

## INDEX

#### **UNITI**

Chapter 1: Thermal Power Plants (Coal, Gas, Disesel and Nuclear Based)

1-1 to 1-56

Syllabus: Layout and working of a typical thermal power plant with steam turbines and electric generators. Properties of conventional fuels used in the energy conversion equipment used in thermal power plants : Coal, Gas/diesel, Nuclear fuels fusion and fission action., Safe practices and working of various thermal power plants : coal-based, gas-based. diesel-based, nuclear-based., Functions of the following types of thermal power plants and their major auxiliaries : (a) Coal fired boilers : fire tube and water tube (b) Gas/diesel based combustion engines, (c) Types of nuclear reactors : Disposal of nuclear waste and nuclear shielding, Thermal power plants in Maharashtra.

1.1	Introduction
1.2	Thermal Power Station (Steam Power Station) 1-2
1.2.1	Most Important Points of Site Selection 1-2
1.2.1(A)	Fuels and their Properties (In Thermal Plant) 1-4
1.2.2	Layout of Typical Power Plant (Coal Fired Steam Plant and its Working) [with steam turbine and Generator] 1-5
1.2.3	Coal Handling (Steps)1-7
1.2.4	Boiler
1.2.4(A)	Comparison of Fire Tube Boiler and Water Tube  Boiler
1.2.4(B)	Chimney 1-9
1.2.4(C)	Superheater
1.2.5	Some other Important Parts their Working, Function and Process
1.2.6	Represent the Power Production by Thermal System of a Line Diagram
1.2.7	Advantages and Disadvantages of Thermal Power Plant
1.2.8	Details of Thermal Power Plants in Different States of India 1-15
1.2.9	Overall Efficiency of the Thermal Power Plant 1-17

Provisions in the System to Improve Thermal Efficiency1-17
Gas Flow Diagram of Thermal Plant1-18
Safe Practices in Thermal Plants1-18
Introduction of Gas Turbine Power Plant1-19
Selection of Site for Gas Power Plant1-19
Fuels used in Gas Turbine Power Plant1-19
Types of Gas Power Plant1-20
Layout and Working of Gas Turbine Power Plant1-20
Advantages and Disadvantages of Open Cycle Gas Turbine1-21
Layout Diagram of Gas Turbine Power Plant1-22
Applications of Gas Turbine Plant1-24
Gas Turbine Power Plants in India1-24
Introduction of Diesel Electric Power Plant1-25
Block Diagram of Diesel Electric Power Station1-25
Factors Considered for Selection of Site for the Diesel Power Plant1-29
Power Plant1-29
Power Plant1-29  Diesel Power Plants in India1-30  Comparison of Diesel Power Plant with Steam Thermal
Power Plant
Power Plant         1-29           Diesel Power Plants in India         1-30           Comparison of Diesel Power Plant with Steam Thermal         1-31           Power Plant         1-31           Applications of Diesel Power Plant         1-31           Advantages (Merits) and Disadvantages of Diesel Power         1-32           Classification of Oil Engines         1-33           Constructional details of Oil Engine         1-33           Working of Four Stroke Oil Engine         1-35           Introduction of Nuclear Power Plant         1-36           List of Nuclear Power Plants in India         1-36



1.5.5	Fuels used in Nuclear Power Station (and their Features)	1-41
1.5.6	Advantages and Disadvantages of Nuclear Power Plant	1-41
1.5.7	Nuclear Reactor - Construction, Main Components and their Function	
1.5.8	Types of Reactors	1-45
1.5.8(A)	Comparison of BWR with PWR	1-49
1.5.9	Safe Practices (Safety)	1-49
1.5.10	Disposal of Nuclear Waste	1-49
1.6	MSBTE Questions and Answers	1-51
	UNIT II	

#### **Chapter 2: Large and Micro Hydro Power Plants**

2-1 to 2-34

Syllabus: Energy conversion process of hydro power plant., Classification of hydro power plant: High medium and low head. Construction and working of hydro turbines used in different types of hydro power plant: (a) High head-Pelton turbine (b) Medium head-Francis turbine (c) Low head-Kaplan turbine Safe Practices for hydro power plants. Different types of microhydro turbines for different heads: Pelton Francis and Kaplan turbines. Locations of these different types of large and microhydro power plants in Maharashtra. Potential locations of microhydro power plants in Maharashtra.

2.1	Energy Conservation
2.1.1	Basic Concept of Hydro Power Generation 2-2
2.1.1(A)	Hydro-Potential in India (Basin, River, Pump-Storage, Small, Mini, Micro Schemes)2-2
2.1.1(B)	Some Important Terms and their Significance in Hydro-Plants
2.2	Classification of Hydro Power Plants 2-4
2.2.1	According to the Installed Capacity2-5
2.2.2	Mini, Micro and Small Hydro Electric Turbine Plants 2-5
2.3	General Layout of Hydro-Electric Power Plant2-7
2.4	Types of Turbines Used in Hydro Electric Plants 2-10
2.4.1	Impulse Turbine
2.4.2	Reaction Turbine

2.4.3	Comparison of impulse Turbine and Reaction	
	Turbine	
2.4.4	Types of Hydraulic Turbines	
	Horizontal Axis Turbine	
2.4.4(B)	Vertical Axis Turbine	.2-11
2.5	Detailed Study of Various Turbines used In Hydro-Projects	.2-12
2.5.1	High Head Pelton Wheel (Impulse Turbine)	.2-12
2.5.2	High Head Francis Turbine	.2-13
2.5.3	High Head Kaplan Turbine	.2-15
2.5.4	Comparison of Francis Turbine and Kaplan Turbine	.2-16
2.6	Sketches of Different Power Plants	.2-17
2.6.1	Pumped Storage Power Plant (Or Hydraulic Accumula System)	
2.6.2	Total Units of Such Plants in India is 52 and Installed Capacity is about 94000 MW	.2-18
2.7	Classification of Hydroelectric Power Plants According Availability of Water Head	_
2.7.1	Low Head Hydraulic Power Plant	.2-19
2.7.2	Medium Head Hydraulic Power Plant	.2-19
2.7.3	High Head Hydraulic Power Plant	.2-20
2.7.4	Comparison of Low Head, Medium Head and High He	
2.8	Hydro Power Plants According to Quantity of Water Available	.2-21
2.8.1	Run-off River Plant (Without Pondage)	.2-22
2.8.2	Run-off River Plants with Pondage	.2-22
2.8.3	Reservoir Plants (Storage Type Plants)	.2-22
2.8.4	Comparison of Run-off River Plant without Pondage, I off River Plant with Pondage and Reservoir Plant	
2.8.5	Classification According to Load	.2-23
2.9	Safe Practices and Environmental Aspects for Hydro Plants	.2-23
2.10	Selection of Site for the Hydro Electric Power Plants (Factors Governing the Selection of Site)	.2-24
2.11	List of Hydro Power Stations with their Capacities and Number of Units in Maharashtra State	
2.11.1	Comparison of the Various Power Plants	.2-28
2 12	Generators used in Hydronower Plant	2-30



2.13	Main Equipments Needed in Hydro Power Plant	.2-30
2.14	Advantages and Disadvantages of Hydro Power	
	Plant	.2-30
2.15	MSBTE Questions and Answers	.2-32

#### **UNIT III**

#### **Chapter 3: Solar and Biomass Based Power Plants**

3-1 to 3-25

Syllabus: Solar Map of India: Global solar power radiation. Solar Power Technology: (a) Concentrated Solar Power (CSP) plants. Construction and working of: Power Tower, Parabolic Trough, Parabolic Dish, Fresnel Reflectors. (b) Solar Photovoltaic (PV) power plant: layout, construction, working. Biomass-based Power Plants: (a) Layout of a Bio-chemical based (e.g. biogas) power plant (b) Layout of a Thermochemical based (e.g. Municipal waste) power plant. Features of the solid, liquid and gas biomasses as fuel for biomass power plant.

3.1	Introduction3-2
3.2	Solar Map of India3-4
3.3	Solar Power Technology3-5
3.3.1	Non Concentrating Collectors3-6
3.3.2	Concentrating Collector3-8
3.3.2(A)	Advantages and Disadvantages of Concentrating Solar Plant3-12
3.3.2(B)	Comparison of Solar Collectors3-13
3.3.3	Comparison of Flat Plate and Concentric Collector3-13
3.4	Solar Photovoltaic (PV)3-14
3.4.1	Types of Solar Photovoltaic Power Plant3-15
3.4.2	Characteristic of Solar Cell (V-I Characteristic)3-17
3.4.3	Brief Explanation of some Solar Power Plants using  Different Solar Collectors3-18
3.5	Biomass Based Power Plant3-20
3.5.1	Layout of Biochemical based Power Plant (Biogas Power Plant)3-20
3.5.2	Layout of Thermochemical based Power Plant (Municipal Waste Plant)3-21
3.5.3	Layout of a Agrochemical based Power Plant (Biodiesel Plant)3-22

3.5.4	Fixed Dome type Biogas Plant3-2	23
3.6	Features of the Solid, Liquid and Gas Biomass as Fuel fo	r
	Biomass Power Plant3-2	23
3.7	MSBTE Questions and Answers3-2	25

## UNIT IV

#### **Chapter 4: Wind Power Plants**

4-1 to 4-25

Syllabus: Wind Map of India: Wind power density in watts per square meter. Layout of Horizontal axis large wind power plant: (a) Geared wind power plant (b) Direct drive wind power plant, Salient Features of electric generators used in large wind power plants. (a) Constant Speed Electric Generators: Squirrel Cage induction Generators (SCIG), Wound Rotor, Induction Generator (WRIG), (b) Variable Speed Electric Generators: Doubly – fed induction generator (DFIG), wound rotor synchronous generator (WRSG), permanent magnet synchronous generator (PMSG), Construction layout of different types of horizontal and vertical axis small wind turbines; direct-drive and geared; permanent magnet generators and induction generators. Location and installation of small wind turbines.

4.1	Wind Map of India4-2
4.1.1	Site Selection for Wind Power Plant4-4
4.1.2	Wind Power Plants in India4-4
4.1.3	Block Diagram of Wind Energy Conversion4-4
4.2	Layout of Horizontal Axis Large Wind Power Plant4-5
4.2.1	Geared Wind Power Plant4-6
4.2.2	Direct Drive Wind Power Plant4-7
4.3	Salient Features of Electric Generators used in Large Wind Power Plants4-8
4.4	Classification of Wind Turbine Generators4-8
4.4.1	Constant Speed Electric Generators4-9
4.4.1(A)	Constant Speed Squirrel Cage Induction Generator (SCIG)4-9
4.4.1(B)	Constant Speed Wound Rotor Induction Generator (WRIG)4-10
4.4.2	Variable Speed Electric Generator4-11
4.4.2(A)	Doubly Fed Induction Generator (DFIG)4-11
4.4.2(B)	Wound Rotor Synchronous Generator4-12
4.4.2(C)	Permanent Magnet Synchronous Generator (PMSG)4-13
4.4.3	Performance of Wind Mills4-14
4.5	Construction Layout of Different Types of Horizontal and Vertical Axis Small Wind Turbines4-17

4.5.1	Horizontal Axis Small Wind Turbine (HAWT)4-18
4.5.2	Vertical Axis Small Wind Turbine (VAWT)4-19
4.6	Working of Different Types of Horizontal and Vertical Axis Small Wind Turbines4-21
4.6.1	Horizontal Axis Small Wind Turbine4-21
4.6.2	Vertical Axis Small Wind Turbine4-22
4.6.3	Comparison between HAWT and VAWT4-24
4.6.4	Comparison between Fixed Speed Wind Turbine and Variable Speed Wind Turbine4-24
4.7	Location and Installation of Small Wind Turbines4-24
4.8	MSBTE Questions and Answers4-25

### **UNIT V**

# Chapter 5: Economics of Power Generation and Interconnected Power System 5-1 to 5-31

Syllabus: Related terms: connected load, firm power, cold reserve, hot reserve, spinning reserve. Base load and peak load plants; Load curve, load duration curve, integrated duration curve., Cost of generation: Average demand, maximum demand, demand factor, plant capacity factor, plant use factor, diversity factor, load factor and plant load factor. Choice of size and number of generator units, combined operation of power station. Causes and Impact and reasons of grid system fault: State grid, national grid, brownout and blackout; sample blackouts at national and international level.

5.1	Economics of Power Generation5-2
5.1.1	Different Load Curves5-3
5.1.2	Base Load and Peak Load Plants5-7
5.2	Cost of Generation5-8
5.2.1	Average Demand5-8
5.2.2	Maximum Demand5-9
5.2.3	Demand Factor5-10

5.2.4	Plant Capacity Factor	5-10
5.2.5	Plant Use Factor	5-10
5.2.6	Diversity Factor	5-11
5.2.7	Load Factor	5-11
5.2.8	Plant Load Factor	5-12
5.2.9	Numericals on Cost of Generations	5-12
5.3	Choice of Size and Number of Generator Units	5-21
5.3.1	Difficulties in Selecting the Number of Units	5-22
5.3.2	Combined Operation of Power Stations	5-23
5.3.2(A)	Advantages of Integrated System (Grid)	5-23
5.3.2(B)	Merits of Combined Operation of Power Plants	5-24
5.3.2(C)	Limitations of Interconnected Power Station	5-24
5.3.2(D)	Co-ordination of Base Load and Peak Load	5-24
5.3.2(E)	Advantages of Grid System	5-24
5.4	Regional Grid / State Grid / National Grid, Reasons of System Fault	
5.4.1	Causes / Reasons of a Grid System Failure	
	(Collapse)	5-25
5.4.2	Impact of Grid Failure (Fault)	5-26
5.4.3	Blackout and Brownout	5-26
5.4.3(A)	Difference between Blackout and Brownout	5-27
5.4.3(B)	Sample Blackout at National and International Level	5-27
5.5	MSBTE Questions and Answers	5-29
>	Appendix A : Solved MSBTE Question Paper of Summer - 2019	4-13



