DEPARTMENT OF EDUCATION IN SCIENCE AND MATHEMATICS
राष्ट्रीय शैक्षिक अनुसंधान और प्रशिक्षण परिषद्
NATIONAL COUNCIL OF EDUCATIONAL RESEARCH AND TRAINING

EXHIBIT COMPETITION

in

Mathematics of Planet Earth – 2013

DEADLINE FOR SUBMISSION

10 JULY 2013

NCERT

NATIONAL COUNCIL OF EDUCATIONAL RESEARCH AND TRAINING
New Delhi

Prizes

Selected exhibits will be invited for display and presentation in a national level ceremony on 1 September 2013 in NCERT, New Delhi and a National Award will be given by NCERT.

How to Participate

Anyone may develop a virtual or physical exhibit on any of the given topics/themes. Supporting documents like complete write up, clear audio-video presentation, poster or graphic presentation, etc. along with filled-in registration form (annexure) should be submitted in digital form latest by 10 July 2013 to:

Head
Department of Education in Science and Mathematics
National Council of Educational Research and Training
Sri Aurobindo Marg
New Delhi-110016

For electronic submission or further discussions/queries please contact on e-mail id:

mpe.ncert@gmail.com

Contact Address

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Exhibit Competition
Mathematics of Planet Earth–2013

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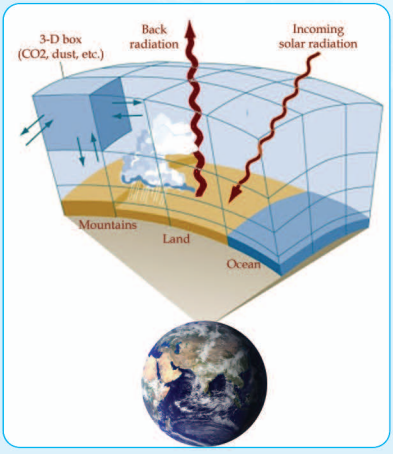
About the Theme

The fascinating world of mathematics provides us an unlimited scope to perceive problems under three situations — concrete, abstract and intuition. The important segment of mathematics — the ability to reason and think clearly — is extremely useful in every aspect of life. It deals with data, measurement, observations from science, mathematical models of natural phenomenon including human behaviour and social system. Mathematics offers a distinctive mode of thought which is versatile and powerful, including mathematical modelling, optimisation, logical analysis, inference from data and use of symbols. Experiences with mathematical modes of thought build mathematical power — a capacity of mind of increased value in this technological age that enables one to read critically, to identify fallacies, to detect biases, to assess risk and to suggest alternatives. From medical technology to economic planning, from genetics to geology, mathematics has made an indelible imprint on every part of modern science, even as science itself has stimulated the growth of many branches of mathematics. Therefore, mathematics is a powerful way of investigating and understanding the world.



With this motive, the international mathematical community mooted the idea of Mathematics of Planet Earth (MPE) – 2013. More than a hundred scientific societies,

universities, research institutes and organisations all over the world have come together to dedicate 2013 as the 'Year of Mathematics of Planet Earth'. During this year an attempt will be made to explore the mathematical framework in nature and to see how mathematics with the help of other disciplines can provide solutions that will help to face the challenging problems on the planet earth, like the problem arising out of growing population competing for the limited global resources, the dramatic meteorological changes in climate, environmental issues, etc. In this connection intensive researches are going on. The ideas generated and the initiatives thought during MPE–2013 are likely to make an impact on the society in such a way that a new generation of researchers will be motivated to explore mathematics involved in scientific problems related to sustainability of planet earth. These efforts may provide opportunities for exploring mathematics with interdisciplinary approaches in the context of evolution of planet earth and its development (historical, geographical, political, astronomical, environmental, etc.).

MPE–2013 intends through brainstorming to create awareness among the teachers, teacher educators, researchers and students about looking for mathematics in all the situations on the planet earth. It includes the challenges faced in different spheres of life on planet earth. In addition to the scientific component, the outreach component of MPE–2013 illustrates the role of mathematical sciences in tackling the world's challenging problems for the public in general and for the schools in particular. It may motivate children in schools by providing stimulating answers to challenging problems faced by the society involving the crucial role of mathematics. It may also motivate the community to appreciate and join interdisciplinary courses in future.

The National Council of Educational Research and Training (NCERT), New Delhi is organising various activities including an **Exhibit Competition** on the occasion of Mathematics of Planet Earth–2013.

The main objectives of the exhibit competition are:

1. To create awareness about association of mathematics with various changes and challenges being faced on planet earth.

2. To popularise interdisciplinary approach of teaching-learning of mathematics in the context of evolution of planet earth, its development (historical, geographical, political, astronomical, environmental, etc.)
3. To sensitise teacher/teacher educators regarding the use of mathematics in identifying and predicting various aspects of environment and physical features of planet earth.
4. To encourage the problem-solving approach in various aspects of planet earth.
5. To develop creative thinking, habit of exploration and manipulative skills through their self-devised exhibit in teacher/teacher educations, etc.
6. To create awareness about how mathematics can be used to solve the problems arising out of limited natural resources and their economical use.

In order to facilitate the preparation of exhibits/models for participating in **Exhibit Competition,** the following topics along with themes/subthemes have been suggested. However, apart from these, to prepare an exhibit participants may select, on their own, any topic or theme that has relevance to Mathematics of Planet Earth.

With mathematical endeavour, the topics for Mathematics of Planet Earth (MPE)–2013 have been broadly classified into four themes, which are as follows:

1. **The Planet to Discover:** oceans, meteorology and climate, natural resources, solar systems, etc.
2. **The Planet Supporting Life:** ecology, biodiversity, evolution, environment.
3. **The Planet Organised by Human beings:** social, political and economic systems; organisation of transport and communication networks; management of resources, energy.
4. **The Planet at Risk:** climate change, sustainable development, epidemics, invasive species, natural disasters.

With the focus on mathematical framework involved in the above themes/subthemes, the following topics have been suggested for the development of a virtual or physical exhibit for the participation in **Exhibit Competition**.

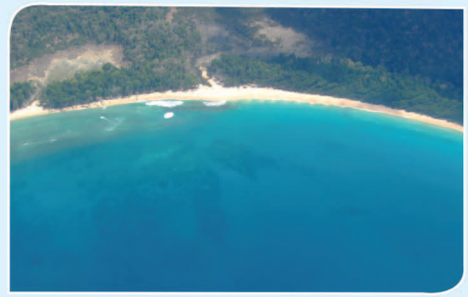
1. Climate Change
2. Natural Resources
3. Human Resources

The exhibits may explain "the concept involved" with mathematical emphasis in the following or may discuss various issues/difficulties mentioned below. The emphasis should be mathematical for the presentations.

1. Climate Change

Climate change refers to any significant change in measures of climate (such as temperature, precipitation or wind) lasting for decades or even longer. These changes may result from change in earth's orbit around the sun, change in intensity of sun rays, change in ocean circulation, and various human activities (like excessive burning of fossil fuels, deforestation, urbanisation, desertification, etc.) that change the atmospheric composition.

Climate is always changing, but scientists are concerned that global warming caused by human activities has overtaken natural fluctuations in climate and that this is having serious consequences for people and the planet earth. It can upset the delicate ecological balance of the earth and its living organisms. Data of tree growth, tropical air temperature and carbon dioxide emission collected over many years indicate that a warming climate may cause the tropical forests to give off more carbon dioxide than they take up. Climate change affects all — plants, people and animals. Human health can be affected directly or indirectly by climate change, through extreme periods of heat and cold, storm and smog episodes and climate sensitive diseases such as malaria, yellow fever and dengue. Melting of glaciers, sea level rise, exposure to climate, disasters due to erratic weather patterns, food insecurity, water stress, declining health, collapsing ecosystem are various other



consequences of climate change. Many species are on the verge of becoming extinct. Loss of key predators or key species may affect the life cycle of other organisms in the food chain. Even small change in climate may cause fundamental disruptions in habitat.

Keeping mathematical framework in prime focus, the exhibits/models in this sub-theme may pertain to:

- What is climate change? Studies of impact of climate change;
- study on how scientists discover the patterns for change in climate;
- study on the parameters which are constantly changing resulting on climate change;
- predicting climate change through patterns;
- effect of climate change on carbon cycle and water cycle;
- estimating one's carbon footprint on the globe;
- data emphasising conditions of drought, flood, famine and effective measures required to combat them;
- study and measure to control air/water pollution/various methods of air/ water purification/ effect of pollution on living beings;
- study on adoption of living beings to increased temperature for their survival;
- emphasising geometry/reasoning in designs and development of automatic weather-recording devices;
- emphasising ratios, proportions and percentages, etc. of different components in making/use of ecofriendly and innovative devices that may help in combating climate change;
- estimation of greenhouse gases emission of your area and ways to mitigate their impact on the climate;
- emphasising geometry/reasoning in innovative designs/methods of waste water recycling/

reclamation/using recycled water in industries/ homes;

- study on ground water recharging using water of impaired quality;
- emphasising geometry/reasoning in innovative technologies/designs of sanitation/hygiene related issues, for enhancing efficiencies of existing lighting system/automobiles/machines/stoves/chulhas, environmental friendly electricity generation, devices for the assessment of wind energy/ solar insulation;
- study on innovative methods to reduce ozone pollution;
- genetics and disease-using mathematical models to eradicate disease;
- mathematical modelling and computer simulation of climate dynamics/prediction of weather phenomena based on a number of predictions; and
- mathematical modelling to show spread of forest fire depending on the types of tree, weather and nature of the ground surface, etc.

2. Natural Resources

The natural resources of earth are finite. It means that if we use them continuously we will eventually exhaust them. Conversation of natural resources preserves the ecological diversity and our life supporting systems — water, air and soil.

Deforestation, overgrazing, indiscriminate mining and faulty tillage practices have led to serve soil erosion. Over irrigation and over harvesting of agricultural lands have resulted into salinity of soil, water logging and land degradation. Overuse of tube-wells has substantially lowered down the underground water table. Industrial effluents, forest fire and unplanned growth have led to severe water and air pollution.

Air, water, man, animals, plants and plankton, soil and

bacteria are all invisibly inter-linked in a life sustaining system of the earth.

In design and development of innovative new and economically viable technologies to harness and conserve natural resources, we can emphasis on geometrical structure and the reasoning behind that.

Keeping mathematical framework in prime focus, the exhibits/models in this sub-theme may pertain to:

- study on evolution of earth – how old is earth;
- predicting about various physical features of earth and changes in them;
- study on data regarding usage of natural resources;
- study on prediction of depletion of natural resources;
- study on how mathematicians help in planning sustainable use of natural resources;
- study on solar noon, solar day, mean solar time or equation of time;
- chaos in solar system — transient behaviour pattern of the sun
- mathematical emphasis on plans for proper management of natural resources and monitoring of the changes in wildlife population caused by human encroachment;
- ecological studies of plants and animals;
- emphasising mathematical reasoning in schemes/ designs to help reduce production cost and conservation of various raw materials;
- sustainable land use practices/ecologically sustainable farming methods;
- emphasising geometry/reasoning in devices/methods that control air/ water/land pollution;
- mathematical study on impact of pollution on living and non-living;
- mathematical emphasis on preservation/ conservation/ management of soil/ water;

- factors necessary for soil formation;
- analysis of soil samples for their components;
- study on various ways of harnessing geothermal energy such as energy from hot springs/geothermal desalinisation/geothermal heating — controlling heating and cooling of a building using underground heat by vertical/horizontal loops/geothermal power/electricity generated from naturally occurring geological heat sources;
- emphasising geometry/reasoning in models of green building/environment building which harvest energy, water and materials;
- study on green roof technologies/ roof mounted solar technologies such as solar water heater, solar lighting system;
- emphasising geometry/mathematical reasoning in solar cooker/solar distiller/solar dryer for food processing/solar heated houses, solar thermal electricity/community solar project, innovative designs and installation of solar tower, model of wind turbine with vertical/horizontal axis, wind mill/water mill for grinding grains/drawing water from the well and to generate electricity, water sensitive urban design to mitigate water shortage, use of tidal waves/ ocean currents/salinity gradient for generating electricity, renovation of ponds, tanks and reservoirs, waste water treatment and recycling, development of low cost technology for producing potable water, model of canals to minimise losses by water seepage, cost effective heating and cooling system, models to control loss of natural resources due to disasters, etc., wave energy from oscillating water conversion/tidal barrage generator;
- mathematical emphasis on production of electrical energy from mechanical energy/nuclear resources;
- emphasising geometry/mathematical reasoning in mechanism of extraction, storage and processing of fossil fuels;
- study of air tides.

3. Human Resources

The scientific and technological information available today has revolutionised worldwide means of communication, which plays a key role in the growth and development in all walks of life.

Keeping mathe-matical framework in prime focus, the exhibits/models in this sub-theme may pertain to:

- emphasising geometry/ mathematical reasoning in improvised/ indigenous models for efficient transport and fast communication;
- study on how GPS work;
- mathematical emphasis on innovative ideas for efficient management of road, rail, water and air transport systems;
- mathematical emphasis on preparedness for disaster both natural and man-made management;
- emphasising geometry/reasoning in developing innovative designs/models of multimedia equipments/materials;
- technologies in forecasting and warning of cyclones, floods and storms;
- emphasising geometry/reasoning in improvised/ improved devices for effective transport and communication between various emergency services, namely, medical, police, military and other administrative bodies/committees;
- mathematical emphasis on information management from ships and ocean buoys — use of radars in cyclone detection/information management and early warning system for flash floods;
- mathematical emphasis on working and use of

geostationary satellites in providing information pertaining to meteorological processes, etc;

- emphasising mathematical framework while demonstrating the principle and functioning of modern devices of communication;
- study the Stanley Miller experiment "The Origin of Life";
- mathematical emphasis on working and use of internet and communication in various perspective;
- mathematical exploration in health care and health related issues;
- study of new scientific, technological aids in bio-medical area with mathematical emphasis;
- highlighting data in demonstration of means and ways to adopt methods for self concentration and meditation; known facts and research findings in different medical systems like Indian, modern, homoeopath, etc., lifestyle and relationship with good and bad health based on known facts and researches, the role of traditional knowledge of herbal products for community health, etc;
- mathematical modelling and computer simulation of climate dynamics/production of weather phenomena based on a number of predictors;
- mathematical modelling in physical geography such as rotation and revolution of earth, precession and equinoes, etc.;
- mathematical modelling to predict orbital path of comets, meteor and other minor planets;
- mathematical modelling to show how disease might spread in human beings in the event of epidemics/ bioterrorism;

- mathematical modelling to predict the devastating effects of wars/nuclear explosions;
- mathematical modelling to show spread of forest fire depending on the types of trees, weather and nature of the ground surface;
- mathematical modelling to demonstrate the action of medicines in human system;

- mathematical modelling of the working of heart, brain, lungs, kidney, bones and endocrine system;
- mathematical modelling of fluid flow in drain, spillways, rivers, etc.;

- mathematical modelling to describe traffic flow/stock market options;
- mathematical modelling for increasing production of crops;
- mathematical modelling on social insects such as honeybees, termites, etc. to know how they use local information to generate complex and functional patterns of communication;
- mathematical modelling of maximum speed in fibre optic links, highly abstract problems arising from control and communication processes in the brain, urban city planning;
- mathematical modelling for predicting future population and knowing impact of population;

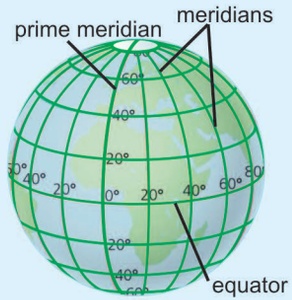
- mathematical modelling for increasing production of crops, etc.;
- application of semi-elliptic springs and elliptic shaped gears in engineering and industry;
- applications of linear programming in solving problems pertaining to manufacturing of goods/transport/diet issues;
- study of rotational symmetry in plants and animals/role of repeated symmetrical patterns in making fabric designs, wallpapers, etc,;
- applications of mathematics in decorating home;
- use of triangles/making geometrical designs on a table cover;
- using mathematics in cooking and nutrition/estimating number of calories and quantity of nutrients in a sample portion of various food items;
- estimating quantity of seeds needed for a crop/estimating crop yields in a particular field without cutting or weighing/estimating/calculating length of wire needed to fence a field/estimating life span of an electric bulb/estimating the volume of blood inside the body of a person/estimating amount of water needed to fill a swimming pool;
- helping to decide/determine premium on insurance policies/to make important decisions in business;
- finding instantaneous velocity of a piston in a cylinder of an automobile engine, etc.

As example, couple of concepts have been given below. A virtual or physical exhibit on these concepts may be designed in such a format that demonstrates various aspects of the concept with complete write up and presentation.

1. The Equation of Time

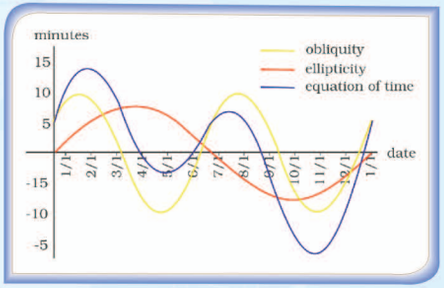
We know that earth revolves around the sun and also rotates on its own axis. It causes day and night effect as well as days, months and years.

A **meridian** (or **line of longitude**) is the half of an imaginary great circle on the earth's surface terminated by



the North Pole and the South Pole, connecting points of equal longitude. The position of a point along the meridian is given by its latitude. Each meridian is perpendicular to all circles of latitude.

The solar noon is defined as the time of the highest position of the sun in the sky and occurs when the sun crosses the meridian at a given position. The mean length of the day is 24 hours. It is a little less than the period of rotation of the earth around its axis, since the earth makes 366 rotations around its axis during an year of 365 days. The length of the solar day is the time between two consecutive solar noons.



An **equinox** occurs twice a year (around 20 March and 22 September), when the tilt of the earth's axis is inclined neither away from nor towards the sun, the centre of the sun being in the same plane as the Earth's. Another meaning of **equinox** is the date at which day and night are of equal length. The equinox that occurs in the spring is the spring equinox. If the axis of the Earth were vertical and the orbit of the earth around the sun circular, the mean length of the day would be the time between two consecutive solar noons. For Greenwich's meridian, the official noon is defined as the solar noon at the spring equinox. A period of 24 hours from this solar noon is the day of the year. The solar noon oscillates during a year: it is only equal to the official noon four days a year. The difference between the solar time and the official time, called mean solar time is called the equation of time. Since the solar noon oscillates, the equation of time also oscillates. The amplitude of the oscillation of equation of time (approximately 30 minutes) can be explained by two phenomena. The first one can be explained through the fact that the earth's axis is oblique. If the orbit of the earth around the sun would be circular, the

official noon would correspond to the solar noon at the equinoxes and at the solstices. The official noon would be after the solar noon in fall and spring and before the solar noon in summer and winter. The second phenomenon is that the orbit of the earth around the sun is an ellipse and not a circle. When the earth is closer to the sun (this is during the winter of the Northern hemisphere), it has a higher angular velocity around the sun, yielding longer solar days.

2. How Old is the Earth?

The first serious attempts to compute the age of the earth were done by Lord Kelvin around 1840. Kelvin used Fourier's law of heat, with the gradient of temperature measured empirically, and some very strong hypotheses simplifying the problem: there are no external sources of heat, and the planet is rigid and homogeneous. He gave an interval of 24 to 400 million years. It is now known that the age of the earth is 4.5 billion years. Already at the time of Kelvin, his estimate was in contradiction with the observations of the geologists, and it was incompatible with the new theory of evolution of Darwin, which required a much older planet. It was Kelvin's assistant, John Perry, who pointed out that the gradient of temperature was too large for Kelvin's hypothesis of homogeneity, and that this gradient could be explained by convection movements inside a fluid under a thin outer solid mantle: these convection movements would slow down considerably the cooling of the mantle, and allow the age of the earth to be over 2 billion years. Radioactivity, a source of heat, was soon after discovered, showing that energy could not be assumed to be constant. John Perry was visionary at his time: he was arguing that the mantle of the earth is solid on short time scales, and fluid over longer time scales. But the idea of the continental drift met strong skepticism among the scientific community including the geologists, and it is only in the 1960s that it finally prevailed. (Reference: Kelvin, Perry and the Age of the Earth, P.C. England, P. Molnar and F.M. Richter, *American Scientist*, Volume 95, 2007)*.

You may also refer to the NCERT books, Exemplar Problems in Mathematics, Class VII and Exemplar Problems in Mathematics, Class VIII, to access several mathematical problems concerning interdisciplinary scenario.

**Source :* www.mpe.org

Annexure

Mathematics of Planet Earth–2013

Registration Proforma for Exhibit Competition
Information about the Exhibit/Model

1. Title of the Exhibit/Model (in block letters) _____
2. Name(s) of the Participant(s) _____(M/F) Ph._____
   _____(M/F) Ph._____
   Email: _____
3. Name and complete address of the organisation (in block letters):.....
   .....
   .....Pin .....
   Phone.....Email: .....
4. Type of Organisation G/LB/PA/PU
   Any other (Please Specify)
5. Location of the Organisation Tribal/Rural/Urban
6. Nature of the Exhibit/Model Innovative/Improvised
   Apparatus/Working/
   Static Model/Study Report
   Any other (Please Specify)
7. Requirement for Display
   (i) Shamiana/Open Space/Dark room_____
   (ii) Table Size Length: _____m; width:____m.
   (iii) Water Supply Yes/No
   (iv) Number of Electrical Points No.: _____(5 A); No.:_____(15 A)
   (v) Any other _____

G. Government: A Government School is that which is run by the State Government or Central Government or Public Sector Undertaking or an Autonomous Organisation completely financed by the Government;

L.B. Local Body: A Local Body School is that which is run by Panchayati Raj and Local Body Institutions such as Zila Parishad, Municipal Corporatoin, Muncipal Committee or Cantonment Board;

P.A. Private Aided: A Private Aided School is that which is run by an individual or a private organisation and receives grants from the Government or Local Body;

P.U. Private Unaided: Private Unaided School is that which is managed by an individual or a private organisation and does not receive and grant from the Government or Local Body.

8. Source of inspiration/help for preparing the exhibit/model. (Please explain briefly about the nature and form of help received from the following):

(i) From Teachers/School

_____

(i) From Parents

_____

(iii) From Peer Group

_____

(iv) Any other

_____

9. Brief Summary (Please explain the purpose and the scientific principle involved)

_____

_____

10. Write-up of the Exhibit/Model (not more than 2,500 words) in the following format. (*Note:* Proper submission of the write-up should be ensured.)

I. Introduction

(i) Rationale behind construction of the exhibit; and

(ii) The scientific principle involved.

II. Description

(i) Materials used for the construction;

(ii) Construction and working of the exhibit/model; and

(iii) Application, if any.

III. References

Books, Journals or magazines referred for preparation of the exhibit/model.

IV. Annexures

(i) Virtual demonstration/graphics/diagram of the model illustrating the working of the exhibit.

(ii) Close-up photographs of the exhibit.

Note: Enclose the photographs of the exhibits in a separate folder. Description of the photograph may also be written.

(Signatures of Participants)