Summary of the discussions of the Twenty seventh meeting of Scientific Advisory Committee to Cabinet (SAC-C) held on 22nd October, 2013 at CSIR Vigyan Kendra, Lodi Garden,New Delhi

The agenda of the meeting, list of participants and Opening remarks by Dr. R. Chidambaram are at Annexure I, Annexure II and Annexure III, respectively.

M27 A1& A2 Opening Remarks & Action Taken Report

Dr. R. Chidambaram, Chairman SAC-C warmly welcomed all the members. He then briefed about the agenda of the day. Expressing his views on India becoming a Knowledge Economy, he said that the country had to first achieve Global Leadership in Science, Technology, Manufacturing and Innovation. Elaborating further, he said that to become a Global Scientific Leader, India must excel in Basic Research including Directed Basic Research. Similarly, for a Global Technology and Innovation Leadership, it has to excel in Applied Research and R&D led innovations. All these in turn must be backed by high-quality Manufacturing skills. Therefore there is a need for comprehensive manufacturing strategy, as national development & security are both strongly dependent on manufacturing facilities. He further said that though substantial high end manufacturing capabilities exists in strategic sectors such as DRDO, Space, Atomic energy etc., these have not yet permeated into the civilian sector. Machine tool industry is the mother of mechanical manufacturing and he expressed his happiness at CMTI Bangalore receiving very strongsupport of DIPP with a grant of Rs.150 crore.

He observed that the third industrial revolution is being driven by the internet and additive manufacturing (3-D printing technology), backed up by other technologies such as Robotics with an emphasis on Green Technologies. The advantage of Additive Manufacturing is that much of the information flows through net and not dependent on economies of scale.Medical implants, for example, areideal for additive manufacturing as customized products can be developed.Fragmented capabilities are present in IITB, CMTI, CMERI, GTREetc. The technology has already spread with polymers, but with metals,the expertise is limited. Prof. Karunakaran and Dr.Chellapandi will talk about it.

On Big data Science**Dr. Chidambaram**said that it has become very important due to the availability of high speed electronic connectivity as also for

programmes such asClimate Change Sciences, Astrophysics, Molecular biology etc. He mentioned the Indianadvantage in terms of NKN that can facilitate high speed transfer of big data. NKN also connects to EU, CERNand a dialogue is on to connect to INTERNET-2 USA.He complemented NIC for their effort in setting up the NKN as also the progress in finally connecting more than 1500 knowledge institutions (1150 are already covered). He said that afew speakers have been invited to talk on different applications.

Dr. Chidambaram complimented IMD for the wonderful job in correctly and timely predicting the cyclone Phailin. He praised Prof.Kapil Gupta from IITB for providingthe first information report of the cyclone.These inputs have led to excellent ground level management and thus minimizing the human life loss to very low levels. We shall hear more about this, he said.

He then referred to the 'Action Taken Report'. Members appreciated the action taken. Thereafter Chairman took up the Agenda item on Big Data Science and invited Dr.ParthaMajumdar to make his presentation.

M27 A4 Big data Science

Speaking on **Novel insights in Human Disease Gleaned from Massive Genomic Data Sets - Cancer as an illustrative Example- Dr.Partha P. Majumdar, National Institute of Biomedical Genomics, Kalyani** shared his experiences. He said that earlier first understanding of Human disease came from physiological, metabolic, biochemical alternations. Genetic basiswere attributed for such diseases,if these alternations ran in families.In non-infectious diseases, it led to identification of the mode of inheritance in families or the human genetic defects that resulted in these diseases. This whole process was called forward genetics which was very tedious & pains taking, for example, the work carried out by Brown &Goldstein for which they received Nobel Prize in 1985.

Explaining the concept of reverse genetics which started in 1980s, he said that if particular markers are knownthen specific characteristics (genotypes) of this genetic marker will more faithfully associate with disease, usually transmitting in families from one generation to the next. And if a genotype at a marker associated with disease, then the disease causing gene must be in proximity of the marker. After 1990, millions of markers were found and it led to new technologies, new study designs, new statistical methods as big data was generated.

Dr.Majumdar informed that in their lab they now routinely screen 5 million marker for every individual in 100s/1000s of individuals (patients & normal) generating enormous big data. Data size has increased from Kb (till 1990) to Tb (1995 onwards). This Tb is per individual so when thousands of individuals are screened big data is generated. With big data science they were able to saturate the entire chromosome, identify disease causing variants in every particular position of human genome. DNA variants for various diseases such as cardiovascular, cancer etc. have been mapped on the chromosome and discussed the genes causing breast cancer and the concept of driver and passenger mutations. He further elaborated the goal of International Cancer Genome consortium and the role of India as a founding member in generating data for oral cancer.

Dr.Majumdar said that in last three years his institution has generated 6,529 Gb of sequence data and have 3 world records in data generations.The project has helped to understand cancer cells e.g of P53 mutation in many individuals. Tumoursuppresser like MLL4, US P9X and new pathways were discovered. Thus genomics is now driving cancer therapy. Concluding his talk he said that big data science is not hypothesis driven andhas high impact on health technology generations, data storage & management.Secure & very high speed network (NKN) is being used for data transfer data and scientists are working without barriers. New statistical computational methods are coming up &compression algorithms are to come up. (Details of his presentation are at Appendix Á)

Sharing**Perspectives on big data science in nuclear physics: Road map for creation and implementation,Dr.S.Ganesan, BARC, Mumbai** said thatBig Data centres have helped in lowering the gap between advanced countries & developing countries. He discussed visualization & processing of large data bases for Monte Carlo application and other applications e.g. for multi physics-multi scale modelling where integral results based upon physical real system experiments are carried out.The nuclear data physics efforts have helped eliminating the pitfalls associated with limited efforts of individuals. The big data science helped to increase system intelligence and system performance bringing in factors of correlations and has become affordable due to advances in computer science.

Dr.Ganesan explained that reactor design issues are shaped by number of considerations, such as materials development, design ability, passive safety etc.,and data has greatly helped in designing the nuclear power reactors. He

highlighted the importance of generation of variance-covariance error matrix in basic experimental nuclear physics data. He also talked about Mirror of IAEA Nuclear Data Services in India and experimental nuclear criticality benchmarks of International Criticality Safety Benchmark Evaluation Project.

He concluded by saying that Big nucleardata science at differential and integral level is part of pursuit of excellence in nuclear science & technology and there is a need to promote big data science in educational institutions.(Details of his presentation are at Appendix 'B')

Presenting**"The role of BIGDATA in Astronomy & Astrophysics " Dr.Dipankar Bhattacharya, IUCAA Pune** said that there is explosive growth of datawith telescopes becoming more powerful covering entire electromagnetic band from radio to Y-rays, and non-electromagnetic messengers.Till now very small fraction of the objects in the universe has been catalogued, even less studied in detail. Since lot of astronomy today is done using archival data,Substantial data is entering in public astronomical archives. This is enabling the researchers to find patterns & outliers, time series analysis, construct spectral energy distribution, study dependence of properties over cosmic time, the contents of our universe including exotic components such as dark matter & dark energy.

He explained about recording of multidimensionality of Astronomical data such as data related to spatial location, spectroscopic parameters, time domain, polarization etc. for each object and this data volume can exceed 1 GB/object and total no. of catalogued objects is~ $10^{9.}$The current holdings in the major data repositories in public archives are ~ 10 peta bytes(e.gNASA, ESO, ESA, CSIRO, CADC). Major escalation in data production has taken place with commissioning of new facilities e.g. LSST, TMT, SKA etc. He said that many complex astrophysical problems such as cosmological structure formation, star information, origin of magnetic fields, etc., requires extensive computer simulation. He informed that in India public archives are maintained by GMRT (>50 TB) & IUCAA.

He then explained the virtual observatory system, a global service, to facilitate consumption of Astronomical Data that provides access to multiple archives, tools to visualise and interpret the data. He said that virtual observatory is being run by IUCAA, Pune in collaboration with industry (Persistent Systems Ltd.). He then highlighted the challenges in the field such as Archives architecture (need to migrate from conventional SQL to Big Data

paradigm- e.gHadoop/Sci DB), high efficiency, low redundancy, application development & custom data and building effective partnership between Astronomies and Data Scientists/ Technology Experts. Details of his presentation are at Appendix 'C'.

Initiating the discussions on Big data Science **Dr.Sikka**observed that in India there is lack of experimental facilities for generating data to compliment theoretical data. He emphasized that nuclear reactor data is not only meant for making nuclear reactors but can alsobe used in various other situations e.g. fordelivering a radiation dose to a cancer celletc.

-It was mentioned that for modelling the effect of climate changeone need huge amount of data. NASA maintains about 12 data bases like, Agriculture, Atmosphere, Biosphere, Climate Indicators, Human Dimension, Solid Earth, Hydrosphere, Ocean, Sun-Earth Interactions etc. NKN is helping Indian climate science scientists to access this data.

-Dr.S K Joshi complimented for the interesting talks. He expressed his concern for the challenging task of handling the immense amount of data generated. India has progressed in the field of Astronomy, Medical-Cancer diagnostics through Genomics. He enquired to know how well are weequipped to handle the huge data and develop our own techniques to meet these challenges.

-Dr.Selvamurthy said that SAC-C has rightly chosen this topic for discussion sincethe country is generating a large volume of data in different areas and needs to strengthen its capabilities. He complimented Dr.ParthaMajumdarin explaining how genomic data can be used for accurate prediction of disease or treatment to a disease like gene therapy, even the biomarkers to see the susceptibilityof an individual to a disease.He then suggested that one must look at proteomics,lipidomics& metabolomics together rather than only genes, since the future is for customized medicine. He observed that if NKN has a dropbox like facility,people who would like to develop Central National Data Base can use it and National Central Archives of Data can be created in which the organizations/individuals may voluntarilyput their data creating huge data base which can be used for research purpose.

-Dr. Krishna Ella raised the point that whether there is a need for mega or few big data centres for various fields. He expressed his concernon the issue of protecting the data and need for human resources for data mining. He requested to include clinical trials centrally linked to data management.

-Dr.Badwecommented thatthe rate at which the analysis is evolving, validation process for it is not evolving at the same rate. It is a good idea to see big data that what comes out of it, even better if we have a priory and then it is tested through this big data which is not happening at this moment. He suggested that the data should come into public domain after some lock-in period so that more minds can be engaged on it. He remarked that lot of side effects of drugs go unnoticed in huge populations and big data science can be used in pharmacovigilance and more funds are needed for this activity. Presently, safety of individualis based on the data brought by industry and it is too small a data to look for long term toxicity.

-Dr.Gairola said that NKN has the capability to take care of the three components i.e. storage, computation & communication of data. It's important how the data is handled, parallisation of data processing &its interpretation. In most of these areas the software arehighly expensive &proprietary. More resources have to be put on developing the tools to handle the data.

-Dr.Devrajsaid thatalong with genomic analysiswork on stem cells and epigenetics is important for cancer analysis.

-Dr.P.GhoshappreciatedDr.P.Majumdar for his excellent presentation and said that there is a need to go from data analysis to application. After finding genomic anomalies, we need to tie up with developing therapies. He suggested that the M.Phil students must do validation of published work and that it will fill the core need of this work. He added that there is a need to develop large national base for traditional knowledge & biodiversity & involve school students in systematic collection of biodiversity which can be important for e.g. pharmaceutical industry.**Dr. Chidambaram**informed that a model project on NKN with National BiodiversityAuthority (NBA) has been initiated for creationof a biodiversity grid.

Commentingon role of big data**Prof.Dinesh Singh** said thatusually there has to be a hypothesis in advance but in mathematics sometimes you keep looking at data and a pattern emerges and then the hypothesis is developed & validated e.g. Prime Number theorem. Giving the example of Multivariable harmonic function which was rediscovered by a young person using software, he saidthat bringing young minds to analyse big data will have great impact.

-Dr.Chellapandisaid that Virtual reactor on computer can create big data &can be used by students to understand the design, process and manufacture & analysis of some safety aspects etc.

-Dr.Ramasami informed that as per the National data sharing access policy data created by public funds must become available for needs of civil society. As per the security considerations only 4 departments come under the category where data sharing leads to security concerns. The rest of 71 departments can share the data with restricted and regulatory use. He suggested identifying the areas for value in big data science. Need to build certain verticals such as nuclear, cancer, Astrophysics etc., assess the integrated value of the hardware & software infrastructure and the percentage of Indian Scientists which can bring value to big data science. He iterated that there is need for planning and developinga national model.

Dr.R.Chidambaram appreciated the presentations in big data science. He said that Climate science expertsuse maximumamount of data for more accurate climate related predictions.

After much deliberation the committee arrived at the following decisions:

- *Each specialised area should continue on present path as it requires exceptional domain knowledge and improved resources such as supercomputing, storage space, e-connectivity(national & international)*
- *International Collaboration essential in all areas as itenhances the value.*
- *Sharing the best practices across the fields whether it is in data mining, data processing, development of mirror sites, visualization etc.*
- *Creation of DATA with application specific interdisciplinary grids e.g under NKN there are verticals such as brain grid, cancer grid etc., where all research data can be stored and shared for research.*
- *Computationalinfrastructure(Supercomputers),Common Infrastructure(NKN), Common Platforms (enhanced GARUDA or Colllab DDS etc.,) to be used in conjunction with sector specific verticals to be developed by Scientists/Engineers/Data Scientists.*
- *The guidelines provided by Data Sharing and Data Security have to be followed.*
- *Suggestions related to attracting young people to careers in these fields, simulation databases etc., may be taken up.*
- *Form a brainstorming group on Big Data Science,starting with a collaborative meeting under the Indo-US S&T Forum.*

M27 A3 "Additive Manufacturing & Allied Technologies", byProf. K.P.Karunakaran,IIT, Bombay

Dr.Karunakaran explained the principle of additive manufacturing, also called 3-D printing,in which total automation system prevails i.e. converting CAD model to physical object. It is a layer by layer manufacturing process and also called Rapid prototyping (RP). This approach has revolutionized the way products are designed and manufactured. The important points to be considered for the process are the selection of material to be used, minimum layer thickness & requirement of support mechanism. Solid (polymeric, metallic, ceramic) & liquid form has been used for this type of manufacturing. He then highlighted the research being carried out at IIT Bombay in this area with 3 axis& 5 axis hybrid layered manufacturing (HLM) capabilities, high polystyrene prototyping, and the benefits of high bandwidth communication tool for Gas Turbine made along with GTRE. He said that many design iterations within limited time can be made using this technology and discussed a case study carried out for L &T, where Additive Manufacturing was used to make products such as conformal cooling channels, assemblies without joints, gradient materials, non-equilibrium objects, difficult or impossible shapes.

He furthersaid that with use of additive manufacturing design innovation need not be limited by manufacturing constraints. He highlighted some of the challenges in AM as, poor internal quality, inherently anisotropic, all rapid prototyping materials are proprietary. These limitations can be overcome by appropriate pre/in-situ/post-build processes. He felt that Additive manufacturing along with Allied Technologies may lead to Rapid Manufacturing(RM). **Dr.Kanunakaran** cited examples of hot Iso-static Pressing, Investment casting, sand casting without pattern etc. for RM and said that unlike the layered manufacturing approach of RP, RM would require multi-faceted and hybrid approaches to meet the varied needs of material, quality, quantity, cost etc. Concluding his talk he said that RM exists for any situation of geometric and material complexity and gives greater design freedom. He then showed few objects made by Additive manufacturing in his lab to all the members. Details of his presentation are at Appendix 'D'.

Speaking on **"Prospective of Additive Manufacturing towards Fast Breeder Reactor Technology"Dr.P. Chellapandi, Director, Reactor Design Group IGCAR, Kalpakkam** said that there is tremendous development in the area of Additive manufacturing. Interestingly, the technology is not restricted to plastics& ceramics and uses even metals & stainless steel. Presently in the

country this technology is being used only in few places like IITB, CMTI Bangalore, GTRE, few SMEs and few other organizations. He opined that it is opportune time to initiate activities in this interesting field, as it will take some time to contribute significantly to manufacturing. He highlighted the areas where this technology can effectively be used in nuclear reactors, such as orifices, flow distributer within pump header, impeller, hard facing on grid plate, absorber rod driver mechanism, teflon coating on large diameter rotatable plugs on mating surface with seals, repair of defects of fuel pellets, radial & circumferential cracks etc. This technology is also very useful in In-service inspection & repair. He explained the characteristic features of components to be used in fast breeder reactor applications such as large sized components (upto 7m), austenitic stainless steels, operating temperatures (200-600^{0}C), longer life (40-60 yrs.), and high surface finish & practically defect free. He iteratedthat lot of big as well as small industries will get business opportunities if the additive manufacturing is brought in reactor technology. Details of his presentation are at Appendix 'E'.

During subsequent discussion, following points emerged:

-Dr.Selvamurthy shared that DRDO is already using this technology. Institutions such as GTRE, DEBEL, DRDL are using the technology & also have the 5-axis machine. He commented that in the civilian sector the technology is useful in biomedical- customized application for prosthesis, maxillary, dentures, bone replacement etc. He urged that there is need to sensitize the Indian industries making these implants and suggested that a workshop can be organised either by NMCC or FICCI, to sensitize the industry & engineering institutions such as CMTI can take a lead role in this.

-Dr. R. Chidambaram opined that high-end additive manufacturing is the technology for the future and said that an important feature of this technology is that it can be customized. He mentioned about the project in total knee prosthesis of Office of PSA and the model project in NKN on CollabDDS where additive manufacture can be applicable and requested Prof. Raghavan to elaborate on the latter model project.

-Prof. S.V. Raghavan explained that NKN model project CollabDDS is a CAD tool extended to digital diagnostics for medical application. Initially started with NIC, CSIO and AIIMS, then extended to other institutions such as IITB, ATREC to find out whether personalised prosthesis manufacturing is possible using this technology. Medical input in a personalised manner is targeted in this

project and when CollabDDS becomes a platform it will be a National asset in software area.

-Dr.Krishna Ella observed that additive manufacturing is a powerful tool for surgeries etc. and also extremely good for MSMES.

-Prof. S.V. Raghavan said that in future Additive manufacturing may become a centralised service such as computer service cloud computing. This will happen for economy of scale but design which is major manpower component may get decentralised. He cited the example of TVS which is carrying out additive manufacturing for its captive use.

The committee after deliberation recommended a brain storming meeting and then form a Group along with the industry to develop a India specific report and the demand needs to popularize the technology in civilian sector.

Dr. Chidambaram congratulated Dr. L.S. Rathore, DG, IMD for his excellent prediction of recent cyclone and invited him to present the details.

M27 A5 "Very severe Cyclonic Storm, Phailin (8-14th October, 2013)" by Dr.L.S.Rathore, DG Meteorology, IMD.

Dr.Rathore said that metrology is a multidisciplinary subject needing significant amount of observation, communication and analysis to accurately predict. The cyclone Phailin is one such example of collective strength of Indian metrology. He informed that till 2008 IMD was able to predict only up to 24 hrs., but from 2012 it started to predict 5 days in advance. Cyclonic storm PHAILIN was the most intense cyclone that crossed Indian coasts after Odisha Super Cyclone on 29th October, 1999.

Cyclone Phailincrossed land near Gopalpur with winds of 200-210 Km/h.estimated central pressure was 940 hPa, with a pressure drop of 66 hPa at the centre. **Dr.Rathore** stated that from 10th to 11th October morning rapid drop in pressure & increase in wind speeds were observed though the observations. US, Japan & Europe were giving different predictions for intensity. However, IMD stuck to its data & prediction assessment. Both track& intensity forecast was predicted correctly. The forecast for surge, gate wind & rainfall was also very good. He said that correct prediction of Phailin is not an isolated case of success but other cyclonessuch as Laila in AP (2010), Thane, (2011) &Nilam (2012) were also correctly predicted. Significant improvement has taken place in track forecast error,track forecast skill, mean landfall point forecast error etc.

This has been achieved through improvement in observational network, satellite images, fast communication, superior computational capabilities, skilled human resources, excellent support & other ministerial collaboration and R&D.

He explained the four stage cyclone warning system for various stake holders before the cyclone and alerted all the nearby states about rainfall forecast so that they could be better prepared to handle the situation. He said that better linkages with Disaster management Authorities, national collaboration with depts. such as MoES, IITM, ISRO, IAF, Indian Navy, IISc, IITD etc. helped in better management and communication during the cyclone. Details of his presentation are at Appendix 'F'.

Presenting **"Flood Early warning systems - with special reference to Phailin"Dr.Kapil Gupta, IIT Bombay** said that since 2005 Mumbai floods, he had been monitoring & analysing cloud systems as detailed data is difficult to access in real time. He had been involved in analysing rate of cloud movement & cloud temperature from weather animation sites & used to estimate the heavy rainfall threat in cities. **Dr. Gupta**informed that on their suggestion, Mumbai Municipal Corporation has installed 60 automatic weather stations, coupled with the ultrasonic flow (level) gauge on Mithi River at Powai for forecasting the flood levels. He shared that presently he is working on an international collaborative project on flood resilience in various cities of Europe & Asia. Also monitoring & analysing weather systems in both Europe & Asia in real time.

He explained that Cyclone Phailin was first predicted by his group on 6th October, 2013 based on the weather data and was then subsequently informed to the concerned authorities. He then discussed & elaborated on the movements and track of cyclone. Details of his presentation are at Appendix 'G'.

During the discussions **Dr.P.Ghosh** observed that development of these capabilities on climate is very important because of the intensification of climate change.

-Dr.R. Chidambaram expressing his interest in Urban Science mentioned about the talk by Director of Argon Labs in the IISc Alumnus Global meet in Chicago and talk of Prof. Anurag Kumar, IISc on planning of various things during urban flooding.

-**Dr.Kapil Gupta** mentioned that with early warning systems, impact of extreme events can be minimized in Urban Areas. Since the time of response is

extremely small during urban flooding,an early warning will help municipals to take decisions and evacuate people, where necessary.

After lot of discussions the SAC-C recommended to hold a brainstorming on the Challenges & Issues on Urban Science.

Dr. Chidambaram then invited Dr.DipankarChatterjeeto share the excellent work ofDr. R. Srinivasan on experiments of physics for students.

Dr.DipankarChatterjee stated that the work by Dr. R. Srinivasan is not a big science but extremely important for manpower development. The course is sponsored by Indian Academy of Sciences, Bangalore from 2001. Academy invited Dr.Srinivasan to develop a Refreshers Course in Experimental Physics to train teachers to introduce good experiments. Dr.Srinivasan developed a kit with analogue electronic circuits and mechanical items having 38 experiments. It was commercialized in 2008 and a company in Bangalore is manufacturing the kit.The cost of the kit is about Rs.72,000/- . At Indian Academy of Science at Jalahalli a laboratory is built and about 4 courses are conducted. 46 Refreshers courses have been conducted throughout the country using this kit. UGC was approached for wider publicity through Academic Staff College but couldn't get positive response. He said that the though academy and DST is supporting the course but needs SAC-C support to make it a country wide teachers programme.

Dr.Pritibha Jolly appreciated the work by Dr.Srinivasan and said that along with active learning,minds on learning are also important. It's important to integrate these experiments in pedagogic framework of research driven education. She then shared her work on capacity building workshops for school teachers and agreed that lateral spread is difficult. She mentioned the workshop on active learning, FRIZBAY for strengthening active learning using hands on and locally produced items with a strong pedagogic content. She also elaborated few other projects on enhancing learning in the laboratory. She reiterated that kits will be only used for demonstrations, but its impact on meaningful learning should be studied.She said that through INSPIRE camps 18 very innovative workshops were developed but dissemination and scale up is a problem. She also said that educating the educators is important.

Dr. S K Joshi praised the work by Dr.Srinivasan, Dr. Jolly and earlier by Dr. B L Saraf but said that unless one follows it up with some concerted effort, all these will fizzle out. Organizations such as CBSE and NCERT and other

educational boards can propagate this effort. Teachers training institutes can also take a lead role and some part of it should be embedded in INSPIRE.

Dr.Satyamurthyobserved that it's a continuous process; sustainability has to be built in. It is important to involve the industry to facilitate the process and take it forward.

SAC-C after deliberations decided that Dr.DipankarChatterjee and Dr.Pritbha Jolly may take lead and invite 5-6 experts in the area and develop a future course of action on how to propagate this effort.

Concluding the meeting**Dr. R. Chidambaram** said that when perceived benefit is marginal, scaling of innovation becomes difficult. He said that in rural developmentinstead of technology transfer concept transfer & re-innovation is more important.

The meeting ended with a vote of thanks to the chair.

Annexure II

LIST OF PARTICIPANTS

1.	Dr. R. Chidambaram	Chairman
2.	Dr. R.A. Badwe	Member
3.	Dr. Dinesh Singh	Member
4.	Dr. B. K. Gairola	Member
5.	Prof. S.K. Joshi	Member
6.	Dr. Krishna M. Ella	Member
7.	Dr.Pratibha Jolly	Member
8.	Dr.ProdiptoGhosh	Member
9.	Dr. M.S. Raghunathan	Member
10.	Dr. N. Sathyamurthy	Member
11.	Dr. W. Selvamurthy	Member
12.	Dr. S.K. Sikka	Member
13.	Dr. J.S. Yadav	Member
14.	Dr.DipankarChatterji	Member
15.	Shri H. Devaraj	Representative, UGC
16.	Dr.Avinash Pant	Member
17.	Shri M.P. Singh	Representative, MSME
18.	Dr. T. Ramasami	Member
19.	Prof. S.V. Raghavan	Member Secretary
20.	Prof. Dipankar Bhattacharya	Speaker
21.	Prof. Partha P. Majumder	Speaker
22.	Dr. S. Ganesan	Speaker
23.	Dr. L.S. Rathore	Speaker
24.	Prof. Kapil Gupta	Speaker
25.	Dr. K.P. Karunakaran	Speaker
26.	Dr. P. Chellapandi	Speaker
27.	Prof. ParamjitKhurana	Invitee
28.	Shri S.S. Mahlawat	Invitee
29.	Dr. D. YogeswaraRao	Invitee
30.	ShriNeerajSinha	Invitee
31.	Dr.KetakiBapat	Invitee
32.	Dr.Manju Gerard	Invitee