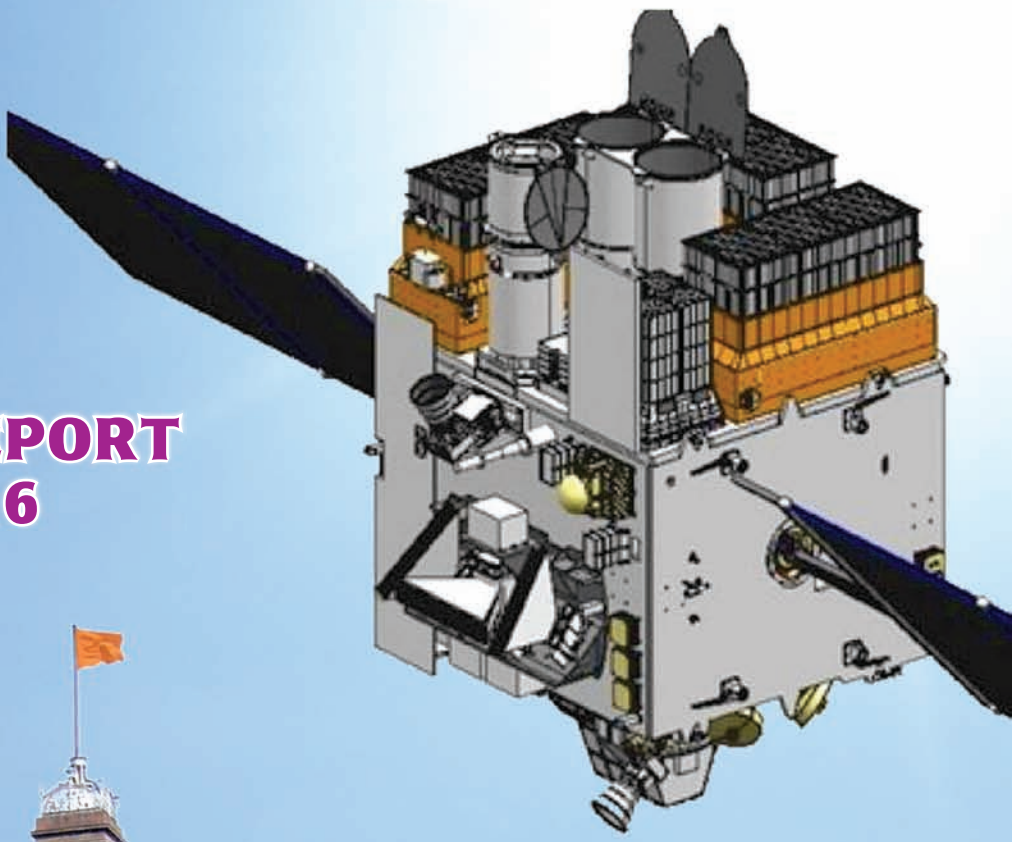
ISRO - UoP Space Technology Cell

Savitribai Phule Pune University

(formerly University of Pune)



ANNUAL REPORT 2015-16

JPC Members in a discussion

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Space Technology Cell

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SUMMARY

This document presents the details of the activities of ISRO-UoP Space Technology Cell (STC) at Savitribai Phule Pune University during the year 2015-16. A brief report on completed projects, giving summary of findings, is included in the document. Current status of ongoing projects is also presented. List of the new projects approved under ISRO-UoP Joint Research Programme, is given. The major establishments of DOS and their areas of activities in brief, were included in the Annual Report 2014-15. Through their various research and development programmes, these Centres/Institutes/Laboratories provide exciting opportunities and attract young Indian Research Scientists and students to space science arena. With a view to bring out the potential research areas for the benefit of the prospective Investigators, salient features of the technical activities of main ISRO Centres are being provided in the Annual Reports. Accordingly, brief history and technical activities of National Remote Sensing Centre (NRSC/ISRO), Hyderabad have been added in the present Annual Report 2015-16.

Thrust areas in the suggested research topics have been included for the guidance of prospective Investigators.

Contents

1. Introduction

Aim of the Indian space programme is to promote the development and application of space science and technology for the socio-economic benefit of the country. With the aim to encourage quality research in areas of relevance to the Indian space programme, ISRO has 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 Chairman ISRO and Vice Chancellor, Savitribai Phule Pune University (SPPU) on 21 January 1998. Initially five broad disciplines were identified for carrying out this JRP. The co-operation between the two organizations had been 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

Indian Space Research Organization (ISRO) is the primary agency under the Department of Space (DOS) for executing space programmes. In addition, Physical Research Laboratory (PRL) at Ahmedabad, National Atmospheric Research Laboratory (NARL) at Gadanki (near Tirupati), North Eastern-Space Applications Centre (NE-SAC) at Umiam (near Shillong) and Semi-Conductor Laboratory (SCL) at S A S Nagar, (Near Chandigarh), all under DOS, are making valuable contribution towards the above goal. Antrix Corporation, established in 1992 as a government owned company, markets the space products and services. The major establishments of DOS and their areas of activities have been given under **Introduction** in the Annual Report 2014-15. Through their various research and development programmes, these Centres/Institutes/Laboratories provide exciting opportunities and attract young Indian Research Scientists and students to space science arena. With a view to bring out the potential research areas for the benefit of the prospective Investigators, salient features of technical activities of the main ISRO Centres are planned to be included in the Annual Reports. To begin with, brief history and technical activities of National Remote Sensing Centre (NRSC/ISRO), Hyderabad (extracted from ISRO & NRSC websites) are explained below:

National Remote Sensing Agency (NRSA) was established as a registered society on 2nd September 1974. Objective was to undertake and facilitate remote sensing activities in the country. Since the

initial emphasis was on aerial surveys, NRSA took over the works and functions of Research Flight Facility of the Ministry of Defence. The NRSA Society's governing body was chaired by the then Prime Minister of India, Mrs Indira Gandhi. NRSA started functioning from hired premises in Secunderabad from mid April 1975. Indian Photo Interpretation Institute (IPI) of Survey of India, located at Dehradun was merged with NRSA in 1977. MOU was signed between India and USA for setting up of an earth station to receive earth resources data directly from the Landsat series of satellite launched by NASA. The Earth Station at Shadnagar, south of Hyderabad, became operational by 1st January 1980 and with that NRSA established the first operational satellite data reception facility in the country. NRSA was transferred from DST to Department of Space in 1980 as an autonomous centre. Indian Photo-interpretation Institute was renamed as Indian Institute of Remote Sensing in 1983. On 1st November 1995, the UN affiliated Centre for Space Science and Technology Education in Asia and the Pacific (CSSTE-AP) was created and hosted at Indian Institute of Remote Sensing (IIRS), Dehradun. On September 1, 2008 NRSA was converted from an autonomous organization to a fully Government organization under ISRO and renamed National Remote Sensing Centre (NRSC). IIRS was made as independent unit on April 30, 2011 and thus ceased to be a part of NRSC. During December, 2009 Regional Remote Sensing Service Centres located at Dehradun, Kolkata, Jodhpur, Nagpur and Bengaluru were renamed as Regional Remote Sensing Centres and amalgamated with NRSC. Regional Remote Sensing Centre, Dehradun was merged with Indian Institute of Remote Sensing (IIRS), Dehradun on November 1, 2011. National Remote Sensing Centre (NRSC) is presently the focal point for distribution of remote sensing satellite data products in India and its neighboring countries.

Starting with IRS-1A in 1988, ISRO has launched many operational remote sensing satellites. Currently, eleven operational satellites are in orbit – RESOURCESAT-1 and 2, CARTOSAT-1, 2, 2A, 2B, RISAT-1 and 2, OCEANSAT-2, Megha-Tropiques and SARAL. Varieties of instruments have been flown onboard these satellites to provide data in a diversified spatial, spectral and temporal resolutions. The data from these satellites are used for applications covering agriculture, water resources, urban planning, rural development, mineral prospecting, environment, forestry, ocean resources and disaster management. NRSC has wealth of images from Indian and foreign remote sensing satellites in its archives and has the capability to acquire data pertaining to any part of the globe on demand.

Earth Observation (EO) from satellite platforms is an indispensable tool for natural resources mapping, monitoring and management, including environmental assessment at global, regional and local levels. This is particularly due to multi-platform, multi-resolution, multi-temporal and synoptic viewing capabilities from space platforms. Data from EO satellites support wide range of information needs for better understanding of the Earth system at global to local scale and helps in providing information on natural resources such as agriculture, water, land use, forests, weather and natural disasters. Geophysical products developed in this Centre are listed below:

Normalized Difference Vegetation Index

Basic index for measuring the 'greenness' of the earth's surface is Normalized Difference Vegetation Index (NDVI). Its value ranges from -1 to 1. Values greater than 0.2 generally denote increased greenness and intensity of vegetation and from 0 to 0.2 show rocks and bare soil. Values less than 0 indicate clouds, rain, and snow. Vegetation Index is used in global monitoring of vegetation conditions and as input for modeling global biogeochemical and hydrologic processes. Global OCM2 vegetation indices are determined from GAC L1B / Resourcesat-2 data. NDVI is cyclical and smooth in nature, sudden changes in NDVI are therefore assumed to be from atmosphere, clouds etc. Processing based on modified FASIR (Fourier adjusted + Spline fit) method to estimate the pixels contaminated by cloud is carried out and filtered products made available.

Vegetation fraction

Vegetation fraction (VF) denotes occupation of vegetation canopy in a given ground area in vertical projection. It is popularly treated as a comprehensive quantitative index in forest management to monitor land cover conditions. Field measurement approach has been the traditional method of estimating the vegetation fraction but involves high cost. Oceansat-2 with its 2 days repeats cycle and swath of 1420 km, now provides data from its Ocean Color Monitor (OCM2) sensor for generating Vegetation fraction.

Broadband & Visible Albedo Products

Albedo is a key parameter widely used in land-surface energy balance studies, mid to long-term weather prediction and global climate change investigation. Surface albedo is the ratio of upwelling radiant energy relative to the down-welling irradiance incident upon a surface. OCM2 Level-1C imagery is used to generate composites of snow free land surface albedo in Broadband (0.3-3 µm) and visible (0.3-0.7µm) region. Knowledge map (LULC maps), helps in classification of water features. Information from DEM prevents misclassification of terrain shadows as water bodies.

Broadband Snow Albedo

Broad band Snow albedo is an important geophysical parameter for studies related to weather, climate, and hydrometeorology. Snow has the highest albedo in nature and hence has a significant influence on surface energy budget and on Earth's radiative balance. Abedo of snow is defined as the ratio of reflected to incident solar energy and is a function of sun angle, atmospheric parameters and size, shape, density and impurity contaminations of the snow crystals. Freshly fallen snow has a very high reflectance in the visible wavelength. As it ages, the reflectivity of snow decreases in the visible and especially in the longer (near-infrared) wavelengths. Resourcesat-2/AWIFS imageries are used to generate broadband snow albedo and Topographic correction due to differential illumination in rugged terrains like that of Himalayas, is incorporated.

Surface Water Layer

Spectral absorption characteristics of water in visible and NIR bands are used for the extraction of water features from OCM imagery. Knowledge map in the form LULC maps assist the classification of water features. Illumination angle information from DEM is used to eliminate errors in classifying terrain shadows as water bodies. With two days repeat cycle of OCM, water layer map for the entire country is generated every alternate day. Surface water products classify pure and mixed water pixels.

Water Fraction

As water pixels are mostly surrounded by vegetation or soil pixels, the spectral signatures of water pixels are affected by contribution from these two major ground covers. Generating water fraction using satellite data from Resourcesat-2 involves steps such as precision correction of images, creating top of the atmosphere reflectance, cloud & cloud shadow masking etc.

Tropical Cyclone Heat Potential, Ocean Mean Temperature & Ocean Heat Content

Ocean Heat Content (OHC) and Ocean Mean Temperature (OMT) are important climatic parameters in atmospheric and oceanic studies like cyclone and monsoon predictions. The data used in estimating these parameters are sea surface height anomaly, sea surface temperature (SST) from Tropical Rainfall Measuring Mission (TRMM) Microwave Imager (TMI) and the climatological values of OHC and OMT at various depths. Data required to estimate these parameters include sea surface height anomaly (SSHA), sea surface temperature (SST) and climatological values of OHC and OMT at various depths these parameters are estimated on a daily basis using artificial neural network techniques.

Sea Ice Motion Products

Polar sea ice plays an important role in climate system; however there are difficulties in obtaining regular information about the state of the sea ice cover, in particular in the Antarctic. Vector of sea ice motion couples the vertical momentum fluxes in the lower atmosphere and in the upper ocean, causing opening and closing of the ice cover. This affects heat exchange and transports ice from the areas of freezing to those of melting and thus influences the thermohaline structure of the ocean as well as the convection by changing the density of water. Ice covered parts of the ocean with their high albedo change the surface heat balance of these areas due to the high amount of reflected radiation. Sea ice kinematics is studied over large areas taking advantage of the availability of satellite data on scales of 25 km to 60 km. Synthetic aperture radar data of satellites allow the investigation of sea ice motion at scales of individual floes. For understanding deformation processes and for improving coupled sea-ice-ocean models, RISAT-1 SAR CRS data at 36 m spatial resolution over Antarctica is used to generate Sea Ice Displacement products.

2. Management of Joint Research Programme

Under ISRO-UoP Joint Research Programme, emphasis has been on promoting research and applications in Space Science and Technology. A Joint Policy Committee (JPC), constituted jointly by Vice Chancellor, Savitribai Phule Pune University (SPPU) and Chairman, ISRO with appropriate representation from both ISRO and SPPU supervises the overall management of the Interaction Programme, recommends the funds requirement for the approved and the planned programmes to ISRO HQs and suggests new areas of activities as and when necessary. The Hon. Director, ISRO-UoP STC, is responsible for the administration, fund utilization and day-to-day functioning of the STC. Following were the JPC Members during the year 2015-16 with Vice Chancellor, Savitribai Phule Pune University, as ex-officio Chairman.

Joint Policy Committee (JPC)

Prof (Dr) W N Gade, Vice Chancellor, SPPU	Chairman
Dr MYS Prasad, Director, SDSC/ISRO	Member
Dr G Nagendra Rao, Director, LEOS/ISRO	Member
Dr S Aravamuthan, Dy Director, PCM, VSSC/ISRO	Member
Dr Vikram Desai, Director, DECU/ISRO	Member
Dr CBS Dutt, Group Director, ESAG, NRSC/ISRO	Member
Shri MS Anurup, Dy Director, LVPO, ISRO HQs	Member
Dr K Ganesh Raj, Dy Director, RESPOND, ISRO HQs	Member
Prof S Ananthakrishnan, Adjunct Professor & Raja Ramanna Fellow	Member
Shri P P Kale, Director, VLSI	Member
Dr V B Gaikwad, Director BCUD, SPPU	Member
Dr Neelima Rajurkar, 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-UoP STC, SPPU	Member Secretary

Preliminary Evaluation Committee (PEC)

The 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 the 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 2015-16.

Dr S Ananthakrishnan (Adjunct Professor & INSA Senior Scientist)	Chairman

Shri PP Kale, Director, VLSI, SPPU	Member
Dr (Mrs) Deepti Deobagkar, Director, Dept of Bioinformatics, SPPU	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 Neelima Rajurkar, 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 S J Sangode, 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-UoP STC, SPPU	Member Secretary

3. Completed research projects

Beginning in 1998-99, a total of 158 research projects were undertaken by the various departments of the University and its affiliated colleges under ISRO-UoP Joint Research Programme and 129 of these projects were completed in the previous years ending in March 2015. During the year 2015-16 studies in respect of six more projects, as listed below, have been completed and final technical reports received from the Investigators. Summary of findings of these projects is given in subsequent paragraphs. 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 also 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 2015-16

1. Hazardous nitrous oxide gas leakage detection and monitoring system using wireless sensor network (Project No.126)
2. Development of conducting polyaniline-ZnO nano particle composite paint coating for corrosion protection (Project No.127)
3. Impact of Geo-hazards on human settlement (Project No.128)
4. Splitting of carbon dioxide into oxygen and carbon moiety using biomimetics of biological catalysts involved in photosynthesis (Project No.129)
5. Development of transition metal oxide nanoparticle films for solar radiation protection and solar cells (Project No.130)
6. Preparation of Co_3O_4 films by using electrochemical and spray pyrolysis deposition methods for gas sensing applications (Project No.131)

Summary of findings and brief details of completed projects:

PROJECT NO	126
TITLE	Hazardous Ammonia gas leakage detection and monitoring system using wireless network
INVESTIGATORS	Dr Arunkumar K Walunj (PI), A.K.I's Poona College of Arts, Science & Commerce, Camp, Pune Dr A D Shaligram (Co-PI), Dept of Electronic Science, SPPU
DURATION	2 years (Started on: Jan 2013)
BUDGET (₹)	8,06,000
SUMMARY OF FINDINGS	Ready to use Wireless sensor network uses available sensors for sensing, communicating and computing. Development of Wireless sensor network is based on star topology. It consists of sensor node, router and coordinator or base station. In star topology network all sensor nodes are transmitting data to router and router transmitting data to coordinator or base station. From base station data is monitored on computer screen using Pervcom software. Pervcom software was developed with Java, Apache Tomcat and mysql. The wireless sensor network configuration consists of two main sections, Transmitter and Receiver. Required algorithms to establish communication for following sections have been developed.

i. Initializing and Sending Beacon packet
ii. End Device start sending packet to routers
iii. Router communicates with End Tag and Coordinator
iv. Coordinator communicates with Routers and Computer

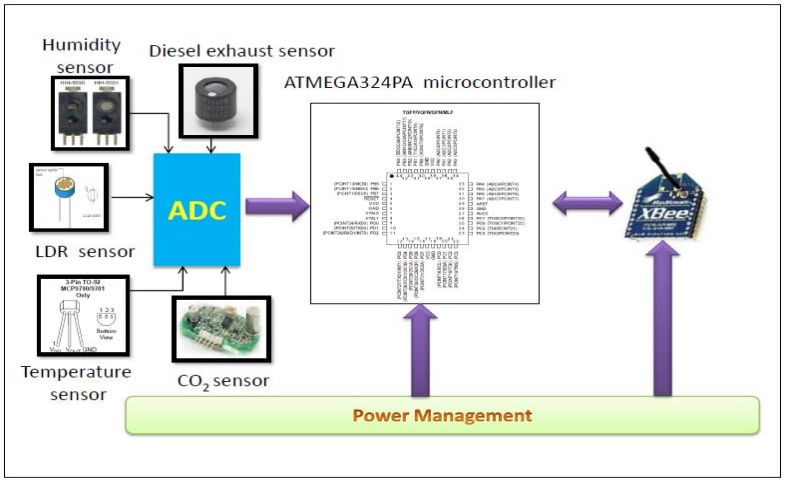

Figure shows the transmitter section of developed wireless sensor network

PROJECT NO	**127**
TITLE	Development of conducting Polyaniline-ZnO nanoparticle composite paint coating for corrosion protection
INVESTIGATORS	Dr Praveen P Deshpande, Assistant Professor, Department of Metallurgy & Material Science, Govt. College of Engineering (COEP), Shivajinagar, Pune - 411005
DURATION	2 years (Started on: Jan 2013)
BUDGET (₹)	9,50,000
SUMMARY OF FINDINGS	Conducting polyaniline-nano zinc oxide composite was synthesized by chemical method and used as a pigment for making paint. UV-Visible spectroscopy was used to find nature of polyaniline and band gap. Transmission electron microscopy was employed to determine nature of the pigment. Corrosion protection performance of the paint was studied using potentiodynamic polarization and electrochemical impedance spectroscopy. UV-Vis spectroscopy revealed peaks at 330 nm and 620 nm indicating polyaniline base formation and band gap was found to be 1.66 eV. Transmission electron microscopy conforms the formation of nano zinc oxide as a core and Polyaniline as a shell around the core. Potentiodynamic polarization studies on polyaniline-nano zinc oxide based paint coated low carbon steel in 3.5 wt % NaCl solution exhibits corrosion rate 1.16 mpy, i.e. 90% reduction in corrosion rate than that of uncoated steel. Electrochemical Impedance spectroscopy reveals long term protection ability of Polyaniline- nano zinc oxide based paint coating due to the formation of passive film after 96 hours. In typical nano materials, the majority of the atoms are located on the surface of the particles where as they are located in the bulk of conventional materials. In the present work, as the polymerization was carried out in the presence of nano Zinc oxide dispersed in the medium, it is expected that the conducting polyaniline film forms around the nano Zinc oxide particles giving a core shell type structure. Nano Zinc oxide being n-type and Polyaniline being p–type semiconductor this core structure forms p-n junction which inhibits further charge transfer across the depletion layer formed at the interface. Polyaniline being p-type presents a large barrier for electron transport while Zinc oxide being n-type, gives hindrance to hole transport across the interface. Mott Schottky studies reveal that the intact paint coating is n-type and damaged coating is both n-type and p-type in nature. Polyaniline being p-type presents a barrier for electron transport while zinc oxide being n-type gives hindrance to hole transport across the interface and thereby prevents corrosion.

PROJECT NO	**128**
TITLE	Impact of flood hazards on human settlement in Pune region
INVESTIGATORS	Dr Vijaya Khairkar, Dept of Geography, SPPU
DURATION	2 years (Started on: Jan 2013)
BUDGET (₹)	6,44,000
SUMMARY OF FINDINGS	Aim is to study emerging phenomenon of flood and its impact on settlement in Pune from 1961 to 2014. Study shows that majority of floods occur in the month of July. In the last six decades, every decade has

recorded one severe flood. A map for flood hazard is prepared based on data of precipitation, runoff volume, peak discharge and cross section using the HEC-RAS model. The map showing flood risks indicates higher risk in the core and at the reservoir area. The highest velocity of a flood in the inner core is found to be varying from 6 m/s to 34 m/s. Areas located on the banks of Mula and Mutha rivers, and prone to floods, have been identified using GIS platform. It is observed that majority of the areas located around the river are slums. Primary data is collected using questionnaire from flood prone areas of the city. The statistical method of population projection has been used to calculate the damage. This again, is classified into gender, number of children, Scheduled Castes and Scheduled Tribes population, workers, literates and number of dwellings to represent the loss of manpower and habitat. Evacuation is a part of mitigation and management of floods. Colleges and hospitals are some of the evacuation sites, where sanitation facilities are available, thus, can be a shelter to the victims. Sites have been selected around the rivers Mula, Mutha and Pavana. The socio-economic situation of dwellers in the flood prone areas has been studied using primary data. Parameters like frequency of floods, availability of warning systems, animal displaced during flood, time taken to recover etc have been studied. The relationship between different factors and recovery time has been calculated using Linear regression method. Factors like age and education are found to be in direct proportion to the recovery time. Using Chi-Square test, it is found that flood intensity is strongly associated with gender. The highest rainfall in the recorded rainfall history was in the year 2006, along with severe flood in Pune region. Return period analysis indicates that, there is approximately a 2.5 % chance of one or more 40 -year floods occurring in any 100-year period.

PROJECT NO	**129**
TITLE	Splitting of carbon dioxide into oxygen and carbon moiety using biomimetics biological catalysts involved in photosynthesis
INVESTIGATORS	Dr (Mrs) Waghmode Shobha, Associate Professor, Dept of Chemistry,, Abasaheb Garware College, Karve Road, Pune - 411004
DURATION	2 years (Started on: Jan 2013)
BUDGET (₹)	9,13,000
SUMMARY OF FINDINGS	Work was divided into two major areas: 1. Synthesis of biomimetic model compounds using Mn, Ru Cu, Fe Zn and Mg salts with self organising molecular assembly (SOM) like ligands, as quinone based ligands help to mimic biological systems 2. Development of method for catalytic splitting of carbon dioxide (either gas or using dry ice) with metal complexes as a catalyst Following has been achieved: • Synthesis of perfect SOM assembly of organic ligands which works best for formation of metal complex • Synthesized monomeric as well as dimeric/ bimetallic metal complexes which are biomimetics

- Catalytic reduction of dry ice as well as CO_2 gas in presence of hydrogen
- Formation of methane achieved but to get evidence difficult due to lack of instrumentation

PROJECT NO	**130**
TITLE	Development of transition metal oxide nanoparticle films for solar radiation protection and solar cells
INVESTIGATORS	Dr Jayashree Pant, Associate Professor, Dept of Physics, Abasaheb Garware College, Karve Road, Pune - 411004
DURATION	2 years (Started on: Jan 2013)
BUDGET (₹)	10,00,000
SUMMARY OF FINDINGS	Aim was to synthesize nanoparticles of transition metal-oxides by chemical routes like sol-gel technique and to make good quality films for use as coatings on solar cells for UV radiation protection. Nanoparticles of transition metal oxides, namely ZnO, NiO, Fe_2O_3, CuO and CoO were synthesized by sol-gel technique and microwave heating. These were calcined at various temperatures to study the effect on size, morphology and optical / magnetic properties. The size of these nanoparticles was determined from the XRD spectra. All the nanoparticles had diameters in the range of about 20 nm to 80 nm. Transition metal oxide nanoparticles behave as wide band gap semiconductors. Thus they are suitable for space applications. UV-vis spectra of the synthesized nanoparticles were taken to determine the band gap energy. SEM spectra revealed the morphology of these particles. Zinc oxide nanoparticles, in particular act as UV radiation protectors for solar cells. Coatings of ZnO of varying thicknesses were obtained on solar cells. The open circuit voltages and saturation currents of these were measured, both using incandescent light and solar radiations. It was found that though UV radiation is absorbed, the effect on efficiency and fill factor of the solar cell is negligible. Thus, thin coatings of transition metal oxide films like ZnO on solar cells can protect them from UV radiation damage without sacrificing their efficiency, thereby improving their life.

PROJECT NO	**131**
TITLE	Preparation of Co_3O_4 films by using electrochemical and spray pyrolysis deposition methods for gas sensing applications
INVESTIGATORS	Dr Shelke Pandit Nivrattirao, Associate Professor, Dept of Physics, Baburaoji Gholap College, Sangvi, Pune - 411027
DURATION	2 years (Started on: Jan 2013)
BUDGET (₹)	14,25,000
SUMMARY OF FINDINGS	The present work deals with the preparation of Co_3O_4 films by electrochemical and spray pyrolysis deposition methods for gas sensing applications. For this purpose, the DC electrochemical deposition system, spray pyrolysis deposition system and static gas characterization system were fabricated. Films were deposited on stainless steel, copper and glass substrates using cobalt sulpahte + cobalt chloride, cobalt nitrate and cobalt

acetate precursors. Deposited films were annealed at 350^{O}C for 2 hrs. Resultant films were characterized using various physical techniques. Ammonia and LPG gas sensing properties were measured using home-built static gas sensing characterization system. XRD results indicate the formation of single phase Co_3O_4 with cubic spinel symmetry. This is because, all the reflections of various XRD patterns are perfectly matching with the diffraction peaks given in JCPDS data file for Co_3O_4 only. Further, reflection lines corresponding to other cobalt oxide phases are not observed in any XRD patterns. Lattice parameters are also found to be matching with the lattice parameter a_o = 8.084 Å reported for Co_3O_4 phase with cubic spinel symmetry. These observations are found to be consistent with the FTIR results obtained for resultant films. The bands corresponding to the various vibrational modes of cubic spinel Co_3O_4 are found in the FTIR spectra of all resultant films. Both XRD and FTIR observations are supported by the results obtained during characterization of resultant films using Raman spectroscopy. Gas sensing characterization studies show highest values of sensitivity factor for the films deposited by $CoCl_2$ + $CoSO_4$ on Cu and Glass substrates. For ammonia gas sensing, the highest values of sensitivity factor are observed for the films deposited by using the spray pyrolysis technique as compared to the films deposited by using DC electrochemical deposition route.

4. Ongoing research projects

Presently there are 23 ongoing projects (listed below) including seven projects initiated in June 2015. 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 8th & 9th Feb 2016, reviewed the progress of all ongoing projects and had detailed interaction with the investigators of five projects, which have direct relevance to ISRO programme.

List of Ongoing projects

1. Naphthoquinone containing metal polypyridyl complexes for solar cells: computational and experimental study (Project No.136)
2. Feasibility study on indigenous development of electrochemical based gas sensors and transmitters (Project No.137)
3. Development of microwave excess noise generator heads using gas discharge of reactive and non reactive gases (Project No.138)
4. Development of graphite fiber reinforced Aluminium (7075) in the rolled sheet form (Project No.139)
5. Halophilic bacterial diversity of marine ecosystems from West Coast of India (Project No.140)
6. Studies on nano-porous metal oxides via anodization and their applications in super capacitors (Project No.141)
7. The development of the F.C. Observatory - an autonomous robotic telescope (Project No.142)
8. Multifunctional conducting polymer transition metal nano structure based sensor device for detection of NO_2, H_2S and NH_3 (Project No.143)
9. Development of Flexible and high temperature aerogels (Project No.144)
10. Occurrence and distribution of fluoride in groundwater of Terekhol river basin, Sindhudurg district, Maharashtra: A Remote Sensing and GIS based study (Project No.145)
11. Remote sensing application in Coastal geomorphology, changes in morphology in parts of West coast of Maharashtra, (Project No.146)
12. Study of precipitation characteristics using disdrometer and satellite datasets over Pune (Project No.147)
13. Optimization of low voltage DC micro-grid with intelligent Solar PV Utilization for a Computer laboratory (Project No.148)

14. 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)
15. Stabilization of zirconia for electronic applications, in tetragonal and cubic structure using various dopants (Project No.150)
16. Interaction of plasma with Thermal Protecting System (TPS) material during Re-entry of Space Vehicle (Project No.151)
17. Development of Nuclear Batteries using Radioactive Sources (Project No.152)
18. Design, fabrication and testing of a compact and robust Monochromator (Project No.153)
19. Fabrication of Magnetoelectric Energy harvesters by Utilizing Piezoelectric-Macro fiber composite (MFC) and Magnetostrictive-Nickel/Metglas/ Magnetic oxide materials (Project No.154)
20. Design feasibility of PLL frequency synthesizer for Ku band (Project No.155)
21. Space Radiation from the Optically Transparent Planar Microstrip Antenna Integrated with the Solar panels of Small Satellites (Project No.156)
22. Development of coating/manufacturing technology for friction stir coating/welding tool for welding of 3 mm thick stainless steel sheets (Project No.157)
23. Studies on Biodiversity of poly-extremophilic bacteria for their probable use as test organisms in space research (Project No.158)

Current status:

Sr No.	**Project title, Name of Investigator, Budget, Duration & ISRO/DOS Contact Scientist**	**Current status of the study and observations**
1	Naphthoquinone containing metal polypyridyl complexes for solar cells: computational and experimental study (Project No.136) PIs: Dr Sunita A Salunke and Dr. Subhash S Pingale Budget: ₹ 16.26 lakhs Duration:2 years (Started on: November 2013) ISRO/DOS Contact Scientist: Dr C P Raghunadhan Nair, VSSC	• Aim is to study theoretically and experimentally effects of substituents on properties of 2-hydroxy-1,4-naphthoquinone dye • Conversion efficiency of the product was observed to be low and it was suggested to examine the cost benefits of the process • Project extension given till March 2016

2	Feasibility study on indigenous development of electrochemical based gas sensors and transmitters (Project No.137) PIs: Prof A D Shaligram/ Prof S Haram Budget: ₹ 29.60 lakhs Duration:2 years (Started on: November 2013) ISRO/DOS Contact Scientists:Shri M B N Murthy/Shri R Senthil Kumar, SDSC	• Aim is to carry out feasibility study on indigenous development of gas (NO_2 & N_2H_4) monitoring sensors • Modeling and simulation of prototype cell and 3D printing in progress • Experiments regarding recovery of sensors in progress • Project extension given till March 2016
3	Development of microwave excess noise generator heads using gas discharge of reactive and non reactive gases (Project No.138) PI: Dr (Ms) S A Gangal Budget: ₹ 13.50 lakhs Duration:2 years (Started on: November 2013) ISRO/DOS Contact Scientist: Dr Rajeev Jyoti, SAC	• Aim is to design, develop and study indigenous microwave excess noise generator (ENR) based on gas discharge tubes • Technical presentation to be made to SAC/ISRO engineers for assessing the possible applications • Project extension given till March 2016
4	Development of graphite fiber reinforced Aluminium (7075) in the rolled sheet form (Project No.139) PI: Prof Madhuri Deshpande Budget: ₹ 20.05 lakhs Duration:2 years (Started on: December 2013) ISRO/DOS Contact Scientists: Dr S C Sharma and Dr S V S Narayanmurty, VSSC	• Aim is to prepare 7075 Aluminum MMC by carbon fiber reinforcement to enhance thermal and mechanical properties • PI made a technical presentation to VSSC/ISRO engineers and actions identified • Project extension given till August 2016
5	Halophilic bacterial diversity of marine ecosystems from West Coast of India (Project No.140) PI: Prof Rebecca S Thombre Budget: ₹ 16.04 lakhs Duration:2 years (Started on: January 2014) ISRO/DOS Contact Scientist: Dr C S Jha, NRSC	• Study is towards isolation, characterization and identification of halophiles • Microgravity related Data to be reevaluated • Statistical analysis to be included • Examine if this study could lead to addressing the disposal of Ammonium perchlorate solution • Extension given till March 2016
6	Studies on nano-porous metal oxides via anodization and their applications in super capacitors (Project No.141) PI: Dr Arif V Shaikh Budget: ₹ 11.76 lakhs Duration:2 years (Started on: January 2014) ISRO/DOS Contact Scientist: Prof S Ananthakrishna Adjunct Professor / Dr	• Aim is to develop material suitable for fabricating supercapacitor • Maximum possible capacity of the specimen that could be made in their laboratory, to be examined • PI to submit an interim report by March 2016 • Extension given till May 2016

	Shantanu Das (ex-BARC) as subject experts	
7	The development of the F.C. Observatory - an autonomous robotic telescope (Project No.142) PI: Dr Ms Raka V Dabhade Budget: ₹ 11.00 lakhs Duration:2 years (Started on: January 2014) ISRO/DOS Contact Scientist: Shri P P Kale	• Aim is to develop a 9.25" class remote telescope facility and to fabricate a Solar telescope and amateur photometer • No significant progress made, PI has been advised suitably • Extension given till March 2016
8	Multifunctional conducting polymer transition metal composite nano structure based sensor device for detection of NO_2, H_2S and NH_3 (Project No.143) PI: Dr Vasant Vidyadhar Chabukswar Budget: ₹ 15.82 lakhs Duration:2 years (Started on: January 2014) ISRO/DOS Contact Scientist: Prof SA Gangal, ISRO Chair Professor	• Aim is to synthesize conducting polymer metal nanocomposites for gas sensing applications • Recovery period of sensing element needs further examination • Extension given till June 2016
9	Development of Flexible and High Temperature Aerogels (Project No. 144) PI: Dr N B Chaure Budget: ₹ 15.99 lakhs Duration:2 years (Started on: August 2014) ISRO/DOS Contact Scientist: Dr V Sekkar, VSSC	• Aim is to synthesize flexible, thermally and acoustically insulating aerogels - both silica and carbon aerogels • Synthesis of silica and carbon aerogels completed • Electrochemical i.e. Cyclic Voltametry, Impedance completed • Spectrometry for Supercapacitor application completed
10	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: Dr S K Gaikwad Budget: ₹ 16.00 lakhs Duration:2 years (Started on: August 2014) ISRO/DOS Contact Scientists: Dr K Ganesh Raj / Dr MA Paul, ISRO Hq	• Aim is to carry out geological as well as geochemical investigations of Terekhol basin • Morphometric studies- completed • Field Studies- Three seasons completed
11	Remote sensing application in coastal geomorphology, changes in morphology in parts of West coast of Maharashtra, India. (Project No. 146) PI: Dr Milind Herlekar Budget: ₹ 11.05 lakhs Duration:2 years (Started on: August 2014) ISRO/DOS Contact Scientist: Dr A S Rajawat, SAC	• Aim is to identify historical shoreline changes and study evolutionary trend • Changes from Harnai to Ladghar area documented • Within study area, different coastal geomorphic features identified and mapped

12	Study of precipitation characteristics using disdrometer and satellite datasets over Pune. (Project No. 147) PI: Dr Rohini Bhawar Budget: ₹ 8.41 lakhs Duration:2 years (Started on: August 2014) ISRO/DOS Contact Scientist: Dr N V P Kiran Kumar, NRSC	• Aim is to characterize rainfall by studying physical and dynamical aspects with respect to variability of different atmospheric properties • Case studies separating the disdrometer rain rate and reflectivity data into convective, transition and stratiform period carried out • Drop size distribution (DSD) for three rain types done
13	Optimization of low voltage DC micro-grid with intelligent Solar PV Utilization for a Computer laboratory. (Project No. 148) PI: Dr Vivek Aranake Budget: ₹ 21.39 lakhs Duration:2 years (Started on: August 2014) ISRO/DOS Contact Scientist: Prof S Ananthakrishnan Adjunct Professor/Raja Ramanna Fellow	• Project is to design, implement and optimize a low voltage micro-grid for a typical computer laboratory as a prototype for an educational institute • Design and implementation of DC-DC converter for PC completed • Design and implementation of 48 Volts/70 Amp Bi-Directional Power supply completed
14	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: Dr R D Chaudhari Budget: ₹ 23.66 lakhs Duration:2 years (Started on: August 2014) ISRO/DOS Contact Scientist: Prof S A Gangal, ISRO Chair Professor	• Aim is processing of silk cocoons to obtain silk fibres and study their physic-chemical and mechanical properties • Extraction of fibroin protein for Mulbery & Tasar silk fibers accomplished • Study of physic-chemical and optical properties completed
15	Stabilization of ziroconia in tetragonal and cubic structure using various dopants for electronic application (Project No. 150) PI: Dr M Y Khaladkar Budget: ₹ 15.02 lakhs Duration:2 years (Started on: August 2014) ISRO/DOS Contact Scientist: Dr Surinder Singh, SAC	• Aim is to find suitability of synthesized products for various applications like gas sensors, explosive detection, catalysts etc • Synthesis of YSZ in 5, 8 and 15 mol% of Yttria, using different precursors completed • Thermal analysis done
16	Interaction of plasma with Thermal Protecting System (TPS) material during Re-entry of Space vehicle (Project No. 151) PI: Dr V L Mathe Budget: ₹ 12.56 lakhs Duration:2 years (Started on: August	• Aim is to use ECR plasma facility to generate ionized species of oxygen, hydrogen, atomic oxygen, atomic nitrogen and to study the emission spectra • Recombination coefficient calculated for different metals and metal oxides

	2014) ISRO/DOS Contact Scientist: Dr M R Ajith, VSSC	• Development of Radiative heater in progress • Deposition of thick coating in progress
17	Development of nuclear batteries using radioactive sources (Project No. 152) PI: Prof Sanjay D Dhole Budget: ₹ 19.98 lakhs Duration: 2 years (Started on:June 2015) ISRO/DOS Contact Scientist: Dr S A Ilangovan, VSSC	• Aim is to study alpha and beta sources, their activity, energy and half-lifetime for betavoltaic devices • Proto type Direct Charge Collection type nuclear battery made and tested with radioactive P-32 source
18	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: Mr Saji Kuriokose, SAC	• Aim is to design and realise a compact monochromator • Optical Design optimization completed • Design of Data acquisition system completed
19	Fabrication of magnetoelectric energy harvesters by utilizing piezoelectric-macro fiber composite (MFC) and magnetostrictive Nickel/Metglas/Magnetic oxide materials (Project No. 154) PI: Dr Kambale R C Budget: ₹ 10.00 lakhs Duration:2 years (Started on:June 2015) ISRO/DOS Contact Scientist: Dr Bhanu Pant / Dr H Sreemulanadhan, VSSC	• Aim is to design magnetoelectric (ME) structures of Macro fiber composites • $CoFe_2O_4$ prepared by dry combustion synthesis route • As-synthesized powder sintered • Particles characterized by SEM and vibrating sample magnetometer
20	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: Mr D K Das, SAC/ Dr H S Jattana, SCL	• Aim is to study Design feasibility of PLL frequency synthesizer for Ku band, using cadence tool at 180 nm foundry • Discussions held with SCL/ISRO engineer • Work on 90 nm technology started
21	Space radiation from the optically transparent planar microstrip antenna integrated with the solar panels of small satellites (Project No. 156) PI: Dr Jayashree Pratap Shinde Budget: ₹ 11.75 lakhs Duration: 1 year (Started on:June 2015) ISRO/DOS Contact Scientists: Sri R Rama Subrahmanyam, ISAC / Sri M Viswanathan, LEOS	• Aim is to establish feasibility of designing and simulating an optically transparent antenna using meandered patch structure • Antenna configuration including optical transparency being finalized • Weight of transparent antenna for small satellites being studied

22	Development of coating/manufacturing technology for friction stir welding tool for welding of 3 mm thick stainless steel sheets (Project No. 157) PI: Prof Rajesh Chaudhari Budget: ₹ 23.02 lakhs Duration: 2 years (Started on:June 2015) ISRO/DOS Contact Scientist: Dr D Sivakumar, VSSC	• Aim is to demonstrate feasibility of friction stir surfacing/welding (FSW) of austenitic stainless steel AISI 316 to form defect free coating/ joint Literature survey completed • Design and fabrication of fixture for plates completed • Machine set up in progress • First set of tools designed and fabricated
23	Studies on biodiversity of poly-extremophilic bacteria for their probable use as test organisms in space research (Project No. 158) PI: Dr Neelima M Deshpande Budget: ₹ 9.00 lakhs Duration: 2 years (started on: July 2015) ISRO/DOS Contact Scientist: Shri K R Manjunath, SAC	• Study aims at Microbial census of radiation resistant bacteria with respect to poly-extremophily • Identification and enrichment of samples collected from salt pans, hot water spring and sea water completed • Isolates fitting the criteria of poly-extremophily isolated • UV and Gamma exposure to isolates in progress

5. New research projects

In response to ISRO-UoP STC's call for new projects, 98 study proposals were received from various Departments and affiliated colleges of the University. These proposals, along with two other proposals received in the previous years and duly processed but could not be initiated due to certain valid reasons, were evaluated by the Preliminary Evaluation Committee (PEC) chaired by Prof S Ananthakrishnan for their suitability. Committee recommended a list of 11 projects for the consideration of Joint Policy Committee (JPC) chaired by Hon'ble Vice Chancellor. JPC considered these proposals and after interaction with the prospective investigators, approved 8 proposals for taking up in the year 2016-17 under ISRO-UoP Joint Research Programme. Budget requirement of these approved studies are given below.

Sr. No	Project Title/PI	Duration (years)	Total funds requirement (₹ in Lakhs)	Funds for 2016-17 (₹ in Lakhs)	Funds for 2017-18 and subsequent years (₹ in Lakhs)
1	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 *Dr Ganesh G Dongre, Vishwakarma Institute of Technology, Pune*	2	38.32	32.41	5.91
2	Valve-less linear compressor driven stirling cycle cryocooler for space applications *Prof (Dr) Virendra Bhojwani,Jaywantrao Sawant College of Engineering, Pune*	3	22.10	2.90	19.2
3	Converting energy derivable from low energy sources into electrical power for autonomous sensors applications *Prof Subhash V Ghaisas, Dept of Electronic Science, SPPU*	2	10.10	5.00	5.10
4	Development of high current density thermal-field (T-f) cathodes *Prof M A More, Dept of Physics, SPPU*	2	10.58	7.29	3.29
5	Studies on glare reduction techniques for indoor illumination systems *Dr Jayashri A Bangali, Kaveri College of Arts, Science and Commerce, Pune*	2	18.32	12.16	6.16
6	Fabrication of a small satellite for monitoring radiations in different orbits of outer atmosphere where orbit maneuvering will be controlled by solar sail *Rohini P Mudhalwadkar,College of Engg, Pune*	2	20.60	12.80	7.80
7	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	2	28.20	12.40	15.80

	Dr Mrs D C Gharpure, Dept of Electronic Science, SPPU and Shri Rajeev Jyoti, ISRO				
8	Bioleaching to Electronics Wastes (E-wastes) *Prof Amita Ravikumar, Dept of Biotechnolgy, SPPU*	2	20.93	11.96	8.97
	Total		**169.15**	**96.92**	**72.23**

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 five PEC meetings held during the year 2015-16. JPC had its two-days meeting on 8 and 9th February 2016. Highlights of these events are given below.

23rd PEC meeting held on 11 August 2015

Committee reviewed the progress of the 18 ongoing projects. Investigators made a detailed technical presentation highlighting the progress of their work. While reviewing the progress of the projects, Committee stressed on the following points:

i. Progress of the study with respect to overall goals as spelled out in the research proposal

ii. Relevance of study with respect to developing new science/technology

iii. Deliverable products as a result of the study

iv. Publications of research findings in refereed journals

v. Timely completion of the projects and submission of final technical reports

24th PEC meeting held on 21 September 2015

The main agenda of this meeting was to assess the status of the project titled *Feasibility study on indigenous development of electrochemical based gas sensors and transmitters (*Project No.137) by Prof A D Shaligram / Prof Santosh Haram. Prof Shaligram and Prof Haram gave a detailed presentation on the work carried out stressing the technical achievements. Brief summary of their presentations is given below.

- **Prof Shaligram reported:**

Analysis of various parts of the existing sensor –Electrodes, electrolyte, Electrolyte container, gas permeable membrane and filter - completed.

Main features are

Gas permeable membrane and Electrodes: TiAu coated Teflon mesh

Electrolyte: 0.5 molar aqueous solution of H_2SO_4

Electrolyte container: Teflon (PTFE)

Wick: porous Ceramic

Reference electrodes: Pt

- **Prof Haram reported:**

Au/C/PTFE membrane electrodes have been developed successfully for the NO_2 sensing applications. For that Carbon powder was cold pressed on commercial Teflon porous membrane and dried at 70 ^{0}C in an oven. Gold salt solution was used to impregnate membrane electrodes with gold particles. The membrane was sandwiched in Nylon support and fixed in the specially developed electrochemical cell. The 0.5M sulfuric acid was used as electrolyte. Ag/AgCl and Pt wire were used

as reference and counter electrode, respectively. The cell was transferred into 5 liter air-tight jar. Prior to the experiment, the jar was flushed with N_2. A know volume of 11 ppm NO_2 gas was introduced and current response was recorded at step potential. It gave consistent current of few hundred microamps for 11 ppm NO_2. The sensor gave no response for CO_2, H_2, NH_3.

The Committee suggested to check the stability of membrane and effect of temperature and moisture and the recovery time.

25th PEC meeting held on 8 December 2015

This meeting was held for initial evaluation of new research proposals. Against our invitation of new research proposals, 98 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 noted that there are several proposals where similar study has been done in the past under ISRO-UoP Joint Research Programme and such studies need not be repeated. Members also expressed their concern about the lack of clear objectives in some of the proposals. Prof Ananthakrishnan mentioned that while considering the new proposals, we may also broaden the list of the Principal Investigators to include the new researchers. Repetition of carrying out research in the same topic which has been extensively covered should be also avoided. After a detailed scrutiny of the new proposals, Committee short listed 17 proposals and decided to invite the prospective investigators for clarifications and technical presentation. Committee also agreed to include two other proposals received in the previous years and duly processed but could not be initiated due to certain valid reasons,

26th PEC meeting held on 19 January 2016

The prospective investigators of the shortlisted 17 new proposals were invited to make technical presentation to the Committee and provide necessary clarifications. After a careful screening, Committee recommended a list of 11 projects for the consideration of Joint Policy Committee (JPC)

27th PEC meeting held on 28 January 2016

Agenda for this meeting was to review the six-monthly progress of all ongoing projects. Investigators of 23 ongoing projects were invited to make technical presentation to PEC, but Investigators of following three projects could not come due to exigencies. They had sent the progress reports.

1. Development of graphite fiber reinforced Aluminium (7075) in the rolled sheet form (Project No.139)
2. Development of Flexible and high temperature aerogels (Project No.144)
3. 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)

Committee reviewed the progress of these projects and gave necessary directions to investigators.

JPC meetings held on 8 and 9 February 2016

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 8 & 9th February 2016 to take a stock of the ongoing projects and consider new research proposals for the year 2016-17. JPC approved 8 new research proposals and recommended a total budget of ₹166.92 lakhs for the year 2016-17.

Commencement of new projects

After the receipt of Grants-in-aid from DOS, for the year 2015-16, seven research projects, which were approved in the JPC meeting held on 4 & 5th February 2015, made a beginning in the month of June 2015 with the release of first installment of funds. One research proposal titled *Access, exposure and impact of EDUSAT program: An intervention study of stakeholders and beneficiary* submitted by Dr Vaibhav Jadhav, Dept of Education & Extension, SPPU, was not taken up as PI had not submitted the modified proposal after interaction with DECU/ISRO scientists.

7. 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-UoP 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

8. Supported areas of research

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

Scrutiny of new research Proposals

ISRO-UoP Space Technology Cell
Savitribai Phule Pune University

Discussion on new Research Proposals in PEC Meeting

New Research proposals presentation during 26th PEC Meeting

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