

### 3.4 PHARMACEUTICAL ENGINEERING (THEORY)

75 hours ; 3 hours/week

- 1. Stoichiometry:** Unit processes, material and energy balances, units and their conversions, dimensional formulae, dimensionless equations. **2 hours; 2-3 marks**
- 2. Heat transfer:** Concept of heat flow by conducting through single wall, applications of Fourier's law, forced and natural convections, surface co-efficients, study on single, multi pass heat exchangers and liquid-liquid heat interchangers, radiation, black body, Stefan-Boltzmann equation. **6 hours; 6-8 marks**
- 3. Evaporation:** Theory of evaporation. Evaporators – steam jacketed kettle, horizontal tube evaporator, vertical tube evaporator, climbing film evaporator, falling film evaporator, forced circulation evaporator, multiple effect evaporator. **5 hours; 6-8 marks**
- 4. Distillation:** Raoult's law, volatility, Rayleigh's equation, Study on principles and equipments of simple, flash, fractional, azeotropic, extractive, vacuum, steam, and molecular distillation methods. **6 hours; 6-8 marks**
- 5. Drying:** Theory of drying, Classification and types of dryers – Principle, construction and working of tray dryer, fluidized bed dryer, drum dryer, vacuum dryer, freeze dryer, and spray dryer. **6 hours; 6-8 marks**
- 6. Size reduction:** Definition, objectives, factors affecting size reduction, laws governing energy and power requirement of a mill, stress strain relationship of deformation in solids. Types of mills, construction and working of ball mill, hammer mill, fluid energy mill, edge runner mill, end runner mill, and cutter mill. **1 hours; 6-8 marks**
- 7. Size separation:** Definition and objectives of size separation, standard sieves as per IP. Mechanical sieve shakers, sedimentation tanks, mechanical classifiers, cyclone separators, air separators, bag filter. **4 hours; 4-6 marks**
- 8. Mixing:** Theory of mixing, solid-solid, solid-liquid and liquid-liquid mixing. Equipments- cylindrical, V-cone, double cone, ribbon, sigma blade, planetary, zig-zag and barrel mixers. Mixing devices, -propellers, turbines, paddles, and baffles. Vortex formation and prevention. Homogenization and study on Silverson emulsifier, Rapisonic homogenizer and colloid mill. **7 hours; 8-10 marks**
- 9. Material Handling Systems:** Transportation of solids: Construction and working of belt conveyor, screw, chain, pneumatic, and bucket conveyors.  
**Transportation of fluids:** Pumps - positive displacement pumps, centrifugal pump, peristaltic pump. Cycloidal blower. **7 hours; 8-10 marks**
- 10. Filtration and centrifugation:** Study of Poiseuille's equation, Kozeny-Carman equation, Darcy's equation, filter aids and filter media. Construction and working of filter press, filter leaf, meta filter, drum filter, sintered glass filter, seitz filter, and

candle filter. Theory and principle of centrifugation, industrial centrifuges - basket, super, and conical disk centrifuges. **8 hours; 8-10 marks**

**11. Crystallization:** Definition, characteristics, crystal forms, crystal habits, mechanism of crystallization, solubility curves, Mier's super-saturation theory, construction and working of agitated batch crystallizer, Swenson-Walker crystallizer, Krystal crystallizer and vacuum crystallizer. Caking of crystals and its prevention.

**6 hours; 6-8 marks**

**12. Humidification:** Definition of humidity, humid heat, humid volume, study of psychrometric charts, wet bulb theory. Applications of humidity, control in various pharmaceutical departments like powders, capsules and tablets. **4 hours; 4-6 marks**

**13. Materials of construction:** Applications and corrosion resistance properties of stainless steel, plastic and rubber, classification and mechanism of corrosion, factors, prevention and control. **4 hours; 4-6 marks**

**14. Ion exchange:** Mechanisms, ion exchange resins, preparation and applications of ion exchange resins. Ion exchange equipment – Fixed bed ion exchange equipment, moving bed ion exchange equipment, fluidized bed ion exchange equipment.

**4 hours; 4-6 marks**

## PHARMACEUTICAL ENGINEERING (PRACTICALS)

75 hours ; 3 hours/week

- 01 Drying of wet granules/calcium carbonate slurry and plotting drying rate curves.\*\*
- 02 Size reduction of granular material using ball mill and calculation of Rittinger's, Kick's and Bond's coefficients.\*\*
- 03 Determination of particle size weight distribution of a sample using sieve shaker and derivation of various statistical parameters.\*
- 04 Study of the effect of materials related factors like concentration, viscosity, filter aids on the rate of filtration using calcium carbonate suspension.\*
- 05 Study of the effect of process related factors like surface area, thickness, pressure on the rate of filtration using calcium carbonate suspension.\*
- 06 Determination of the mixing index for the blending of calcium carbonate and talc (or salicylic acid and lactose)\*\*
- 07 Determination of leaching of ampoules and vials in terms of powdered glass test and water attack test.\*\*
- 08 Determination of mixing efficiency when the propeller blade is introduced in different positions during liquid-liquid mixing.\*\*
- 09 Measurement of homogenizing capacity of Silverson Emulsifier for mixing of immiscible liquids (liquid paraffin-water)\*\*
- 10 Preparation of crystals of potassium nitrate by shock cooling technique and study of its crystal habit.\*
- 11 Study of the effect of surface area, viscosity, concentration on the rate of evaporation\*
- 12 Study the influence of centrifugal effect in separating the oil phase of turpentine liniment.\*\*
- 13 Separation of turpentine oil from oil mixture by steam distillation process.\*
- 14 Determination of water vapour permeability across packing material\*
- 15 Determination of equilibrium moisture content (EMC) of substances (starch or bentonite) at different humidities at room temperature.\*
- 16 Analysis of pharmaceutical packing materials: Corrugated box.\*

**Note: \*\* Denotes major experiments      \* Denotes minor experiments**

### SCHEME OF EXAMINATION

1. Synopsis	-10 Marks
2. Major experiment (indicated by **)	-30 Marks
3. Minor experiment (indicated by *)	-20 Marks
4. Viva voce	-10 Marks

**Total**

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**= 70 Marks**

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## PHARMACEUTICAL ENGINEERING REFERENCE BOOKS

1. Badger WL, Banchero JT. Introduction to chemical engineering. Singapore:McGraw-Hill Book Company;1955.
2. Carter SJ. Cooper and Gunn's Tutorial pharmacy. 6<sup>th</sup> ed. New Delhi:CBS Publishers;2000.
3. Coulson JM, Richardson JF, Backhurst JR, Harker JH. Chemical engineering Vol 1 and 2. 2<sup>nd</sup> ed. New Delhi:Asian Book Pvt Ltd;1998.
4. Don WG, James O. Perry's chemical engineer's handbook. Singapore: McGraw-Hill Book Company;1984.
5. Gennaro AL. Remington: The science and practice of pharmacy Vol I and II. 20<sup>th</sup> ed. Philadelphia:Lippincott Williams and Wilkins;2000.
6. McCabe WL, Smith JC, Harriott P. Unit operations of chemical engineering. 5<sup>th</sup> ed. Singapore: McGraw-Hill Book Company;1993.
7. Paradkar A. Introduction to pharmaceutical engineering. 11<sup>th</sup> ed. Pune:Nirali Prakashan;2009.
8. Rawlins EA. Bentley's textbook of pharmaceutics. 8<sup>th</sup> ed. New Delhi:Reed Elsevier India Pvt Ltd;2010.
9. Sambamurthy K. Pharmaceutical engineering. New Delhi: New Age International Publishers;1998.
10. Subrahmanyam CVS, Thimmasetty J, Sarasija S, Kusumdevi V. Pharmaceutical engineering Unit operations I and II. 2<sup>nd</sup> ed. Delhi: Vallabh Prakashan;2012.

## LIST OF MINIMUM EQUIPMENTS REQUIRED

1. Autoclave	01 no.
2. Automatic ball mill	01 no.
3. Buchner filtration apparatus	01 no.
4. Centrifuge	01 no.
5. Desiccators	05 nos.
6. Double cone Blender	01 no.
7. Permeability cups	05 nos.
8. Propeller type mechanical agitator	05 nos.
9. Refrigerator	01 no.
10. Sieve Shaker with set of sieves	01 no.
11. Silverson Homogeniser	03 nos.
12. Steam distillation still	01 no.
13. Tray dryer	01 no.
14. Vacuum Pump	01 no.
15. Water bath	01 no.