

# UTTAR PRADESH TECHNICAL UNIVERSITY LUCKNOW



## SYLLABUS

### Bachelor of Food Technology

3<sup>rd</sup> Year (V & VI Semester)

(Effective from Session 2015-2016)

**UTTAR PRADESH TECHNICAL UNIVERSITY, LUCKNOW**

**STUDY AND EVALUATION SCHEME  
B.TECH (FOOD TECHNOLOGY) THIRD YEAR  
[Effective from the Session 2015-16]**

**B.Tech (Food Technology)**

**Year 3<sup>rd</sup> Semester-V**

S.No	Course Code	Subjects	Periods			Evaluation Scheme				Subject Total	Credit
			L	T	P	SESSIONAL EXAM					
						CT	TA	TOTAL	ESE		
<b>1</b>	NHU-501	Engineering Economics	<b>2</b>	<b>0</b>	<b>0</b>	15	20	25	50	<b>75</b>	2
<b>2</b>	NAS-501	Computer Based Numerical Methods	<b>3</b>	<b>1</b>	<b>0</b>	30	20	50	100	<b>150</b>	4
<b>3</b>	NME-509	Machine Design	<b>2</b>	<b>1</b>	<b>0</b>	15	10	25	75	<b>75</b>	3
<b>4</b>	NFT-501	Principles of Food Preservation	<b>3</b>	<b>1</b>	<b>0</b>	30	20	50	100	<b>150</b>	4
<b>5</b>	NFT-502	Fruits, Vegetables & Plantation Products	<b>3</b>	<b>1</b>	<b>0</b>	30	20	50	100	<b>150</b>	4
<b>6</b>	NCH-507	Instrumentation and Process Control	<b>3</b>	<b>1</b>	<b>0</b>	30	20	50	100	<b>150</b>	4
<b>7</b>	NFT-551	Food Preservation Lab	0	0	3	20	20	40	60	<b>100</b>	2
<b>8</b>	NFT-552	Fruits, Vegetables & Plantation Products Lab	0	0	3	10	10	20	30	<b>50</b>	1
<b>9</b>	NAS-551	Computer Based Numerical Methods Lab	0	0	3	10	10	20	30	<b>50</b>	1
<b>10</b>	NGP-501	General Proficiency						50		<b>50</b>	
		TOTAL	16	5	9					<b>1000</b>	25

**UTTAR PRADESH TECHNICAL UNIVERSITY, LUCKNOW**

**STUDY AND EVALUATION SCHEME  
B.TECH (FOOD TECHNOLOGY) THIRD YEAR  
[Effective from the Session 2015-16]**

**B.Tech (Food Technology)**

**Year 3<sup>rd</sup> Semester-VI**

S.No	Course Code	Subjects	Periods			Evaluation Scheme				Subject Total	Credit
						SESSIONAL EXAM					
			L	T	P	CT	TA	TOTAL	ESE		
<b>1</b>	NHU-601	Industrial Management	<b>2</b>	<b>0</b>	<b>0</b>	15	10	25	50	<b>75</b>	2
<b>2</b>	NFT-601	Cereals, Pulses & Oilseed Products	<b>3</b>	<b>1</b>	<b>0</b>	30	20	50	100	<b>150</b>	4
<b>3</b>	NFT-602	Dairy Technology	<b>3</b>	<b>1</b>	<b>0</b>	30	20	50	100	<b>150</b>	4
<b>4</b>	NFT-603	Bakery Technology	<b>3</b>	<b>1</b>	<b>0</b>	30	20	50	100	<b>150</b>	4
<b>5</b>	NCH-607	Chemical Reaction Engineering	<b>2</b>	<b>1</b>	<b>0</b>	15	10	25	50	<b>75</b>	3
<b>6</b>	NCH-608	Mass Transfer Operations	<b>3</b>	<b>1</b>	<b>0</b>	30	20	50	100	<b>150</b>	4
<b>7</b>	NFT-651	Advanced Food Processing Lab-I	0	0	6	20	20	40	60	<b>100</b>	2
<b>8</b>	NCH-655	Mass Transfer Operations Lab	0	0	3	10	10	20	30	<b>50</b>	1
<b>9</b>	NFT-652	Seminar	0	0	3			50		<b>50</b>	1
<b>10</b>	NGP-601	General Proficiency						50		<b>50</b>	
		<b>TOTAL</b>	<b>16</b>	<b>5</b>						<b>1000</b>	<b>25</b>

## **NHU-501: ENGINEERING ECONOMICS**

**L : T: P**

**2 : 0: 0**

### **Unit-1 Introduction to Engineering Economics and Managerial Economics**

Concept of Efficiency, Theory of Demand , Elasticity of Demand, Supply and Law of Supply indifference Curves, Budget Line, Welfare Analysis, Scope of Managerial Economics, Techniques and Applications of Managerial Economics.

### **Unit-2 Market Structure**

Perfect Competitions Imperfect- Monopolistic, Oligopoly, duopoly sorbent features of price determination and various market conditions.

### **Unit-3 Demand Forecasting and cost Estimation**

Characteristics of Forecasts, Forecasting Horizons, Steps to Forecasting, Forecasting Methods, Seasonal Adjustments, Forecasting Performance Measures, Cost Estimation, Elements of cost, Computation of Material Variances Break-Even Analysis.

### **Unit-4 Management Aspects**

Functions of Management, Project Management, Value Engineering, Project Evaluation, Decision Making

---

## **NAS-501: COMPUTER BASED NUMERICAL METHODS**

**L : T: P**

**3 : 1: 0**

### **Unit 1**

Problem solving on computer. Algorithms and flow charts. Introduction to numerical computing, approximations and errors in numerical computations. Truncation and round off errors, propagation of errors. Root finding: bisection method, regula falsi method, iteration method, Newton Raphson method, Secant method, systems of nonlinear equations.

### **Unit 2**

Matrix algebra, Solution of simultaneous linear algebraic equations: Gauss elimination, Gauss Jordan method, LU decomposition, Jacobi method, Gauss Seidel method, SOR method, convergence of iterative methods. Tridiagonal systems and Thomas algorithm, Condition of a system and stability issues.

### **Unit 3**

Interpolation and Extrapolation: Newton's forward and backward interpolation formula, Lagrange interpolation formula. Divided differences and Newton's general formula. Numerical differentiation, Numerical integration : Trapezoidal and Simpson's rules. Newton-Cotes integration formulas, Romberg integration, Gaussian Quadrature.

#### **Unit 4**

Numerical solution of O.D.E.: Taylor series method, Euler's method, Runge Kutta methods. Multistep methods: Milne's method, Adams method, accuracy, Convergence criteria, stiffness, systems of equations.

#### **Unit 5**

Boundary Value problems: Finite difference method, solving eigenvalue problems, polynomial method, power method. Numerical solution of Partial Differential equations. Elliptic, Parabolic and hyperbolic PDEs.

#### **Books Recommended**

E. Balagurusamy: Numerical Methods, Tata McGraw hill.

1. Sastry, S. S. "Introductory Methods of Numerical Analysis", 3 rd ed. Prentice- Hall of India, New Delhi (2002).
2. "Schaum's Outlines: Numerical Analysis", 2 nd ed. Tata Mc Graw Hill Publishing Co. Limited (1968)
3. Kandasamy, P. Thialagawathy, K. & Gumawathy, K. "Numerical Methods", S. Chand & Company Ltd., New Delhi (1999).
4. Balaguruswamy, E. "Numerical Methods. Tata Mc Graw Hill Publishing Company Limited, New Delhi (2001).
5. V. K. Singh "Numerical and Statistical Methods in Computer" (2005), Paragon International Publishers, New Delhi.
6. Jain, Iyengar and Jain, "Numerical Methods for Scientific and Engineering Computation" (2003), New Age International, New Delhi.
7. Grewal B.S., "Numerical Methods in Engineering and Science", Khanna Publishers, Delhi.

---

#### **NME 509 : MACHINE DESIGN**

**L: T: P**

**2 : 1: 0**

#### **Unit-I**

Introduction to the methodology of Engineering design; Design circle for a product/ system; Important considerations in design; Formulation of design concepts; Miscellaneous considerations like wear, environmental, human and aesthetic aspects; Ergonomics considerations. 8

#### **Unit-II**

Estimation of design load under static and dynamic conditions; Design for safety; Stress concentration and its effect and its prevention; Consideration of creep, fatigue and thermal stresses in design. 8

#### **Unit III**

Design of power transmission systems- belt, pulley and shafts; Design of riveted and welded joints; Design of keys, couplings, lever and brackets. 8

#### **Unit-IV**

Design of pressure vessels- thick and thin cylinders, pipe and joints; Elementary ideas and importance of computer aided design; Basics of computer graphics - general introduction to AutoCAD. 8

---

**NFT-501 : PRINCIPLES OF FOOD PRESERVATION**

**L : T: P**  
**3 : 1: 0**

**Unit-I**

Basic considerations: Aims and objectives of preservation & processing of foods, Characteristics of tissues and non-tissues foods, Degree of perishability of unmodified foods, Causes of quality deterioration and spoilage of perishable foods, intermediate moisture foods, wastage of foods.

**Unit-II**

Preservation of foods by low temperatures:

(A) Chilling temperatures: Consideration relating to storage of foods at chilling temperatures, Applications and procedures, Controlled and Modified atmosphere storage of foods, Post storage Handling of foods.

(B) Freezing temperatures: Freezing process, Slow and fast freezing of foods and its consequence, other occurrences associated with freezing of foods. Technological aspects of pre freezing, Actual freezing, Frozen storage and thawing of foods.

**Unit-III**

Preservation of foods by high temperatures: Basic concepts in thermal destruction of microorganisms D,Z,F values. Heat resistance and thermophilic microorganisms. Cooking, Blanching, Pasteurization and Sterilization of foods. Assessing adequacy of thermal processing of foods, General process of canning of foods, Spoilage in canned foods.

**Unit-IV**

Preservation by water removal:

(a) Principles, Technological aspects and application of evaporative concentration process; Freeze concentration and membrane process for food concentrations.

(b) Principles, Technological aspects and application of drying and dehydration of foods, Cabinet, tunnel, belt, bin, drum, spray, vacuum, foam mat, fluidized-bed and freeze drying of foods.

**Unit-V**

Principles, Technological aspects and application of sugar and salt, Antimicrobial agents, Biological agents, non ionizing and ionizing radiations in preservation of foods. Hurdle technology.

**Book References**

**O.R.Fennema : Principles of Food science**

## **NFT – 502 : FRUITS, VEGETABLES AND PLANTATION PRODUCTS**

**L : T: P**

**3 : 1: 0**

### **Unit-I**

Structural, Compositional and Nutritional aspects of fruits and vegetables. Physiological development: Growth, Maturation, Ripening and Senescence. Post harvest handling including controlled and modified storage. Techniques of processing and preservation of fruits and vegetables by refrigeration and freezing, canning and bottling, drying and dehydration.

### **Unit-II**

Technology of fruits and vegetable products: Juices and pulps, Concentrates and powders, Squashes and cordials. Beverage: Still and carbonated. James, Jellies and Marmalades. Preserves, candies and crystallized fruits. Tomato products: Puree, Paste, Ketchup, Sauce and soup. Chutneys, pickles and other products.

### **Unit-III**

Spices: Composition, Structure and characteristics. Preservation and processing of major and minor spices of India; whole spice, Spice powder, Paste and extracts, Spice oils and oleoresins. Composition, Structure ,characteristics & processing of cashew nut and other dry fruits

### **Unit-IV**

Composition, Production and processing of Tea leaves: Black tea, Green tea and Oolong tea. Instant tea. Production and processing of coffee cherries by wet and dry methods to obtain coffee beans, grinding, storage and preparation of brew, Soluble /Instant coffee, Use of chicory in coffee, decaffeinated coffee.

### **Unit-V**

Production, processing and chemical composition of cocoa beans. Cocoa Processes: Cleaning, roasting, alkalization, cracking and fanning, Nib grinding for cocoa liquor, cocoa butter and cocoa powder. Manufacturing process for chocolate: Ingredients, Mixing, Refining, Conching, Tempering, Moulding etc. to obtain chocolate slabs, chocolate bars. Enrobed and other confectionary products.

### **Book References:**

G. Lal, G.S. Siddappa and G.L. Tondan Preservation of fruits & vegetables.

B. Shrilakshimi Food Science.

Bernard. W. Minifie Chocolate, Cocoa and Confectionary: Science and Technology.

R.H.H. Wills et.al. An introduction to the Post-harvest physiology and handling of fruits and vegetables.

---

**NCH- 507 : INSTRUMENTATION AND PROCESS CONTROL**

**L : T: P**

**3 : 1: 0**

**Unit-I**

Elements of measurement , functions and general classifications of measuring instruments. Indicating and recording type of instruments. Elements of measuring instruments,static and dynamic characteristics of measuring instruments.(6)

**Unit-II**

Principle of operation, construction and application of important industrial instruments for the measurement of temperature, flow, liquid level and composition. (10)

**Unit-III**

Dynamic behavior of first order, second order and two or more first order systems in series. (10)

**Unit-IV**

Block and physical diagrams of control system. Open and closed loop control systems. Characteristics of measuring elements, controllers and final control elements. Mode of control actions. (08)

**Books**

1. Eckman, D.P., Industrial Instrumentation, Wiley Eastern Ltd., New York 1990.
2. Process system Analysis & Control, D.R. Coughanoowr, McGraw Hill Publication
3. Process Control. Peter Harriot, Tata McGraw Hill.
4. Process control, Staphno polies, Prentic Hall India Ltd.

=====

**NFT-551 : FOOD PRESERVATION LAB**

**L : T: P**

**0 : 0 : 3**

1. To check the adequacy of Blanching process
2. Extension of shelf life/ preservation of foods by use of low temperature.
3. Processing and preservation of Peas by use of high temperature.
4. To determine the effectiveness of sterilization process.
5. Preservation and processing of certain vegetables by drying and dehydration
6. Osmotic concentration/dehydration of certain fruits and vegetables using concentrated sugar and salts solutions .
7. Preservation of fruit pulp with the help of Chemical preservatives.
8. Preservation of foods by Freezing (Frozen Foods).

=====

**NFT-552 : FRUITS, VEGETABLES AND PLANTATION PRODUCTS LAB**

**L : T: P**

**0 : 0 : 3**

1. Preparation of Jam/Jelly and its preservation by sugar.
2. Preparation of tomato puree/ketchup and its preservation by chemical preservatives.
3. Preparation of Candied fruits.
4. Preparation of cordials and squash as per FPO specification.
5. Preparation of pickles.



6. Preparation of fermented Pickles (Sauerkraut).
7. Preparation of Fruit Preserves.
8. Preparation of Fruit Leather.
9. Preparation of Spice pastes.

**NAS 551 :COMPUTER BASED NUMERICAL TECHNIQUES LAB**

**L : T : P**  
**0 : 0 : 3**

Use of following Techniques in C/C++ Language

1. Solution of single non-linear algebraic equations by Newton Raphson method.
2. Solution of single non-linear equations by Regula-falsi method.
3. Solution of system of linear simultaneous by Gauss Elimination method.
4. Solution of system of linear simultaneous equation by gauss seidel method and successive over relaxation method.
5. Solution of single first order ordinary differential equations by fourth order Runge-Kutta method.
6. Solution of Heat equations (Parabolic equations) by finite difference method.
7. Solution of Laplace equations (elliptic equation) by finite difference method.
8. Solution of wave equations (Hyperbolic equation) by finite difference method.
9. Finding Newton’s interpolatory polynomial for n points.
10. Finding Newton’s interpolatory polynomial based on finite difference table for n points.
11. Simpson’s 3/8-rule.

=====

**NHU 601 INDUSTRIAL MANAGEMENT**

**L T P**  
**2: 0 : 0**

**Unit-I**

**Introduction** : Concept, Development, application and scope of Industrial Management.

**Productivity** : Definition, measurement, productivity index, types of production system, Industrial Ownership.

**Unit-II**

**Management Function** : Principles of Management- Management Tools – time and motion study, work simplification- process charts and flow diagrams, Production Planning.

**Unit-III**

**Inventory control** : Inventory, cost, Deterministic models, Introduction to supply chain management.

**Unit-IV**

**Quality control** : Process control, SQC control charts, single, double and sequential sampling, Introduction to TQM.

**Reference Books**

1. Khanna O.P. : Industrial Engineering
2. T.R. Banga : Industrial Engineering and Management

**NFT – 601: CEREALS, PULSES AND OILSEED PRODUCTS**

**L : T: P**

**3 : 1: 0**

**Unit-I**

Composition, Structure and Processing characteristic of Cereal grains, Legumes and oilseeds, Post harvest, Post processing practices for their safe storage. Parboiling and Milling of paddy, Quality characteristics, Curing and aging of rice, Processed rice products.

**Unit-II**

Wheat and its quality characteristics for milling into flour and semolina, Flour milling, Turbo grinding and air classification, Flour grades and their suitability for baking purposes, Assessment of flour quality and characteristics, Milling of Durum wheat, Macaroni products.

**Unit-III**

Dry and Wet milling of corn, Starches and its conversion products, Cornflakes Manufacture. Malting of barley

**Unit-IV**

Milling of legume-pulses by traditional and improved processes. Pearling of Millets.

**Unit-V**

Processing of oil seeds for direct use and consumption, Oil and protein products. Processing of extracted oil refining, hydrogenation, interestrification. Processing of deoiled cake into protein concentrates and isolates, Textured protein, Functional protein preparations. Peanut butter, Margarine and Spread.

**Book references:**

**C.F.T.R.I. Mysore Manuals on Rice and its Processing**

**N.N.Potter Food Science**

**S.A.Matz Cereal Technology**

---

**NFT-602 : DAIRY TECHNOLOGY**

**L : T: P**

**3 : 1: 0**

**Unit-I**

Fluid Milk: Composition of milk and factor affecting it. Physico-chemical characteristics of milk and milk constituents. Production and collection , cooling and transportation of milk. Packaging storage and distribution of pasteurized milk.:

**Unit-II**

Whole, Standardized, Toned, Double toned and skim milk. Test for milk quality and Adulteration. UHT processed milk, flavoured, Sterilized milk. Cleaning and sanitization of dairy equipments. Definition, Classification, Composition and physico-chemical properties of cream. Production processes and quality control.

### **Unit-III**

Butter: Definition, Classification, Composition and methods of manufacture, Packaging and storage. Butter oil/Ghee. Ice cream: Definition, Classification and Composition, Constituents and their role. Preparation of mixes and freezing of Ice cream, Overrun, Judging, Grading, and defects of Ice cream.

### **Unit-IV**

Evaporated and Condensed milk: Method of manufacture, Packaging and storage. Defects, Causes, and prevention. Roller and Spray Drying of milk solids. Instantization. Flow ability, Dustiness, Reconstituability, Dispersability, Wet ability, Sink ability and appearance of milk powders.

### **Unit-V**

Byproducts of Dairy Industry and their effective utilization. Manufacture of casein, Whey protein, Lactose from milk and their use in formulated foods. Quality Control tests in Dairy industry.

---

## **NFT-603 : BAKERY TECHNOLOGY**

**L : T: P**  
**3 : 1: 0**

### **Unit-I**

Wheat flour and wheat flour treatments – Grade of flour, constituents of flour – ageing of flour – Tests for flour quality. Yeast : Characteristics, Preparation, Handling & Storage, Adequacy for use in bakery industry. Ingredients, Technology and quality parameters for baked products: Bread, Biscuits and cakes

### **Unit-II**

Bakery equipment and machinery .Different types of Mixers, kneaders and cutters.Different types of ovens.Packaging machinery for bread and biscuits. 8. Quality control in bakery industry . Quality control of raw materials. Quality control of finished products. Quality control of packaging materials

### **Unit-III**

Technology of bread making Different methods. Process steps and their significance. Characteristics of good bread. Defects in bread their causes and remedies .

### **Unit-IV**

Technology of Cakes Manufacture. Different cake making processes. Sugar batter method, Flour batter method ,Modified sugar batter method Whipping method, Blending method etc. Process steps and their significance. Importance of baking time and temperature. Recipe balancing .Defects in cakes, their causes and remedies .

### **Unit-V**

Biscuits . Definition and types.Fermented dough biscuits. Cookies. Types of cookies and their manufacture. Cream biscuits. Process steps and their significance. Defects in biscuits their causes and remedies.

---

**NCH- 607: CHEMICAL REACTION ENGINEERING****L : T: P****2 : 1: 0****Unit-I**

Chemical Reactions : Rate of chemical reactions, variable affecting the reaction rate, order of reaction ,reaction rate constant , elementary and non-elementary reaction mechanism. Arrhenius equation, Collision theory and theory of absolute reaction rates, predictability of reaction rate. 8

**Unit-II**

Kinetics of homogeneous chemical reactions, rate equations for simple and complex reactions, irreversible reaction, parallel reactions,consecutive reactions, auto catalytic reactions and homogeneous catalytic reactions. 8

**Unit-III**

Interpretation of reactor data in constant volume and variable volume batch reactions, integral and differential method of following kinetic data. Reactor designs for homogeneous, batch, semi-batch, plug flow and continuous stirred tank. Electrochemical reactors 6

**Unit-IV**

Classification of chemical reactions, Interpretation of reactor data in flow reactions.Isothermal as well as non-isothermal operation, space velocity and residence time in flow reactors. Size comparison of single reactors like batch, plug flow and CSIR for first and second order single reactions. Multiple reactor systems, Plug flow reactions in series and for parallel equal sized CSTR's in series. 6

**Text Books**

- 1.Levenspiel, O.. "Chemical Reaction Engineering", 3rd ed. New York John Wiley (1998)
2. Fogler, H.S. "Elements of Chemical Reaction Engineering", 4th ed. Prentice Hall (1997).
3. Smith, J. "Chemical Engineering Kinetics ", 3rd edition. McGraw-Hill, . (1990).

---

**NCH- 608 : MASS TRANSFER OPERATIONS****L : T: P****3 : 1: 0****Unit-I**

Basic Principles of mass transfer: Molecular diffusion in fluids, mass transfer coefficients, Interphase mass transfer. Vapour pressure, enthalpy, absolute humidity, dew point, etc., Unsaturated vapour gas mixtures.

**Unit-II**

Gas absorption: Countercurrent, co-current, multistage continuous contact operations.Distillation : Entrainment, pressure drops , flooding , transfer coefficients and relative volatility. McCabe Thiele and Ponchon method for binary component distillation of azeotropes. Flash vaporization and Multicomponent distillation.

**Unit-III**

Diffusion: Molecular and turbulent diffusion , diffusion coefficient. Fick's law of diffusion, measurement and estimation of diffusivity. Diffusion in multicomponent gas mixtures. Diffusion in solids: Molecular, Knudsen and surface diffusion. Inter phase mass transfer: Mass transfer coefficients, diffusion between phases, equilibrium solubility of gases in liquids. Mass transfer theories. Mass transfer in fluidized beds

**Unit-IV**

Adsorption and Stripping,Equipments, gas-liquid equilibria, Henry's law, selection of solvent, absorption in tray column, graphical and analytical methods. Adsorption in packed columns. HTU, NTU & HETP concepts, design equations for packed column.

**Unit-V**

Drying: Batch and freeze drying, rotary driers. Surface vs diffusion controlled operations. Solid-gas equilibria, definitions of moisture contents, types of batch and continuous dryers, rate of batch drying , time of drying, mechanism of batch drying, continuous drying.

**Text Books**

1. Treybal, R "Mass Transfer Operations", 3rd ed. New York: McGraw-Hill, (1980).
2. Sherwood T. K., Pigford R. L. and ilke P. "Mass Transfer" McGraw Hill (1975).
1. Foust A. S. et.al., "Principles of Unit Operations" John Wiley (1980).
2. Geankoplis, C.J.. "Transport Processes and Unit Operations", 3rd ed. Prentice Hall. (1993)

**NFT-651: ADVANCED FOOD PROCESSING LAB**

**L : T: P  
O : O : 3**

1. Preparation of Bread/test baking.
2. Preparation of Sweet Buns.
3. Preparation of Pizza base.
4. Preparation of Biscuits
5. Preparation of Nan-khatai.
6. Preparation of Cookies.
7. Preparation of Cakes (Egg/ Egg less).
8. Preparation of Pastries.
9. Preparation of RTS/RTC foods.

=====

**NCH-655 : MASS TRANSFER OPERATIONS LAB**

**L : T: P  
O : O : 3**

1. Separation factors of the experiments with differential distillation.
2. Separation factors of the experiments with flash vaporization.
3. Separation factors of the experiments with vapour liquid equilibrium.
4. Separation factors of the experiments with liquid – liquid extraction.
5. Separation factors of the experiments with solid –liquid extraction.
6. Separation factors of the experiments with ion exchange.
7. Separation factors of the experiments with membrane separation.
8. Studies on Bubble cap/ tray/ fractional column.
9. Studies on Absorption/ Humidification/ Dehumidification columns.
- 10.Studies on crystallization and adsorption.

**NFT-652 SEMINAR**

**L : T: P  
O : O : 3**

The student will be required to prepare and deliver a seminar as well as submit a written report on the topic assigned to him/her

=====