Government of India
Bhabha Atomic Research Centre
Human Resource Development Division
Training School Complex, Anushaktinagar, Mumbai-400 094

TECHNOLOGIES FOR NEW INDIA@75
आज़ादी का अमृत महोत्सव

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Ref. No: HRDD/DMG/QUEST/2022/

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**Sub:** Nominations for Advanced course of Divisional staff under QUEST-Continuing Education Programme for Engineering graduate/ Science Postgraduate Employees of DAE units and HBNI Students

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Human Resource Development Division (HRDD), BARC proposes to offer 5 Advanced courses for Engineering graduate/ Science Postgraduate Employee of DAE units and HBNI Students under QUEST-Continuing Education Programme beginning from 15th February, 2022 in BARC Training School, Anushakti Nagar. The list of 5 courses to be offered and the associated prerequisites as applicable to respective courses are given in the attached table. A brief summary of the programme is given below.

## QUEST-Continuing Education Programme of HBNI: **Details** of 14th Set of Courses

**HRD Division invites applications from employees of DAE units and from HBNI students for 5 Advanced Courses details of which are given on the next page:**

- Each course will comprise about 32 lectures of 1.5 hours (1 hour and 30 minutes) or 45 lectures of 1 hour duration. There will be 2 lectures per week for each course. The lectures will be held at BARC Training School, Anushaktinagar and during **nonoffice/office hours through online mode**. The exact timetable and schedule of course(s) to be offered will be notified later based on the nomination response received for the same.

- A total of 100 marks per course are assigned with breakup of 40 marks (maximum) for periodic tests and assignment and 60 marks (minimum) for written examination to be conducted at the end of the course.

- The nominations received will be scrutinized by the respective course coordinators and the final list of accepted candidates will be put up on BTS with information to the concerned Divisions. **Details of the topics to be covered under each course are put up on the BTS>HRDD> Academics >CEP>QUEST.**

- **The QUEST programme details can also be accessed through *hrdd.hbni.ac.in***

- These advanced **courses are offered to the DAE employees** subject to approval from competent authority (Head of Division or equivalent within BARC & other DAE units). Students pursuing M.Tech/ M.Sc. (Engg)/ Ph.D. programmes of HBNI may forward their applications through their respective guides.

- **For other units of DAE the details of QUEST programme and the Nomination form can be found at BARC website**
  http://www.barc.gov.in/careers/training.html

- It is mandatory that the interested employees/ HBNI students enrolled for the courses have a minimum of 80% attendance in the QUEST classes to be eligible to appear in the final written examination. Kindly note that certificates will be issued only to those who appear in the written examination and score an aggregate of 50% or more in home/classroom assignments & written examinations taken together.

Kindly note that an employee can only register for **a maximum of 2 courses** being conducted concurrently. He/ she needs to submit information pertaining to (i) field of research, and (ii) objective of pursuing the course(s) in the application form.

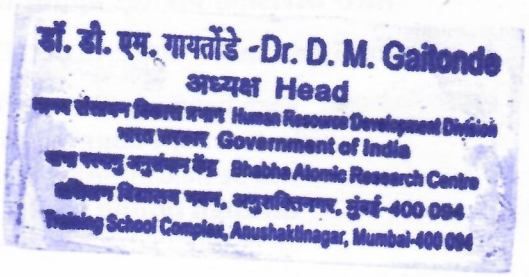
Interested eligible employees of DAE and HBNI students meeting the specified eligibility criteria/ prerequisites, wherever applicable, may forward their applications/ nominations through their Division Head or equivalent competent authority as the case may be, to **Smt. Neelima Prasad, HRDD (email ID: nprasad@barc.gov.in) latest by 31st January, 2022 to ensure programme implementation as envisaged above.**

**Kindly note that a course will be offered subject to the receipt of a minimum number of applications in the same and decision of the coordinator/ Faculty concerned will be final in this regard.**

Thanking you all for continued cooperation.

D. M. Gaitonde

(D. M. Gaitonde)




Encl. 1. List of Advance Courses and their syllabi
2. Application-cum- Nomination form

To
Head of Divisions and Independent Section Head
All Units Heads of DAE

**Cc: Group Directors, BARC : For Kind information**
**Associate Group Directors, BARC : ---------Do----------**
**Dean, HBNI : ---------Do----------**

**QUEST- Continuing Education Programme of HBNI**

**Details of Proposed 14th Set of Courses**

| S. No. | Course Title | Eligibility | Faculty/ Associate faculty |
|---|---|---|---|
| 1 | **State-space approach to Reactor Control** | *Control theory fundamentals & state space approach, Engineering Mathematics, Reactor Instrumentation.* | **Faculty:**<br>Dr. A.P.Tiwari/OS Dir KMG<br>**Associate Faculty**:<br>Dr. S.R. Shimjith, SO(G)/Head RSAS, RCnD |
| 2 | **Signal Conditioning & Recovery** | Engineering graduates (Electrical/Electronics/Chemical/ Instrumentation) | **Faculty:**<br>Dr. S. Mukhopadhyay<br>OS/ Head, SD |
| 3 | **Advanced Concepts in Finite Element Method** | Graduates in Engineering and PG in Science<br>Basic knowledge of Finite Element Method<br>BARC training school course on 'Solid Mechanics' or equivalent course<br>Familiarization with Applied Mathematical Concepts, such as 'Linear Algebra' 'Calculus' and 'Differential Equations' | **Faculty:**<br>Dr. M.K. Samal, SO/H, RSD |
| 4 | **Advance Fluidization Engineering** | B. E /B. Tech/M. Tech in Chemical, Mechanical and Engineering and Metallurgy/Material Science<br>M.Sc. in Physics and Chemistry | **Faculty:**<br>Dr. D. Mandal/Head, AMMD |
| 5 | **Catalysis and Surface Engineering Chemistry** | B. E /B. Tech/M. Tech in Chemical, Mechanical and Engineering and Metallurgy/Material Science<br>M.Sc. in Physics and Chemistry | **Proposed Coordinator** Prof. D. Mandal, Head, AMMD,<br>**Associate Faculties:**<br>Prof. Vincent Tessy, SO/H, PSDD<br>Prof. S. K. Satpati, SO/H, UED<br>Dr. S. Manna, SO/G, UED<br>Dr. Salil Varma,SO/G, ChD,<br>Shri Sandeep K C, SO/F, HWD |

## List of the Proposed Courses

### 1. State-space approach to Reactor Control:

### (Course coordinator: Dr. A.P. Tiwari, BARC)

| Pre-requisites: | Faculty: |
|---|---|
| *Control theory fundamentals & state space approach, Engineering Mathematics, Reactor Instrumentation.* | Dr. A.P. Tiwari, OS/ Dir KMG<br>**Associate Faculty:**<br>Dr. S.R. Shimjith, SO(G)/Head RSAS, RCnD |

**Introduction & Preliminary Concepts:** Components of a nuclear reactor, Neutron balance, Reactivity Control, Neutron Reaction Cross-sections, Fission rate & power, Prompt and Delayed neutrons, Neutron life time.

**Mathematical Modeling of Nuclear Reactors:** Neutron diffusion equation, Derivation of Point kinetics model for zero power operation, Linearization & representation into standard state space form, Controllability, Observability and stability properties, Step response of Nonlinear and linearized forms of Point kinetics model, Log rate and Reactor period.

**Internal Reactivity Feedback Effects:** Moderator, Coolant and Fuel Temperature dependent reactivity feedbacks, void/density dependent reactivity feedbacks, Fission product poisoning, xenon dependent reactivity feedbacks, Modeling of Internal Reactivity Feedback effects, Effect of Internal feedbacks on stability.

**Mathematical modeling of Large Reactors:** Limitations of point kinetics model, Space-time kinetics modeling principles, derivation of modal and nodal models, linearization and representation into standard form, incorporating internal feedback effects into space-time kinetics model, Controllability, observability and stability properties.

**Signals for Reactor Control:** Start-up, intermediate and power range instrumentation, Excore signals, Incore signals, Thermal power, Need and schemes for correction of neutronics signals with thermal signals.

**Reactor Control Design:** Control of total power and power distribution, Significance of feedback of total power, Log rate and linear rate, Design of State feedback control and observer.

**Mathematical Modeling of Plant:** Modeling of SG/SD level and pressure variations, Turbine and Condenser, Feed Control valves.

**Plant Control:** Power plant programming - constant Tav program, constant pressure program, Level and pressure control, Bleed condenser pressure and level control, Pressurizer pressure and level control.

## 2. Signal Conditioning & Recovery:

## (Course coordinator: Dr. S. Mukhopadhyay, BARC)

| ***Pre-requisites:*** | **Faculty:** |
|---|---|
| Engineering graduates (Electrical/Electronics/ Chemical/ Instrumentation) | Dr. S. Mukhopadhyay<br>OS/ Head, Seismology Division |

Conditioning raw signals from transducers, signal extraction from a common mode reference, Error budget in Signal Conditioning circuits, Recovery of Signal buried in Noise, Phase Lock Loops, Lock-in Amplifiers, Noise Equivalent circuits, Advances in A/D and D/A technology, Sigma-Delta converters, Analysis of quantization errors, Application of decimation and interpolation to A/D and D/A conversion, over-sampling, design of digital anti-aliasing filters, fast algorithms for implementation, Function space, orthogonal basis functions, Limitation of Shanon's theorem, Reconciliation by approximation in shift invariant space, generalized basis functions, analysis and reconstruction with B-spline basis, wavelet basis, bi-orthogonal wavelet (dual) basis, consistent estimate (sampling), Interpolating wavelets, perfect reconstruction with wavelets, over-sampling, multi-scale characterization from extreme as in wavelet domain.

## 3. Advanced Concepts in Finite Element Method

## (Course coordinator: Dr. M.K. Samal, BARC

| ***Prerequisites:*** | **Faculty:** |
|---|---|
| Graduates in Engineering and PG in Science<br>Basic knowledge of Finite Element Method<br>BARC training school course on 'Solid Mechanics' or equivalent course<br>Familiarization with Applied Mathematical Concepts, such as 'Linear Algebra' 'Calculus' and 'Differential Equations' | Dr. M.K. Samal, SO/H, RSD, BARC<br>**Associate Faculty:**<br>Dr. M.K. Samal, SO/H, RSD, BARC |

**Total number of lecture hours: 45**

**Basics of Continuum Mechanics (5 lectures)**

Motion and Deformation Gradient, Variational Functionals, Strain and Stress Measures, Green and Almansi Strain Tensors, Polar Decomposition, Energetically Conjugate Stresses and Strains, Transformation of Vectors and Tensors, Time Derivatives, Balance Equations, Balance of Mass, Linear and Angular Momentum, First Law of Thermodynamics, Introduction of Different Strain and Stress Tensors, Balance Equations with Respect to Initial Configuration, Derivatives of Stress Tensors, Concept of objectivity and objective stress tensor, Constitutive Equations, Elastic Material, Elasto-Plastic Material Laws, Visco-Elastic and Visco-Plastic Material Behaviour, Incremental Form of the Material Equations, Weak Form of Equilibrium, Variational Principles, Weak Form of Linear Momentum in the Initial and Current Configurations, Linearization of the Variational Formulation, Linearization of Kinematic and Constitutive Equations, Total and updated Lagrangian Formulation

**Geometric, Material nonlinearities, Bifurcation and Stability Issues (4 lectures)**

Nonlinear Phenomena, Geometrical Nonlinearity, Large Displacements of a Rigid Beam, Large Displacements of an Elastic System, Bifurcation Problem, Snap-Through Problem, Physical Nonlinearity, Nonlinearity Due to Boundary Conditions, Material Nonlinearities and Coupled Problems, Nonlinear Elastic Problems, Small Deformation Theory of Plasticity, Ideal Plasticity, Strain Hardening Plasticity, Elastic-Plastic Analysis of a Bar.

**General solutions schemes for nonlinear finite element problems (7 lectures)**

Solution Methods for Time Independent Problems, Solution of Nonlinear Systems of Equations, Newton-Raphson Method, Modified Newton Scheme, Quasi-Newton Method, Damped Newton Method, Line-Search, Path-Following or Arc-Length Method, Solvers for Linear Systems of Equations, Direct Solvers, Iterative Solution Methods, Parallel Equation Solvers, Examples Related to Algorithms and Equation Solvers.

**Solutions schemes for nonlinear time-dependent finite element problems (6 lectures)**

Solution Methods for Time Dependent Problems, Integration of the Equations of Motion, Explicit Time Integration Methods, Implicit Time Integration Methods, Conserving Algorithms, Numerical Examples, Reduction Techniques for Nonlinear Equation of Motion, Integration of Inelastic Constitutive Equations for Small Deformations, Viscoelastic Material, Elasto-Plastic Material, Elasto-Viscoplastic Material, Integration of Constitutive Equations for Finite Deformation Problems, General Implicit Integration, Implicit Integration with Respect to Principal Axes, Consistent Tangent Modulus, Stability Problems, Computation of Stability Points, Classical and Linear Buckling Analysis, General Investigations of Stability, Direct Computation of Singular Points, Formulation of an Extended System, Computation of the Directional Derivatives, Bifurcation Point of an Arc, Algorithms for Nonlinear Stability Problems.

**Error estimation and adaptive schemes in FEM (6 lectures)**

Adaptive Methods, Boundary Value Problems and Discretization, Boundary Value Problem for Finite Elasticity, The Linearized Boundary Value Problem, Discretization, Error Estimators and Error Indicators, Error Estimation for Nonlinear Problems, Residual Based Error Estimator, Error Indicator Based on the Z Method, Error Estimators Based on Dual Methods, Error Estimation for Plasticity, Mesh Refinement Strategy, Adaptive Mesh Generation and Transfer of History Variables during computation, Examples of Hertzian Contact and Elasto-Plastic Deformation of a Cylindrical Shell.

**Solution for flow of viscous incompressible fluids using FEM (6 lectures)**

Governing differential equation for fluid flow, Conservation of Mass, Momentum and Energy, Governing Equations in Terms of Primitive Variables, Velocity-Pressure Finite Element Model , Weak Form and Finite Element Model, Penalty Finite Element Models, Penalty Function Method, Reduced Integration Penalty Model, Consistent Penalty Model, Computational Aspects, Properties of the Matrix Equations, Choice of Elements, Evaluation of Element Matrices in Penalty Models, Post-Computation of Stresses, Computer Implementation, Mixed Model, Numerical Examples, Fluid Squeezed Between Parallel Plates, Flow of a Viscous Lubricant in a Slider Bearing, Wall-Driven Cavity Flow, Backward-Facing Step, Least-Squares Finite Element Models for fluid flow problems.

**Advanced elements for structural problems (6 lectures)**

Special Structural Elements, Nonlinear Truss Element, Kinematics and Strains, Constitutive Equations for the Truss, Variational Formulation and Linearization, Two-dimensional Geometrically Exact Beam Element, Axisymmetric Shell Element, Kinematics and Strains of the Axi-symmetrical Shell, General Shell Elements, Shell Intersections, Examples of Bending of a Clamped Beam, Quadratic Plate under Internal Pressure, Pinched cylinder.

**Solution of contact problems using FEM (5 lectures)**

Contact Problems, Contact Kinematics, Constitutive Equations at the Contact Interface, Normal and Tangent Contact, Weak Formulation and Discretization, NTS-Discretization, Matrix Form of Contact Residual, Integration of the Friction Law, Special algorithms for contact problems, Linearization of the Contact Residual, Example Problems.

## 4. Advance Fluidization Engineering (Course coordinator: Dr D. Mandal, BARC)

| ***Pre-requisites:*** B. E /B. Tech/M. Tech in Chemical, Mechanical and Engineering and Metallurgy/Material Science, M.Sc. in Physics and Chemistry | **Faculty:** Dr. D. Mandal/Head, AMMD |
|---|---|

| Topics | Lecture Hrs. |
|---|---|
| Introduction of fluidization engineering and gross behaviour of fluidized beds | 3 |
| Hydrodynamics of fluidized beds-static and flowing, Geldart classifications of particles | 3 |
| Bubbles in dense beds, Davidson model, stream of bubbles, bubbling bed models, emulsion phase, turn-over rate of solids, residence time distribution, diffusion model of solid movement, interchange coefficient into and out of wake. | 4 |
| Diffusion model for gas flow. | 2 |
| Two region models, evaluation of interchange coefficients. | 3 |
| Heat and mass transfer modelling of non-reacting and reacting systems in fluidized beds. | 3 |
| Catalytic conversion from bubbling bed model | 3 |
| Contacting efficiency. | 2 |
| Application to successive reactions. | 4 |
| Theories and bed-wall heat transfer. | 3 |
| Entrainment and elutriation, application of enhancement model. | 3 |
| Residence time distribution and size distribution of solids in fluidized beds, particles of changing size. | 3 |
| Circulation rates of solids, flow of high and low bulk density mixtures. | 2 |
| Design for catalytic reactors. | 2 |
| Design for non-catalytic gas-solid reactors. | 2 |
| Fluid catalytic cracking, combustion and gasification, and miscellaneous processes in fluidized beds. | 3 |
| **Total** | **45** |

## 5. Catalysis and Surface Engineering Chemistry
## (Course coordinator: Dr D. Mandal, BARC)

| | |
|---|---|
| ***Pre-requisites:***<br>B. E /B. Tech/M. Tech in Chemical, Mechanical and Engineering and Metallurgy/Material Science, M.Sc. in Physics and Chemistry | **Coordinator** Prof. D. Mandal, Head, AMMD,<br>**Associate Faculties:**<br>Prof. Vincent Tessy, SO/H, PSDD<br>Prof. S. K. Satpati, SO/H, UED<br>Dr. S. Manna, SO/G, UED<br>Dr. Salil Varma,SO/G, ChD,<br>Shri Sandeep K C, SO/F, HWD |

| Topics | Lecture Hrs. |
|---|---|
| Review of chemical kinetics. | 3 |
| Homogeneous, acid-base and heterogeneous catalysis. | 4 |
| Fundamental modelling for catalytic processes. | 3 |
| Introduction to industrial catalysis. | 3 |
| Structure of solid surfaces. | 3 |
| Preparation and characterization of catalysts. | 4 |
| Kinetics of heterogeneous reactions. | 3 |
| Physical, chemical and mathematical description of catalyst deactivation; Deactivation by fouling poisoning and sintering. | 3 |
| Deactivation and regeneration of catalyst pellets. | 3 |
| Deactivation and regeneration of fixed beds. | 3 |
| Dynamics of polyfunctional catalysts. | 3 |
| Electro-catalysis, Bio-catalysis and photo-catalysis. | 3 |
| Mechanism and kinetics of heterogeneous catalytic reactions. | 3 |
| Applications in fertilizer, petroleum, petrochemical industries, pollution control and nuclear facility | 4 |
| **Total** | **45** |

**Application-cum-Nomination Form**

14th Set of QUEST

| | |
|---|---|
| Name of the Applicant (in block letter) | |
| Designation | |
| Name of DAE unit & Division | |
| Email ID | |
| Telephone (O) & Mobile No. | |
| Address (Office) | |
| Present Place of Residence | |
| Training School Batch No. and Discipline (if applicable) | |

## Bhabha Atomic Research Centre
## Human Resource Development Division
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| S. No. | Name of the Course | Faculty/Division | Please **Tick mark** Course(s) you wish to be enrolled (**NOT more than 2 courses**) |
|---|---|---|---|
| 1 | **State-space approach to Reactor Control** | Dr. A.P.Tiwari/ Dir KMG<br>Dr. S.R. Shimjith, Head RSAS, | |
| 2 | **Signal Conditioning & Recovery** | Dr. S. Mukhopadhyay/Head, SD | |
| 3 | **Advanced Concepts in Finite Element Methods** | Dr. M.K. Samal/RSD | |
| 4 | **Advance Fluidization Engineering** | Dr. D. Mandal/ Head, AMMD | |
| 5 | **Catalysis and Surface Engineering Chemistry** | Dr. D. Mandal/ Head, AMMD | |

Brief statement about the nature of your present work/research and how the above course(s) will be useful to you (max 5 lines)

I fulfill prerequisites for the course(s) I have applied for and I shall attend the course(s) with more than 80% of attendance and appear in associated examinations/project work.

Date: Signature of the Applicant

Through: Nominating Authority

(Unit Head- for DAE Unit/Head of Division- for BARC/HBNI PhD Guide)

**To**

Neelima Prasad; nprasad@barc.gov.in

HRDD, BARC.

**Last date of receipt at HRDD: January 31, 2022**