Fe
3. To screen MOFs using molecular modeling
4. To convert CO2 to methanol/fuel molecules (CH4, HCOOH)
7. CO2 capture study using TPD (temperature pressure desorption)
8. To design experimental set-up

Project No.	**174**
Title	Conducting Polymer Supported Bimetallic Nanostructures for Fuel Cell and Hydrogen Storage Applications
Investigators	Geeta Sharma (PI), Dept of Chemistry, SPPU Kiran Kumar K. Sharma (Co-PI), School of Nanoscience & Technology, Shivaji University, Kolhapur
Co-PI/Focal Point/Contact Scientist from ISRO/DOS	Benny K George Vikram Sarabhai Space Centre (VSSC) Thiruvananthapuram
Duration	2 years
Budget (₹)	17,00,000
Summary of the proposed study	Aim is to develop a method for synthesis of porous bimetallic Pt-Ni, Pd-Ni nanostructures supported on conducting polymers like Polyaniline, Polypyrrole and PEDOT using radiation and / or chemical techniques. The morphology and porosity of the nanostructures can be easily tuned using swollen liquid crystalline mesophases (SLCs) as soft templates. The obtained polymer supported nanostructures will be tested for their activity in Direct Methanol Fuel Cells (DMFC) and hydrogen storage applications. It is well known that radiolysis is an efficient tool for the synthesis of homogeneous nanostructures with desired morphology and porosity in SLCs. It is expected that porous Pt-Ni and Pd-Ni based nanostructures supported on CPs will combine together the advantage of noble metals as most effective catalyst with conducting polymers as excellent support to enhance the efficiency of these catalyst. It is further expected that the supported porous nanostructures will exhibit excellent fuel cell activity and hydrogen storage properties for real time technological applications especially in

efficient energy conversion systems and storage materials which could be useful to support the space explorations.

Objectives:

1. Synthesis of CPs (polyaniline, polypyrrole and PEDOT) in SLC
2. Using synthesized CP as support for synthesis of bimetallic (Pt-Ni and Pd-Ni) porous nanostructures by radiolysis
3. Characterization of synthesized supported nanostructures using different techniques *viz* TEM, HRTEM, HAADF-EDS, FESEM, XRD, BET
4. Evaluation of electrocatalytic activity of synthesized nanostructures in direct methanol fuel cells by electrochemical methods
5. Evaluation of capability of these nanostructures for hydrogen storage

Project No.	**175**
Title	Investigations on ZnSe:Te quantum dot scintillators for charge particle detection in space radiation environment
Investigators	Shweta Dilip Jagtap (PI), Dept of Instrumentation Science SPPU
Co-PI/Focal Point/Contact Scientist from ISRO/DOS	Srikar Paavan Tadepalli ISRO Satellite Centre (ISAC) Bangaluru
Duration	2 years
Budget (₹)	16,50,000
Summary of the proposed study	Materials like ZnSe:Te are potential candidates for achieving high output light yield. Present scintillation light yield is around 50000 photons/MeV for thin films and there is still scope for achieving higher scintillation light yield. This needs research work both in materials development and fabrication process. Taking note of this wide scope along with immense innovation possibilities and commercial viability it is proposed to work on development of scintillator based on ZnSe:Te quantum dots. Aim is to chemically synthesize ZnSe:Te quantum dots and to fabricate its planar thick films. Attempt will be also made to tune the material properties to achieve higher efficiency of the scintillator. **Objectives:** 1. Synthesis of ZnSe:Te quantum dots using chemical synthesis method 2. Physico-chemical characterization of synthesized quantum dots using various characterization techniques viz. UV, PL, FTIR, XRD, TEM 3. Design and fabrication of in–house homogenous planar thick films on quartz substrate using screen printing technique

4. Characterization of fabricated thick films viz., UV, XRD, FESEM etc.
5. Optimization of fabricated planar scintillator in particular to material synthesis and thick film fabrication to achieve maximum absolute scintillation light yield

Project No.	**176**
Title	Development of AlN based ceramics for high temperature electrical insulation
Investigators	Kaustubh R Kambale (PI) College of Engineering (COEP), Pune SPPU
Co-PI/Focal Point/Contact Scientist from ISRO/DOS	K M Shanbhogue Liquid Propulsion System Centre (LPSC) Bengaluru
Duration	2 years
Budget (₹)	9,47,600
Summary of the proposed study	Electrically insulating materials with high thermal conductivity, low dielectric loss factor and high thermal shock resistance are required in propulsion systems (e.g. in Hall thrusters) in aerospace programs. Boron nitride (BN) has remained popular choice for such applications because it fulfills the properties mentioned above. Normally, in application BN/SiO2 composites have been used for this purpose. However, these composites suffer from the drawback of low erosion resistance to plasma in Hall thrusters. Thus, in recent times AlN has emerged as an alternative to BN based ceramics. AlN based ceramics would be fabricated by vacuum sintering as well as spark plasma sintering. Structural characterization of sintered ceramics would be carried out using X – ray diffraction. Electrical properties of as sintered and sputtered ceramics would be studied as a function of frequency and temperature using precision impedance analyzer It is proposed to procure high temperature interface for this system available in the department of PI. Morphology and local elemental analysis of as sintered and sputtered ceramics would be studied by scanning electron microscope so as to judge the plasma erosion patterns of ceramics. **Objectives:** 1. To prepare dense AlN based ceramics by vacuum sintering and by spark plasma sintering 2. To bring down the sintering temperature by addition of common sintering additives/aids like B2O3, V2O5, CuO etc. 3. To measure the electrical properties of as sintered and sputtered ceramics as a function of frequency and temperature 4. To study the morphology and elemental composition of as sintered and sputtered ceramics

5. To deliver the cylindrical specimen of AlN ceramics of 10 mm diameter and 15 mm length

Project No.	**177**
Title	QPSK Demodulator based on Wideband Acquisition Technique
Investigators	Wankhede V A (PI), Chudiwal R.M. (Co-PI) SNJB's KBJ COE, Chandwad SPPU
Co-PI/Focal Point/Contact Scientist from ISRO/DOS	K Chandrasekharam Satellite Application Centre (SAC) Ahmedabad
Duration	2 years
Budget (₹)	3,78,000
Summary of the proposed study	Aim is to design a wideband acquisition technique for a Quadrature Phase Shift Keying (QPSK) demodulator. The demodulator is designed at a frequency of 70 MHz to cater data rates up to 6 Mbps. The most important requirement of the design process is to have wide acquisition range of ±125 KHz under narrow Phase Lock Loop (PLL) bandwidth and low input Signal to Noise Ratio (SNR). Hence, a technique based on windowing and interpolation for input signal frequency estimation is planned to be implemented. The efficacy of the technique is verified with extensive simulations in MATLAB. **Objectives:** 1. Development of ground based configurable receiver to support PCM-BPSK, PCM-PSK-Phase Modulation (PM) 2. Modulation formats for variable data rates and support the wideband acquisition range 3. To use bandwidth efficiently as numerically controlled oscillator (NCO) to sweep its frequency

6. Major events in the STC calendar

The Preliminary Evaluation Committee (PEC) carries out preliminary evaluation of new research proposals and interacts with the Investigators to modify the proposals wherever needed. The proposals recommended by the Committee are examined by the Joint Policy Committee (JPC) for final approval. PEC also has the responsibility to periodically review the progress of the ongoing projects and take corrective measures. There were four PEC meetings held during the year 2016-17. JPC had its two-day's meeting on 20 and 21st March 2017. Highlights of these events are given below.

1. 28th PEC meeting held on 5 July 2016

Committee took a stock of the status of all ongoing projects and expressed its concern on delays in timely completion of the projects. In view of the direct relevance of the study on *Feasibility study on indigenous development of electrochemical based gas sensors and transmitters* (Project No 137) to SDSC/ISRO, Shri V Kannan & Shri R Senthilkumar were especially invited to participate in its review. Ex-ISRO scientists Shri Suresh Naik (SAC) and Shri V B Lal (VSSC) also participated as invitees in the assessment of the progress of all ongoing projects. Investigators made a detailed technical presentation highlighting the progress of their work.

2. 29th PEC meeting held on 11 January 2017

This meeting was held for initial evaluation of new research proposals. Against our invitation of new research proposals, 121 proposals were received from various Departments and affiliated colleges of the University. Summary along with the soft copy of the detailed study proposals was sent to all PEC Members for their advanced study. Existing guide lines in evaluation of the new proposals are:

- Relevance of study with respect to overall goals as spelled out in ISRO-UoP Memorandum
- Relevance of study with respect to developing new science/technology – innovative idea
- Deliverable products as a result of the study
- Publications of research findings in refereed journals

Committee examined the new proposals and categorized area wise into eleven groups, as shown below. After a detailed scrutiny of the new proposals, Committee short listed 40 proposals and decided to invite the prospective investigators for clarifications and technical presentation.

List of new research proposals

A. Atmospheric Science:

1. Application of Artificial Neural Networks in forecasting atmospheric aerosol data through data mining algorithm
2. Acquisition of Weather Parameters using Wireless Sensor Networks
3. Study of cloud parameters observed by Ceilometer with the Satellite retrieved and Mesoscale Model generated, cloud parameters

4. A synergetic study of aerosols by surface-based sun photometry and twilight photometry
5. Design and Development of low power intelligent data collection platform with GSM facility for documenting climatic parameters from remotely situated areas

B. Biodiversity:

1. Application of RS-GIS in identification and mapping of informal protected areas from eco sensitive zones surrounding village Amboli from Sawantwadi taluka, Sindhudurg
2. Conservation & Sustainable Management of Wildlife in Eco-sensitive zones for peaceful co-existence of Human – Leopards in human - agriculture dominated landscapes

C. Life Sciences:

1. Astrobiology experiments on Effect of impact and space related stress on micro-organisms isolated from rocks: Implications for origin of life and Lithopanspermia
2. Effects of Simulated Microgravity on Expression Profile of MicroRNA in Human Cardiomyocytes

D. Remote Sensing

1. Application of Remotely Sensed data and GIS for the evaluation of Landslide Hazard and its effect on surface and subsurface area of Western Maharashtra, India
2. Spatial Prediction of soil nutrients and detail soil mapping of some sugarcane growing soils of Maharashtra
3. Landslide Susceptibility Analysis and its forecasting on Mumbai-Pune Expressway
4. Monitoring metal indicator plants of Maharashtra
5. Kernel based Learning/Machine learning for change detection in land cover
6. Geospatial Pedestal GIS Analysis of Water Images using PACA (Parallel Adaptive Clustering Algorithm)
7. Forecasting Urban Growth in Pune Metropolitan Region Using SLEUTH Model and Geoinformatics Technique
8. Forecasting Urban Growth in Pune Metropolitan Region Using SLEUTH Model and Geoinformatics Technique
9. Estimation of Annual Average Soil Loss, Based on RUSLE Model in Mula Watershed, Godavari Basin, Maharashtra, India
10. To design and develop an agricultural web service using cloud computing, Internet of Things, Artificial intelligence and big data processing using Hadoop
11. Assessment of climate change impact on water resource management of Marathwada region, Maharashtra
12. Green Space Conservation and Development Action Plan using an Integrated Approach of Geoinformatics and Fuzzy Logic
13. A Mobile Cloud Computing Based Agricultural Decision Support System To Aid Grape Cultivating Farmers In The Rural Community Of Western Maharashtra
14. A Model For Sustainable Agriculture Development of Mangi Dam in KarmalaTahsil

E. Rural development & communication

1. An empirical study on effectiveness and challenges faced by Universities in eskilling and entrepreneurship spin off in rural and urban area
2. Mobile monitoring and Programmable control system for biogas plant and its environment: Rural Development

F. Image processing

1. Image Fusion to generate Merged Product
2. An immersive satellite image navigator with human gesture recognition
3. Onboard image processing techniques for feature extraction, change detection
4. Hybrid Optimized Graph Partitioning Technique for Segmentation of Satellite Data
5. Machine Learning based Ship detection from Remotely Sensed Images for Coastal Surveillance
6. Development of Image Fusion Techniques for Remote Sensing
7. LPC Technique for Hyper spectral Analysis of Earth observation and planetary applications
8. Fusion of LiDAR and Aerial images for detection of trees and buildings
9. An immersive Satellite image navigator with human gesture recognition
10. Image and video resizing using improved seam carving
11. Moving Object Detection using Thermal Imaging

G. Instrumentation

1. Design, simulation and implementation of controllers for robotic manipulator
2. Acoustic source localization using microphone array technique by employing beam-forming algorithm and finding the major jet noise sources during lift-off from launch pad (SDSC- SHAR)
3. Co-Operative Spectrum Sensing and Allocation in Cognitive Radio Network using Game Theory
4. Robust Position Control of Piezoelectric Actuator using State and Disturbance Estimation
5. Development of Inkjet Printed Electronic Circuits for Space Applications
6. Development of efficient BLDC driven compressor for Air Conditioning of a Computer laboratory powered by low voltage dc bus from Solar PV system.
7. Terahertz Scanner for Material Detection and Characterization
8. Charge pump PLLfrequency synthesizer design (SCL)
9. Design & Development of GPS for I.R.N.S.S. to Provide Positioning Details to User
10. Characterization of Piezoelectric Actuators and MFC for precision position control application & Design and Development of Control Algorithm for precise position control
11. Prototyping of landslide early warning system using PC based Time Domain Reflectrometry and OTDR.
12. Experimental Validation of Proportional Integral Observer Based Control of Flexible Joint System
13. Design, analysis and experimental verification of a force and slip controller for the object grasping

14. Investigations on ZnSe:Te quantum dot scintillators for charge particle detection in space radiation environment
15. Optical Network on Chip for Onboard Sensing and High Speed Data Processing in Satellite Systems

H. Satellite Communication

1. FPGA based Partially Reconfigurable PSK Demodulator with bit-synchronizer
2. Data processing for Smart Satellites
3. QPSK Demodulator based on Wideband Acquisition Technique
4. Design and Development of Microstrip Patch Antennae for Multiband Operations
5. FEM/BI method for Finite Frequency Selective Surface (FSS) Analysis
6. Techniques to reduce Mutual Coupling and improve the Isolation between the antennas in a Diversity System
7. Ka Band phased array antenna design for telemetry for launch vehicle
8. Design and Development of Defective Ground Structure based Microstrip Patch Antenna
9. Miniaturized Microstrip Antenna Designs for 3U CubeSat Covering UHF, L- and S- Band Frequency Spectrum and their Interference Study for Earth Observations
10. Design & Implementation of Compact Substrate Integrated Waveguide (SIW) Monopulse Antenna for Ku band
11. Software Defined Radio (SDR) based VHF/UHF and satellite Multi Mode Communication using GNSS
12. Bandwidth Efficient Communication Link for Satellite Navigation
13. Wireless Data Acquisition System with Over The Air (OTA) programming capability
14. Estimation of Direction of Arrival (DOA), Polarization for Digital Beam forming using Antenna Arrays
15. CMOS Low –Noise Amplifier for 2.4GHZ Wireless

I. Aero Space

1. An Investigation of Influence of Nozzle Pressure Ratio and Control Jets Location in Suddenly Expanded Flows
2. Design and Development of work function measurement set up and its use to measure work function of thrusters
3. Measurement and Characterization of Plasma Plume of a Modified Stationary Plasma Thruster for Space Propulsion
4. Design and analysis of drilling process – Technology for micro holes in superalloys.
5. Use of reactive powder concrete with ceramic aggregate for construction of launch pad.
6. Investigations on ZnSe:Te quantum dot scintillators for charge particle detection in space radiation environment
7. Numerical Investigation of MHD Turbulence for Plasma Wave Interaction in Open FOAM Platform
8. Design implementation of variable frequency and phase power supply for cryo-cooler

J. Material Sciences

1. Design and implementation of Unmanned Aerial Vehicle (UAV) using solar power for surveilling in planetary missions
2. Investigation of high impact resistance graphene nanocomposite
3. Synthesis and characterization of nano nickel hydroxide particles for Supercapacitor, NOx detection and polymer flame retardancy enhancement
4. Low-resistive back ohmic contact to p-type Cds/CdTe solar cells from non-aqueous bath
5. Development of Organo- electronic Material for Photovoltaic Cells
6. Nanocomposite Metal Oxides for Supercapacitors
7. A new route to synthesize nano-scale energy materials
8. Miniature gas sensors for CO, CO2, CH4, NH3, O2, N2O, SO2 and Ozone Greenhouse gas
9. Synthesis and Development of Graphene Based Resistive Gas (O2 and CO2) Sensors
10. Inter-laminar shear stress evaluation of bonded sandwich structuresusing higher order shear deformation theory
11. Highly sensitive graphene and graphene conducting polymer-metal nanocomposite based sensor device for detection of CO2 and O2 gas.
12. Conducting Polymer Supported Bimetallic Nanostructures for Fuel Cell and Hydrogen Storage Applications
13. Advanced Polymer/Ceramic Nanocomposites Substrate for Microwave Communication Applications
14. Through Thickness Measurement of Non-Uniform Residual Stresses in Metallic Components
15. Studies on synthesis of magnetic Mn substituted MFe2O4 (M=Co, Fe, Mg) nanoparticles for magnetic storage devices in space application
16. Wear behavior of the high nitrogen martensitic stainless steel(Fe-17Cr-0.25N-0.45C-1.7Mo-0.12Nb-0.20V in wt %)
17. Development of AlN based ceramics for high temperature electrical insulation
18. Improved Q-LEACH protocol for energy minimizing using Probabilistic model for wireless sensor network
19. Development of nanocomposite coatings for corrosion protection of aluminum alloys
20. Development of solders for use in cryogenic applications
21. Selective capture and conversion of CO2 to methanol from direct air using MOFs supported polyamines
22. Microwave Sintered Lead Free Piezoelectric (Ba,Ca),(Zr,Ti)O3 Ceramics for Satellite Sensor and Actuator Applications
23. Photoconductivity characterization of mixed binder layer for their use as sensor
24. Studies on delayed cracking phenomena on High strength Aluminium alloys using fracture mechanics

K. Miscellaneous

1. Cost Effective Solution for Multimodal Biometric Security for Solar Panel Cleaning System using Android based phone
2. Early digonsis of diabetic retinopathy through image processing for public health

3. Implementation of Medical image feature extraction algorithms using wavelet Transform
4. Analytical and Experimental Investigation on Solar Thermal Water Desalination System using Flat Plate Collector and Parabolic Concentrator.
5. Highly Protect Source-Location Privacy Using Wireless Sensor Networks
6. Iris Recognition System using DFT
7. Double Coding Mechanism For Robust Audio Data Hiding in Videos
8. Performance Evaluation Of Cognitive Radio Networks By Mitigation Of Critical Security Threats Via Cross Layer Optimization
9. Hand Gesture Recognition System
10. Feature extraction and Segmentation for Audio
11. Design and Development of Autonomous Robot for separating oil from oil water spills over water surface with the help of Nano-adsorbent particle
12. Regional monitoring of traces and greenhouse gases
13. Experimental investigation for role of water hyacinth in emission of green house gases around Pune city
14. Black-Box for Automobile
15. Monitoring Geoelectromagnetic Field Signal of Groundwater Movement and Its Effects on Human Body
16. Hidden Markov model Based Heart Sound Segmentation
17. Intelligent Route Guidance System using Inter-vehicular Communication
18. Designing intelligent traffic system using image processing and broadcast real-time statistics
19. Linkage of Aadhaar Card (UIDAI Number) for the Development of local Governments from State of Maharashtra
20. Development of Wearable Device for Health Monitoring
21. Addressing Technical and Economical Issues for Small Scale model of Microgrid using reversible hydrogen production with Regenerative Fuel cell
22. Software defined Radio based GNSS Simulator
23. Impact Assessment of EDUSAT Network as supportive role in the field of education and teacher training

3. 30th PEC meeting held on 30 & 31 January 2017

The prospective investigators of the shortlisted 40 new proposals were invited to make technical presentation to the Committee and provide necessary clarifications. Shri A V Patki, Shri V B Lal and Shri A K Sinha (Ex-ISRO Scientists) and Dr Suresh Kalkarni (Ex-DIAT Professor) also participated as invitees, in the evaluation of the new proposals. After detailed interaction with the investigators, Committee recommended a list of 20 projects for the consideration of Joint Policy Committee (JPC).

4. 31st PEC meeting held on 16 February 2017

Agenda for this meeting was to review the six-monthly progress of ongoing projects. Out of a total of 166 projects, 135 were completed by 31 March 2016 and Final Technical Reports received. Eleven ongoing projects had completed their studies and were in the process of submitting the Final Technical Reports. PEC reviewed the progress of other ongoing projects.

5. 19thJPC meetings held on 20 and 21 March 2017

Joint Policy Committee (JPC) supervises the overall management of the ISRO-UoP Interaction Programme, recommends the funds requirement to ISRO HQs and suggests new areas of activities as and when necessary. JPC meeting was held on 20 & 21st March 2017 to take a stock of the ongoing projects and consider new research proposals for the year 2017-18. Following ISRO Scientists participated in this JPC meeting as Member/Invitee and made valuable suggestions to make research work more relevant to ISRO programme. JPC approved 11 new research proposals and recommended a total budget of ₹212 lakhs for the year 2017-18.

Dr Rajeev Jyoti / SAC, Ahmedabad
Dr Benny George / VSSC, Thiruvananthapuram
Dr (Mrs) Parul Patel / SAC, Ahmedabad
Dr (Mrs) C Gouri / VSSC, Thiruvananthapuram
Dr S Sreedharan / VSSC, Thiruvananthapuram
Shri M V Ramana / NRSC, Hyderabad
Dr B Sivraman / PRL, Ahmedabad
Dr Srikar P Tadepalli / ISAC, Bangalore
Prof D W Pande/ COEP, Pune

6. Commencement of new projects

After the receipt of Grants-in-aid from DOS, for the year 2016-17, eight research projects, which were approved in the JPC meeting held on 8 & 9th February 2016, made a beginning in the month of June 2016 with the release of first installment of funds.

7. R/D activities in DOS/ISRO establishments

With a view to bring out the potential research areas to the notice of prospective investigators, brief description of major establishments of DOS and their areas of technical activities were highlighted earlier in ISRO-SPPU STC's Annual Report 2014-15. This was followed by adding salient features of technical activities of National Remote Sensing Centre (NRSC/ISRO), Hyderabad in the Annual Report 2015-16. To continue, brief history and technical activities (extracted from ISRO websites) of another important ISRO/DOS establishment, namely **Satellite Application Centre (SAC/ISRO) Ahmedabad** is included here.

SAC is engaged in research, development and demonstration of applications of space technology. Activities include development of on-board systems, ground systems and end user equipment hardware and software. Its core competence lies in the development of space borne and air borne instruments/payloads and their applications in the field of communication, navigation and remote sensing. Genesis of the Centre dates back to 1966, with the establishment of Experimental Satellite Communication Earth Station (ESCES). Later in 1972, different units of ISRO in Ahmedabad pursuing research in applications of space technology were merged to form Space Application Centre (SAC). During 1975-76, Satellite Instructional Television Experiment (SITE) was conducted utilizing American ATS-6 satellite. This involved telecasting educational programmes aimed at socio-economic development of rural India. SITE was followed by communication techniques developmental project called Satellite Telecommunications Experiments Projects (STEP), carried out with the Franco-German satellite, Symphony. Payload for the first experimental communication satellite of India, 'APPLE' was designed and fabricated here. For INSAT-1 series, satellites were designed and made by a US company. Subsequently satellites for all INSAT 2 series were developed and made indigenously. Remote Sensing programme started in early 1970s. Payload development started with balloon experiments followed by aerial photography for remote sensing. At the same time activities in the field of meteorology were initiated. Under the programme Satellite for Earth Observation (SEO), Bhaskara I and II satellites were designed and developed. In 1980s, IRS 1A programme was launched and the users started receiving multispectral imagery with 36 m resolution. Major applications in agriculture, hydrology, geology and other areas were defined in close interaction with user agencies. 1990s saw the development of advanced technologies such as design of high resolution sensors in optical and microwave regions, 5.8 m resolution Pan Camera, General Circulation Models, Prediction of weather in extended range and prediction of Ocean state in short range etc. Current activities include design and development of optical and microware sensors, signal and image processing software, GIS software and applications for Earth Observation (EO) programme. Centre also conducts nine-month post graduate diploma courses for students from the Asia Pacific region under the aegis of the Centre for Space Science and Technology Education (CSSTEAP) in satellite meteorology and communication.

Salient features of major projects and activities of the Centre are given below:

Communication and Navigation Payloads

Satellite Communication payloads consist of transponders. SAC designs and develops subsystems of a communication transponder. Transponders for INSAT and GSAT satellites are in various bands of UHF, L, S, C, Ext. C, Ku and Ka bands. Satellite Navigation Payloads are used in

Indian Regional Navigation Satellite System (IRNSS). IRNSS envisages establishment of regional navigation system using a combination of GEO and GSO spacecrafts. Design and development of onboard antenna systems in different bands of spectrum is undertaken. Thrust is on development of advanced technologies involving high power SSPAs and output filters, reconfigurable high throughput satellites, multiport amplifiers for power reconfiguration, multi beam satellite with higher number of beams, unfurlable and reconfigurable antenna etc .

Earth Observation Payloads

After the formation of SAC, development of payloads for Bhaskara 1 and 2 was undertaken. Bhaskara-1 was a small satellite, weighing about 450 kg and it carried two TV cameras operating in red and near infrared spectral regions. Payloads were designed considering the future requirement of users for a variety of applications. Over the decades, SAC has developed expertise in developing multi-platform, multi-spectral, multi-temporal, hyper-spectral, multi-resolution, day and night, and all weather Earth Observation payloads.

Communication and Navigation Applications

Satellite communication (SATCOM) provides ubiquitous coverage, serves far flung areas, enables anywhere connectivity. Thrust areas are satellite based tele-education, tele-medicine, Village Resource Centres and wide-band services. Development of Broadband Internet and VSAT applications using Multi Spot beam high power, high throughput satellites using Ku/Ka frequency bands is taking place. Mobile Satellite Services-MSS is for national disaster management and for strategic applications. One-way text message and position reporting applications have become operational and the system is upgraded for two-way data communication. High power multi beam S-band satellites have miniaturized terminals for popular MSS applications. Handheld and portable terminals with Unified IP based Hub to support different S-band communication services have been developed.

Earth Observation Applications

Applications are in Geosciences, Agriculture, Environment and Climate Change, Physical Oceanography, Biological Oceanography, Atmosphere, Cryosphere and Hydrosphere as highlighted below.

1. **Geosciences :** Thrust areas are coastal and marine geosciences, geodynamics, geo-hazards, mineral, hydrocarbon and geo-archaeological exploration
2. **Agriculture :** Production forecasting of agricultural crops using satellite remote sensing data, multiple forecast and integrating advanced technique in routine crop statistics
3. **Enviroment and climate change :** Research areas include climate change/climate based modeling and characterization studies of habitats ranging from Indian coral reefs and mangrove swamps to high altitude Himalayan alpine ecosystems, Indian eco-hydrology and investigations on Indian monsoon with polar environment processes
4. **Physical oceanography :** Research areas includes Advanced Ocean State Forecast (AOSF) using numerical models and space-borne observations, Ocean Process Studies, and development of Data Assimilation (DA) techniques
5. **Biological ocenoeoagraphy :** Synoptic maps of ocean color images are used to address a large number of science applications. Research areas are estimating ocean primary production, detection and monitoring harmful algal blooms (HAB), mapping dust aerosols,

Remote sensing and GIS based fisheries management, cyclone induced productivity in the Indian Ocean, phytoplankton physiology and climate change studies

6. **Atmosphere :** Developing techniques for analysis and forecasting weather and climate from regional to global scales using satellite data
7. **Cryosphere :** Studies on the earth surface include inventory, dynamics, changes and interaction with hydrosphere, atmosphere etc., of snow, ice cover on land, sea ice and permafrost
8. **Hydrosphere :** Timely and reliable assessment of available water resources through satellites and models provide important input to devise strategies and water management. Research areas are retrieval of hydro-meteorological parameters from satellite and modeling of Hydrological Processes from field to National scale.

Calibration and Validation

Calibration and Validation is important to monitor quality and performance of the sensors. It is done by comparing accuracy of measuring instrument with a standard. Vicarious calibration refers to techniques that make use of natural or artificial 'targets' on the surface of Earth for post-launch calibration of satellite sensors. Instruments like Sun-photometer, underwater radiometer, radar tide gauge, micro-rain radar, disdrometer, bucket rain gauge, corner reflectors, radiosonde, fluorometer are normally used for calibration and validation of satellite data/products. Research areas include vicarious calibration of sensors and validation of its bio-geo-physical products using controlled and instrumented sites over land, ocean and atmosphere.

Exploratory Sciences

The first Indian satellite, Aryabhata, launched in 1975, carried scientific experiments to investigate X-ray astronomy, solar neutrons and supra-thermal electron density. Since then, several instruments for scientific research have been flown on board high altitude balloons, sounding rockets and satellites. Four core payloads were indigenously developed for Chandrayaan-1 mission. These are Terrain Mapping Stereo Camera (TMC), Hyper Spectral Imaging camera (HySI), Lunar Laser Ranging Instrument (LLRI) and High Energy X-ray spectrometer (HEX). For Mars Orbiter Mission, three payloads namely Methane Sensor, Color Camera and Thermal Infrared Imaging Spectrometer for Mars (MSM) were developed and flown. For Chandrayaan-2 mission, indigenous payloads are under development.

8. ISRO Proposal Format

Faculty Members of University of Pune and its affiliated colleges are required to follow the ISRO format as given in http://www.isro.gov.in/scripts/srrespond.aspx and reproduced below for making research proposals and seeking financial grant from ISRO. Requirement is that Principal Investigator(s) should be full-time employee(s) of the concerned institution and proposal is to be forwarded through Head of the academic institution. Research proposals from individuals not affiliated to any recognized institution of the University are not considered. Institutions proposing a project for support are expected to commit the use of the existing infrastructure available with them. ISRO provides financial grants to support fellowship, materials, consumables, internal travel, testing charges, data etc. Funds for purchase of essential minor equipments which are not available in the institution and would be useful for future projects are also provided. There is no provision for any kind of payment to the Principal Investigator (or other staff) belonging to the Institution. The allocated funds cannot be used for travel abroad for any reasons.

Generally invitation for making research proposals is sent in the month of September-October and processing of the proposals is completed in 4-5 months time. For any information/clarification, Faculty Members may contact the ISRO-SPPU Space Technology Cell or visit our website www.unipune.ac.in/isro to get the required information.

Application for grant of funds

1. Application Institution
2. Title of the Research Proposal
3. Name of the Principal Investigator
4. Name(s) of other investigator(s) with the name(s) of their Institution
5. Proposed duration of Research Project
6. Amount of grant requested (in `)

	1st Year	**2nd Year**	**Total**
Staff			
Equipment and Supplies			
Others			
Total			

7. a) Bio-data of all the Investigators (Format-A).
   b) Brief description of the Research Proposal with details of budget (Format-B).
   c) Declaration (Format-C).
8. I/We have carefully read the terms and conditions for ISRO Research Grants and agree to abide by them. It is certified that if the research proposal is approved for financial support by ISRO, all basic facilities including administrative support available at our Institution and needed to execute the project will be extended to the Principal Investigator and other Investigators.

	Name	Institution	Designation
Principal Investigator			
Co-Investigator(s)			
Head of the Department/Area			
Head of the Institution			

Format A

Bio-data of the Investigator(s)*

1.	Name
2.	Date of Birth (dd/mm/yyyy)
3.	Designation
4.	Degrees conferred (begin with Bachelor's degree)

Degree	Institution conferring the degree	Field(s)	Year

5. Research/training experience (in chronological order)

Duration	Institution	Name of work done

6.	Major scientific fields of Interest:
7.	List of publications:
8.	Email id and Telephone number of PI :
9.	Email id of the Head of the academic institution:

* Bio-data for all the investigators should be given, each on a separate sheet.

Format B

Proposal Preparation Format

1. *Title of the research proposal*

2. *Summary of the proposed research*
A simple concise statement about investigation, its conduct and anticipated results in no more than 200 words

3. *Objectives*
A brief definition of the objectives and their scientific, technical and techno- economic importance

4. *Major scientific fields of interest*
A brief history and basis for the proposal and a demonstration of the need for such an investigation preferably with reference to the possible application of the results to ISRO's activities. A reference should also be made to the latest work being carried out in the field and the present state-of-art of the subject.

5. *Approach*
A clear description of the concepts to be used in the investigation should be given. Details of the method and procedures for carrying out the investigation with necessary instrumentation and expected time schedules should be included. All supporting studies necessary for the investigation should be identified. Necessary information of any collaborative arrangement, if existing with other investigators for such studies, should be furnished. The Principal Investigator is expected to have worked out his collaborative arrangement himself. For the development of balloon, rocket and satellite-borne payloads it will be necessary to provide relevant details of their design. ISRO should also be informed whether the Institution has adequate facilities for such payload development or will be dependent on ISRO or some other Institution for this purpose.

6. *Data reduction and analysis*
A brief description of the data reduction and analysis plan should be included. If any assistance is required from ISRO for data reduction purposes, it should be indicated clearly.

7. *Available Institutional facilities*
Facilities such as equipments, test instruments etc available at the parent Institution for the proposed investigation should be listed.

8. *Fund Requirement*

Detailed year wise break-up for the Project budget should be given as follows

	1st Year	2nd Year	Total
8.1 Salaries:			
8.1.1 Research Fellows/			

Project Assistant
8.1.2 Supporting Technical Staff
8.1.3 Other staff, if any

Total:

(Note: please specify designation and rate of salary per month for each category)

8.2 Equipment

1st Year 2nd Year Total

Total:

(Note: Please specify various individual items of equipment and indicate foreign exchange requirement, if any)

8.3 Consumables and Supplies

1st Year 2nd Year Total

Total:

(Note: Please specify the items and indicate foreign exchange requirement, if any.)

8.4 Travel

1st Year 2nd Year Total

Total:

8.5 Other project costs, if any (give details)

1st Year 2nd Year Total

a. Grand Total

9. Whether the same or similar proposal has been submitted to other funding agencies of Government of India. If yes, please provide details of the Institution & status of the proposal.

Format C

Declaration

I/We hereby agree to abide by the rules and regulations of ISRO research grants and accept to be governed by all the terms and conditions laid down for this purpose.

I/We certify that I/We have not received any grant-in-aid for the same purpose from any other department of the central government/state government/public sector enterprise during the period to which the grant relates.

	Name	**Designation**	**Signature**
Principal Investigator			
Head of the Department/Area			
Head of the Institution			

Seal of the Head of the Institution

9. Thrust areas for research proposals

Keeping ISRO's space programme in mind, following thrust areas are suggested for research topics by the prospective Investigators. More details can be found in the University website.

Aerospace

- Propellant formulation with ingredients of Nano size
- Droplet modelling in cryogenic injectors
- Mathematical modelling of liquid migration under Zero 'g' condition
- Modelling of plasma and its dynamics inside hollow cathode in Electric Thruster
- Electronics and signal processing of Ultrasonics used for spacecraft propellant gauging using Ultrasonic Flow meter
- Hydrazine dissociation model and thermal model for the monopropellant thruster
- Development of green propellants Amonium Di Nitramide (ADN), Hydroxyl Ammonium Nitride (HAN)
- Heat transfer characterization of kerosene with Aluminium Nano particles
- Characterization of Heat transfer parameters in Gel Propellant Engines
- Estimation of gaseous radiation for interplanetary missions
- Wing body reentry vehicle optimization studies
- Development of analytical tool for low thrust interplanetary mission trajectories
- Space Debris- setting up experimental set ups in ground lab level simulating space conditions
- Automated acoustic emission data analysis through ANN
- Micro machining of metals to provide low mass flow rates (>0.1 SCM) of Xenon gas for EPS application
- Metallurgical studies on Copper - Nickel dissimilar metals EB weld interface
- Development of vacuum brazing technique for joining carbon fiber reinforced Silicon Carbide (C-SiC) to Columbium and C-SiC to Titanium
- Development of ceramic material with higher electrical insulation at high temperature
- Development of materials / alloys including coatings for high pressure oxygen environment
- Development of graphene based sensors
- Development and characterization of oxygen, moisture and nitrogen absorber (non heating type)
- Theoretical & experimental evaluation of 3D weld porosity effects on integrety of welded structures (pressure vessels & thrust chambers)
- Development of thermal barrier coating with Nano materials
- Development of ceramic coating to prevent metal burning in high temperature and oxygen rich environment
- Physical property measurement at low temperature up to 20K
- Characterization of SS 321 at low temperatures: Study of phase transition relating to Strain rate & temperature
- Development of coating materials used in high temperature environment
- Laser ultrasonic for online EBW evaluation of Ti alloys

Material Sciences

- Experimental evaluation of damping in fluid conveying pipelines immersed in fluid environment
- Crack growth studies in propellant tanks through experiments & theoretical modeling
- Monitoring and assessment of EB weld of titanium, spot welding of aluminium inter-stages through acoustic emission
- Through thickness measurement of non-uniform residual stresses in metallic components
- Development of an algorithm and codes for measurement of non-uniform residual stresses in composite components using the method of incremental hole drilling
- Development of digital holographic microscope for MEMS characterization, deflection and shape measurement
- Thermal characteristics of PUF core sandwich for a temperature range of 600K
- Inter laminar shear stress evaluation of bonded structures
- Evaluation of acoustic characteristics polyamide foam for sandwich application
- Development of finite element software for inflatable structures
- Microgravity slosh analysis
- Dynamic modelling and analysis of human body exposed to vibration environment during space flight
- Visco-elastic structural analysis of solid propellant grains in the presence of voids
- Development of constitutive equations for Nano composites
- Fracture studies on textile composites
- Defect formation in steel and aluminium welds
- Microstructure and micro texture evaluation in age hardenable aluminium alloys
- Submicrostructure characterisation of Al-Li alloys
- Analysis of weld bead instability in the overlap zone of keyhole electron beam welds
- Ceramics for electromagnetic applications
- Oxidation behaviour of advanced high temperature coatings for super alloys and Ti-based intermetallic alloys
- Development of nano composite coatings for corrosion protection of light alloys such as aluminium and magnesium
- Oxidation behavior of cast superalloys and stainless steel
- Development of cast components in Ti-Al intermetallic base alloys
- Influence of pitting corrosion on the fatigue and fracture toughness of high strength aluminum alloys
- Development of aluminium nitride ceramic tapes for space electronic packaging applications
- Development of BaxSr1-xTiO3 tunable dielectric thin films prepared by pulsed laser deposition
- Study of defects in composites
- Development of Hydrogen Peroxide based propellant systems
- Development of software for modeling/simulation of mechanical/ballistic properties of solid rocket propellants
- Development of cubane and substituted cubanes for high energy & high density propellant
- Synthesis and scale up of energetic nitrate binders for solid propellants
- Modelling of polymer derived nanoceramics
- Development of bio-based polyurethane coatings
- Development of metal organic frameworks for the selective adsorption of gases like H_2, CO_2 and CO

Avionics

- Direct approach of generation for three phase motor driver by multi level inverter with reduced computational complexity
- Custom ASIC design of asynchronous RISC processor
- Mixed signal ASIC
- Design, fabrication, testing and realization of a MEMS acoustic sensor
- Design, fabrication, testing and realization of a capacitive, MEMS accelerometer
- Design, fabrication, testing and realization of a MEMS shock sensor
- Design, fabrication, testing and realization of programmable high voltage power supply
- Design and analysis (static & dynamic) of a planetary rollerscrew
- Modeling, simulation, analysis and design of a controller for a robotic manipulator having five degree of freedom for lunar mission
- Fibre optic sensors
- Development of nano technology based gas sensor (both presence & % quantity)

Image processing and pattern recognition

- Relative radiometric normalization techniques
- Advanced image registration models/frameworks/software/libraries
- Image classification and intelligence
- Kernel based Learning/Machine Learning for change detection analysis
- Super resolution approaches for Remote Sensing Images
- Resolution enhancement approaches for scatterometer and radiometer data
- Automatic feature extraction and labeling techniques
- Noise modeling, blur removal
- Image representation
- Image based modeling and 3D re-construction
- Techniques for classification of hyper spectral images
- Techniques for textural feature extraction from multi-spectral and hyper spectral images

Atmospheric sciences

- Measurements of height profiles of electron density, electric field and neutral wind in equatorial F region
- Linking thunderstorm related dynamical forcing on upper atmosphere
- Measurements of upper mesospheric temperature and winds
- Three dimensional simulation of Rayleigh Taylor instability
- Modeling of equatorial electrojet
- Study of low latitude ionosphere applied to satellite based communication and navigation systems
- Study of Electro-dynamical and thermospheric processes leading to positive and negative ionospheric storms in low latitudes
- Modeling of atmospheric tides
- Numerical simulations of stratospheric sudden warming and their global influence
- Use / development of remote sensing techniques for high resolution real time monitoring of convective systems (thunderstorms, cyclones etc)
- Development of advanced techniques for conventional and satellite based data assimilation in weather and climate models

- Satellite weather image processing
- Development of low cost nephelometer
- Development of OH analyzer
- Study of cloud-aerosol interaction in fog/cloud chamber
- Understanding dynamical characteristics of Mesoscale convective systems and their association with energetics of atmosphere
- Understanding the link among surface fluxes, atmospheric boundary layer and clouds
- Understanding the rain processes (both at macroscale and microscale) at a regional level
- Radar signal processing
- Radar Data processing
- Improvements in satellite rain retrievals using advanced statistical or physics based algorithms
- Time dependent attenuator for lidar signal
- Development of a Fiber optic based IF filter for lidar to solve the problem of temperature dependence of filters
- Dual-polarized patch antenna for radar applications
- Design and development of Solid state TR modules for radar applications
- Ocean and weather modeling and Forecasting

Remote Sensing and GIS

- Multi-spectral data compression
- Information fusion methods for multi-sensor data
- Automated cloud detection algorithms
- Automation in aerial/HR data processing and DEM/feature extraction
- Data compression and archival
- Spatial modelling for peri urban areas
- Cognitive techniques in remote sensing data analysis
- Development of automatic feature extraction algorithms (water spread, snow cover, crop and vegetation etc
- Hyperspectral remote sensing for water quality
- Ground water withdrawals using space data
- Altimeter data processing for estimation of water levels in lakes and rivers
- Estimation of snow depth, snow water equivalent and snow pack characterization
- Multi resolution segmentation approaches for classification of land use / land cover
- Forewarning of disasters
- Integration of spectral indices from optical, thermal and microwave based for crop condition assessment
- Forewarning of crop stress
- Polarimetric decomposition techniques for classification of crop / vegetation types
- Interferometric water cloud model for vegetation height assessment
- Assessment of climate variation / change and its impacts using EO data
- Modelling (landslide susceptibility modelling and forecasting, glacier lake outburst flood modelling & snow avalanche modeling
- Green house gases estimation
- Hydrological modeling
- Forest meteorology and ecosystem modeling
- Mangrove ecosystem analysis and its role in climate change

- Coral reef mapping and modeling
- Wetland ecosystem
- Integrated approach (including remote sensing inputs) for multi-crop assessment in sparse cropped regions
- The remote sensing techniques of crop assessment in hilly terrains/ high altitudes
- RS based indices/techniques for agro-ecosystems characterization/evaluation
- Applications of RS/GIS in horticulture studies
- Development of farming systems models with RS inputs/products
- Modelling soil carbon sequestration in relation to cropping systems and climate change

Rural development & developmental communication

- Mapping information and communication practices in the tribal areas
- A comparative study on media habits between rural and urban India
- Community's felt and perceived information needs in the agriculture and health sector
- Impact assessment of Edusat Network as supportive role in the field of formal education and teacher's training
- Benefits and challenges for outsourcing space projects
- Impact analysis of ISRO's space programs in rural and urban India
- Space Technology – need and expectation of society and present scenario study
- Demand assessment for future earth observation requirements
- Demand assessment for future communication services

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Evaluation of new research Proposals

ISRO-SPPU Space Technology Cell
Savitribai Phule Pune University
(formerly University of Pune)

Technical Presentation in PEC Meeting

New Research proposals presentation during 31st PEC Meeting

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