

## TS ECET-2019

### SYLLABUS FOR CHEMICAL ENGINEERING

#### MATHEMATICS (50 Marks)

##### Unit-I: Matrices

Matrices: Definition of Matrix, Types of matrices - Algebra of matrices-Transpose of a matrix-Symmetric, skew symmetric matrices-Minor, cofactor of an element - Determinant of a square matrix-Properties-Laplace's expansion-singular and non singular matrices - Adjoint and multiplicative inverse of a square matrix-System of linear equations in 3 variables-Solutions by Cramer's rule, Matrix inversion method-Gauss-Jordan method.

Partial Fractions: Resolving a given rational function into partial fractions.

Logarithms: Definition of logarithm and its properties, meaning of 'e' exponential function and logarithmic function.

##### Unit-II: Trigonometry

Properties of Trigonometric functions- Ratios of Compound angles, multiple angles, submultiple angles - Transformations of Products into sum or difference and vice versa- Simple trigonometric equations-Properties of triangles-Inverse Trigonometric functions, Hyperbolic functions.

Complex Numbers: Properties of Modulus, amplitude and conjugate of complex numbers, arithmetic operations on complex numbers—Modulus-Amplitude form (Polar form) - Euler form (exponential form)-Properties.

##### Unit-III: Analytical Geometry

Straight Lines-different forms of Straight Lines, distance of a point from a line, acute angle between two lines, intersection of two non-parallel lines and distance between two parallel lines. Circles-Equation of circle given center and radius, given ends of diameter-General equation-finding center and radius, center and a point on the circumference, 3 non-collinear points, center and tangent, equation of tangent and normal at a point on the circle.

##### Unit-IV: Differentiation and its Applications

Functions and limits - Standard limits - Differentiation from the First Principles - Differentiation of sum, product, quotient of functions, function of function, trigonometric, inverse trigonometric, exponential, logarithmic, Hyperbolic functions, implicit, explicit and parametric functions-Derivative of a function with respect to another function-Second order derivatives - Geometrical applications of the derivative(angle between curves, tangent and normal)-Increasing and decreasing functions-Maxima and Minima(single variable functions) using second order derivative only - Partial Differentiation-Partial derivatives up to second order-Euler's theorem.

##### Unit-V: Integration and its Applications

Indefinite Integral - Standard forms - Integration by decomposition of the integrand, integration of trigonometric, algebraic, exponential, logarithmic and Hyperbolic functions-Integration by substitution -Integration of reducible and irreducible quadratic factors - Integration by parts- Definite Integrals and properties, Definite Integral as the limit of a sum - Application of Integration to find areas under plane curves and volumes of Solids of revolution-

Mean and RMS value, Trapezoidal rule and Simpson's 1/3 Rule for approximation integrals

### **Unit-VI: Differential Equations**

Definition of a differential equation-order and degree of a differential equation- formation of differential equations-solution of differential equation of the type first order, first degree, variable-separable, homogeneous equations, exact, linear differential equation of the form  $dy/dx+Py=Q$ , Bernoulli's equation, nth order linear differential equation with constant coefficients both homogeneous and nonhomogeneous and finding the Particular Integrals for the functions  $e^{ax}$ ,  $x^m$ ,  $\sin ax$ ,  $\cos ax$  or a polynomial of m-th degree( $m=1,2$ ).

### **Unit-VII: Laplace Transforms**

Laplace Transforms (LT) of elementary functions-Linearity property, first shifting property, change of scale property multiplication and division by t - LT of derivatives and integrals, Unit step function, LT of unit step function, second shifting property, evaluation of improper integrals, Inverse Laplace transform (ILT)-shifting theorem, change of scale property, multiplication and division by p, ILT by using partial fractions and convolution theorem. Applications of LT to solve ordinary differential equations to solve ordinary differential equations up to second order only.

### **Unit-VIII: Fourier Series**

Define Fourier series, Euler's formulae over the interval  $(C, C+2\pi)$  for determining the Fourier coefficients. Fourier series of simple functions in  $(0, 2\pi)$  and  $(-\pi, \pi)$ . Fourier series for even and odd functions in the interval  $(-\pi, \pi)$ .

## **PHYSICS (25Marks)**

### **Unit-I: Units and dimensions:**

Physical quantity-fundamental and derived physical quantities-units-fundamental and derived units-SI units-multiples and sub-multiples in SI units-advantages of SI units-dimensions and dimensional formulae-dimensionless quantities- applications and limitations of dimensional analysis-problems.

### **Unit-II: Elements of vectors:**

Scalar and vector quantities-examples-types of vectors-addition and subtraction of vectors-triangle law-parallellogram law-polygon law-resolution of a vector-unit vectors(i,j,k)-dot product and cross product of two vectors- characteristics of dot and cross products-examples- problems.

### **Unit-III: Kinematics and Friction**

Equations of motion-acceleration due to gravity-equations of motion under gravity- projectile motion-examples-horizontal and oblique projections-expressions for maximum height, time of ascent, time of flight, horizontal range, problems. Friction- causes and types of friction-normal reaction-laws of friction-coefficients of friction-angle of friction-methods of reducing friction-advantages and disadvantages of friction-motion of a body over a rough horizontal surface-problems.

#### **Unit-IV: Work, Power and Energy**

Work, power and energy-definitions and units-potential and kinetic energies-examples and expressions-work-energy theorem – law of conservation of energy-problems.

#### **Unit-V: Simple harmonic motion and Sound**

Definition-conditions of SHM - examples of SHM - expressions for displacement, velocity, acceleration, time period, frequency and phase of SHM-time period of a simple pendulum-seconds pendulum-problems. Sound-musical sound and noise-noise pollution-Effects and methods of control of Noise Pollution-Beats and echo's-problems-Doppler effect– Explanation, and Applications --Reverberation-Sabine's formula-characteristics of a good building-problems.

#### **Unit-VI: Heat and Thermodynamics**

Expansion of gases-Boyle's law-Absolute scale of temperature-Charles laws-Ideal gas equation-Universal gas constant and its value-SI Units-problems-- isothermal process-adiabatic process-first law of thermodynamics - two specific heats of a gas-relation between  $C_p$  and  $C_v$ -problems-second law of thermodynamics.

#### **Unit-VII: Modern physics**

Photo electric effect–explanation and its laws-applications of photo electric effect (photocell)-Einstein's photoelectric equation–critical angle and total internal reflection– optical fibers - principle, working, types and applications-concept of super conductivity – and applications.

### **CHEMISTRY (25 Marks)**

#### **Unit I: Fundamentals of Chemistry:**

**Atomic structure:** Introduction-Fundamental particles – Bohr's theory – Quantum numbers – Aufbau's principle – Hund's rule – Pauli's exclusion principle- Electronic configurations of elements up to atomic number 30, shapes of **s**, **p**, **d** orbital's.

**Chemical Bonding:** Introduction – types of chemical bonds – Ionic bond taking example of NaCl and MgO –characteristics of ionic compounds and covalent bond taking example  $H_2$ ,  $O_2$ ,  $N_2$ , HCl, characteristics of covalent compounds-Coordinate covalent bond.

**Oxidation-Reductions:** concepts of Oxidation-Reduction, Oxidation number and its calculations, differences between oxidation number and Valency.

#### **Unit-II: Solutions:**

Introduction classification of solutions, solute, solvent, concentration, mole concept–Molarity – Normality, equivalent weight using acids, bases and salts, numerical problems on Molarity and Normality.

#### **Unit-III: Acids and Bases:**

Introduction – theories of acids and bases – Arrhenius, Bronsted – Lowry theory – Lewis acid base theory – Ionic product of water - pH and related numerical problems – buffers solutions – Applications.

**Unit – IV: Principles of Metallurgy:**

Characteristics of metals and distinction between metals and non-metals. Definitions of metallurgy, ore, gangue, flux, slag–concentration of ore-hand picking, levigation, froth floatation – extraction of crude metal – roasting calcination, smelting – alloys – composition and uses of brass, German silver and nichrome.

**Unit-V: Electrochemistry:**

Conductors, insulators, electrolytes - Arrhenius theory of electrolytic dissociation – electrolysis – Faraday's laws of electrolysis- numerical problems – Galvanic cell – standard electrode potential – electro chemical series –emf and numerical problems on emf of a cell.

**Unit –VI: Corrosion:**

Introduction – factors influencing corrosion - electrochemical theory of corrosion-composition cell, stress cell and concentration cells - rusting of iron and its mechanism – prevention of corrosion by (a) coating methods, (b) cathodic protection (sacrificial and impressed voltage methods).

**Unit-VII: Water Technology:**

Introduction – soft and hard water – causes of hardness – types of hardness –disadvantages of hard water – degree of hardness, units and Numerical problems– softening methods – permutit process – ion exchange process – qualities of drinking water – municipal treatment of water for drinking purpose - Osmosis and reverse Osmosis, advantages of reverse Osmosis.

**Unit-VIII: Polymers:**

Introduction – polymerization – types of polymerization – addition, condensation polymerization with examples – plastics – types of plastics – advantages of plastics over traditional materials – Disadvantages of using plastics, thermo plastics and thermo setting plastics– differences between thermo plastics and thermo setting plastics- preparation and uses of the following plastics: 1. Polythene, 2. PVC, 3. Teflon, 4. Polystyrene, 5.Urea formaldehyde – Rubber – natural rubber – processing from latex –Vulcanization – Elastomers – Butyle rubber Buna-s, Neoprene rubber and their uses.

**Unit-IX: Fuels:**

Definition and classification of fuels based on physical state and occurrence – characteristics of good fuel - composition and uses of gaseous fuels. (a) Water gas, (b) producer gas, (c) natural gas, (d) coal gas, (e) bio gas, (f) acetylene.

**Unit-X: Environmental Chemistry:**

Introduction – environment – understand the terms lithosphere, hydrosphere, atmosphere bio sphere, biotic component, energy component pollutant, receptor, sink, particulate, DO, BOD, Threshold limit value, COD- Air pollution - causes-Effects- Forest resources, uses and over exploitation, deforestation acid rain, green house effect –ozone depletion – control of Air pollution – Water pollution – causes – effects – control measures. Renewable and Non Renewable energy sources – concept of ecosystem – producers, consumers and decomposers – Biodiversity, threats to Biodiversity.

## CHEMICAL ENGINEERING (100Marks)

**UNIT I: Material technology:** Mechanical properties of metals and Testing of materials– thermal equilibrium diagram-Production of Iron- plain carbon steels, alloy steels–Non ferrous metals & their alloys - Aluminium, copper, nickel, lead, tin, zinc-Miscellaneous materials – Glass, carbon, graphite, rubber, elastomers – Corrosion-causes, types, methods of prevention.

### UNIT II:

**Mass and Energy Balance:** Determination of molarity, molality & normality, analysis of solids, liquids and gases on dry and wet basis- Daltons law, ideal gas, equation of state, vapor pressure, Material balances with and without chemical reactions - Material balance problems related to evaporation, distillation, drying and mixing, Bypass and Recycle streams– limiting component, excess reactant, percentage conversion & yield and degree of completion - Law of conservation of energy, heat of reaction, heat of formation and heat of combustion – related problems, gross and net calorific values, theoretical air and excess air calculations – Proximate and ultimate analysis.

### UNIT III:

**Organic Chemical Technology:** Coal chemicals, coking of coal, coal tar distillation, petroleum refining - atmospheric distillation and vacuum distillation, fluid catalytic cracking, catalytic reforming, petrochemicals from methane and ethylene- Pulp and paper industry, Kraft process - Oils, fats and soaps-sugar and fermentation–synthetic fibres - rubber industries.

### UNIT IV:

**Inorganic Chemical Technology:** Water-sources, impurities-treatment-dissolved solids-ion exchange process and Reverse Osmosis(RO)process- Manufacture of chemicals like soda ash, ammonia, Urea, nitric acid, sulphuric acid, phosphoric acid, super Phosphate and industrial Gases (O<sub>2</sub>, N<sub>2</sub>, H<sub>2</sub>, CO<sub>2</sub> and acetylene)- Paints, pigments and varnishes, graphite and silicon carbide and cement.

### UNIT V:

**Fluid mechanics:** Flow of incompressible fluids, Newtonian and non-Newtonian fluids, Pressure, viscosity, laminar, Turbulent flow, Mass and momentum balance, Bernoulli's theorem, friction losses, friction factor – pressure drop, flow meters, different types of pumps for transportation of fluids, Centrifugal pump, Reciprocating pump, Flow past immersed bodies-packed bed and fluidized bed, Fluidization.

### UNIT VI:

**Heat transfer:** Conduction–mechanisms of heat flow–Fourier's law, thermal conductivity, steady state conduction- compound resistances in series, heat flow through a cylinder – related problems. Convection–heat flow in fluids-rate of heat transfer, counter current and parallel flows-Overall heat transfer coefficient–LMTD–Fouling factors– Heat transfer to fluids with and without phase change. Dropwise and Filmwise condensation, Heat transfer to boiling liquids, Radiation, emission of radiation, laws of black body radiation – radiation between surfaces. Heat Exchange Equipment – types of heat exchange equipment, Evaporation – types of evaporators, evaporator economy, Boiling point Elevation, single and multiple effect evaporators– related problems.

#### **UNIT VII:**

**Mechanical unit operations:** Size reduction methods, laws of size reduction- crushers and grinders. Different types of equipments for mixing liquids, viscous masses, dry powders, Differential and cumulative screen analysis, screen effectiveness, average particle size, storage of solids, conveyers, mechanical separations - Screening, froth floatation, electrostatic precipitator, scrubber, cyclone separators, filtration, filtration equipment, sedimentation.

#### **UNIT VIII:**

**Thermodynamics and Reaction Engineering:** 1st law of Thermodynamics, PVT relationships for gases, 2nd law of Thermodynamics, refrigeration and liquefaction, chemical reaction equilibria-determination of equilibrium constant and conversion, Temperature effect on reactions- – Arrhenius equation. Basic equations & working of batch, tubular and stirred tank reactors, catalysis.

#### **UNIT IX:**

**Mass Transfer:** Principles of diffusion, Ficks law of diffusion–molecular diffusion, eddy diffusion -inter phase mass transfer, two resistance theory, Distillation, simple, steam and continuous distillation, reflux ratio– McCabe Thiele method, absorption-tower packing, material balance– number of transfer units, Adsorption, humidification, extraction and leaching, drying-drying rate curves, time of drying, equipment for drying–crystallization–equipment.

#### **UNIT X:**

**Instrumentation & Process control:** Static and dynamic characteristics of an instrument-step input, linear input, sinusoidal input, measurement of temperature, pressure, vacuum, liquid levels and composition. Process instrumentation & Instrumentation diagrams-Process control, different types of controllers, P, PI, PD & PID Controllers.

#### **UNIT XI:**

**Environmental Studies and Pollution Control Engineering:** Scope and importance of environmental studies, Effect of human being on environment and vice-versa - Water pollution, types, classification, treatment methods –Air pollution, control methods – Gaseous and Particulate emission control- Solid waste management, sources, classification, disposal methods- Pollution control in sugar, fertilizer, paper & petroleum industries - Legal aspects of pollution control.

#### **UNIT XII:**

**Energy Technology:** Classification of energy sources -Solid, Liquid and Gaseous fuels – Combustion principles, Refractories, Furnaces- Blast Furnace, LD Converter – Nonconventional energy sources (Nuclear Energy, Solar Energy, Wind Energy and Bio-Energy) – Energy Conservation.

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## TS ECET-2019

### MODEL QUESTIONS FOR CHEMICAL ENGINEERING

#### MATHEMATICS

1. If  $\omega$  is a cube root of unity then  $\begin{vmatrix} 1 & \omega & \omega^2 \\ \omega & \omega^2 & 1 \\ \omega^2 & 1 & \omega \end{vmatrix} =$
- 1) 0            2) 1            3) -1            4) 2
2. If  $\frac{2x+5}{(x+1)^4} = \frac{A}{(x+1)^3} + \frac{B}{(x+1)^4}$  Than (A,B)=
- 1) (1,2)            2) (1,3)            3) (2,3)            4) (2,4)
3.  $\tan^{-1}(1/2) + \tan^{-1}(1/3) =$
- 1) 0            2)  $\frac{\pi}{3}$             3)  $\frac{\pi}{6}$             4)  $\frac{\pi}{4}$
4.  $\int_0^{\frac{\pi}{2}} \log(\cot x) dx =$
- 1) 1            2) 0            3)  $2\log 2$             4) None
5. The differential equation  $\frac{dy}{dx} + \frac{ax+by+g}{hx+ky+f} = 0$  is called
- 1) Homogenous            2) Linear            3) Exact            4) None

#### PHYSICS

- 1) Dimensional formula for stress
- 1)  $ML^2T^{-3}$             2)  $ML^{-1}T^{-2}$             3)  $ML^0T^{-2}$             4)  $MLT^{-1}$
- 2) On which principle optical fiber works
- 1) Reflection    2) Refraction    3) Total internal reflection    4) Total internal refraction
- 3) Relation between centigrade and Kelvin scale of temperature
- 1)  $T=t+273$             2)  $T=t-273$             3)  $t=T+273$             4)  $t=T-273$

- 4) Find the dot product of two vectors  
 $A=2i+3j+4k$  and  $B=4i-2j+3k$
- 1) 26                      2) 14                      3) 22                      4) 0
- 5) A work done by a man in carrying a load of 60 Kg over his head when he travels a distance of 5m in horizontal direction is ( $g=9.8 \text{ m/s}^2$ )
- 1) 2940 J                      2) 0J                      3) 2940m                      4) 300J

## CHEMISTRY

1. The Oxidation number of Mn in  $\text{MnO}_4^-$  is
- 1) +5              2) +6              3) +7              4) +4
2. The molarity of 10% NaOH solution is
- 1) 0.025              2) 0.25              3) 2.5              4) 25
3. Galvanic cells are the cells which convert
- 1) Electrical energy to chemical energy              2) Chemical energy to electrical energy  
 3) Chemical energy to Mechanical energy              4) Potential energy to Kinetic energy
4. The exhausted cation exchange resin can be regenerated by using
- 1) NaCl              2) NaOH              3) HCl              4)  $\text{NH}_3$
5. Which of the following is not a Lewis base
- 1)  $\text{H}_2\text{O}$               2)  $\text{BF}_3$               3)  $\text{NH}_3$               4)  $\text{CH}_3\text{OH}$

## CHEMICAL ENGINEERING

1. Maximum heat transfer rate is achieved in ----- flow
- 1) Turbulent    2) Co Current              3) Counter current              4) Laminar
2. The refrigerator works on the principle of ----- law of thermodynamics
- 1) Zeroth              2) First                      3) Second                      4) Third
3. Solutions which distill without change in composition are called
- 1) Ideal              2) Saturated                      3) Super Saturated              4) Azeotropic



4. Which of the following is a first order system
- 1) Interacting system of two tanks in series
  - 2) Mercury in glass thermometer kept in boiling water
  - 3) Damped vibrator
  - 4) Non interacting system of two tanks in series
5. Venturimeter is a ----- meter
- 1) Variable area
  - 2) Variable head
  - 3) Static head
  - 4) None of the above
6. Problem of solid waste disposal can be reduced through
- 1) Recycling
  - 2) Lesser pollution
  - 3) More timber
  - 4) Population control