Contents

	•	Fourth Edition Third Edition	xiii xvii
1.	•	tion: Economics of Power Generation	1
١.	1.1	Introduction I	
		Load–Duration Curves 4	
		Location of Power Plants 11	
		Power Plant Economics 12	
	1.4		
	1.5		
	1.0	Solved Examples 27	
		Short-answer Questions 39	
		Problems 40	
		Bibliography 42	
		Bibliography 42	
2.	Analysis	of Steam Cycles	43
	2.1		
	2.2	•	
	2.3	•	
	2.4	Mean Temperature of Heat Addition 50	
	2.5	Effect of Variation of Steam Condition on Thermal	
		Efficiency of Steam Power Plant 52	
	2.6	Reheating of Steam 54	
	2.7	Regeneration 56	
	2.8	Regenerative Feedwater Heating 58	
	2.9		ir
	2.10	•	
	2.11		
	2.12	Supercritical Pressure Cycle 70	
	2.13	Steam Power Plant Appraisal 70	
	2.14	Deaerator 72	
	2.15	Typical Layout of Steam Power Plant 74	
	2.16	Efficiencies in a Steam Power Plant 76	
	2.17	Cogeneration of Power and Process Heat 78	
		Solved Examples 82	
		Short-answer Questions 95	

5.1 Introduction 221

3.	Combin	ed Cycle Power Generation	•	100
	3.1	Flaws of Steam as Working Fluid in Power Cycle	100	
	3.2	Characteristics of Ideal Working Fluid for		
		Vapour Power Cycle 100		
	3.3	Binary Vapour Cycles 101		
	3.4	Coupled Cycles 104		
	3.5	Combined Cycle Plants 106		
	3.6	Gas Turbine–Steam Turbine Power Plant 106		
		Solved Examples 140		
		Short-answer Questions 150		
		Problems 151		
		Bibliography 153		
4.	Fuels ar	nd Combustion		155
	4.1	Introduction 155		
	4.2	Coal 155		
	4.3	Coal Analysis 156		
	4.4	Fuel Oil 159		
	4.5	Natural and Petroleum Gas 160		
	4.6	2		
	4.7	Coal–Oil and Coal–Water Mixtures 161		
	4.8	Industrial Wastes and Byproducts 162		
	4.9	Synthetic Fuels 163		
	4.10	Biomass 167		
	4.11	Thermodynamic View 169		
	4.12			
	4.13	Mass Balance of a Steam Generator 179		
	4.14	••		
	4.15	Draught (or Draft) System 182		
	4.16	Fans 188		
	4.17	Heat of Combustion 190		
	4.18	Heating Values: Enthalpy of Combustion 193		
	4.19	Theoretical Flame Temperature 195		
	4.20	Free Energy of Formation 196		
	4.21 4.22	Equilibrium Constant $K_p = 197$		
	4.22	Effect of Dissociation 200		
		Solved Examples 202		
		Short-answer Questions 215 Problems 217		
		Bibliography 220		
5.		stion Mechanism, Combustion Equipment		
	and Firi	ing Methods		221

		Kinetics of Combustion Reactions 222	
		Mechanism of Solid Fuel Combustion 224	
	5.4	Kinetic and Diffusion Control 225	
	5.5	Combustion Equipment for Burning Coal 228	
	5.6	Fuel Bed Combustion 228	
	5.7	Mechanical Stokers 230	
	5.8	Pulverized Coal Firing System 234	
		Cyclone Furnace 258	
		Fluidized Bed Combustion 259	
	5.11	Coal Gasifiers 283	
	5.12	Combustion of Fuel Oil 289	
	5.13	Combustion of Gas 291	
	5.14	Combined Gas Fuel Oil Burners 291	
		Solved Examples 292	
		Short-answer Questions 295	
		Problems 298	
		Bibliography 298	
,	Ctoom (Generators	200
6.		Introduction 300	300
		Basic Types of Steam Generators 300	
		Fire-tube Boilers 301	
		Water-Tube Boilers 304	
		Economizers 336	
		Superheaters 339	
		Reheaters 343	
	6.8		
		Air Preheater 354	
		Fluidized Bed Boilers 359	
	6.11(a)		
		Ultra Supercritical Technology 385	
		Advanced Ultra Supercritical Technology (AUSC) 385	
		Flue Gas De-nitrification and Desulphurization 386	
		Electrostatic Precipitator 387	
		Fabric Filters and Baghouses 390	
		Ash-Handling System 392	•
		Feedwater Treatment 393	
		Deaeration 399	
	6.17	Evaporation 400	
	6.18	Internal Treatment 401	
	6.19		
	6.20		
	0.20	Solved Examples 403	
		Short-answer Questions 412	
		Problems 414	
		Bibliography 417	
		Dionography T11	

7.	Steam T	urbines	418
	7.1	Introduction 418	
	7.2	Flow Through Nozzles 422	
	7.3	Turbine Blading 439	
		Electrical Energy Generation 492	
		Solved Examples 494	
		Short-answer Questions 533	
		Problems 534	
		Bibliography 539	
8.	Conden	ser, Feedwater and Circulating Water Systems	540
	8.1	Need of a Condenser 540	
	8.2	Direct-Contact Condensers 541	
	8.3	Surface Condensers 543	
	8.4	Feedwater Heaters 552	
	8.5	Circulating Water System 555	
	8.6	Cooling Towers 557	
	8.7	Cooling Tower Calculations 564	
		Solved Examples 568	
		Short-answer Questions 575	
		Problems 576	
		Bibliography 577	
9.		Power Plants	578
	9.1	Introduction 578	
	9.2		
	9.3		
	9.4		
	9.5	Radioactive Decay and Half Life 582	
	9.6	Nuclear Fission 586	
	9.7		
	9.8	Neutron Energies 589	
	9.9	Nuclear Cross Sections 592	
	9.10	Neutron Flux and Reaction Rates 594	
	9.11	Moderating Power and Moderating Ratio 595	
	9.12	Variation of Neutron Cross Sections with Neutron Energy	595
	9.13	Neutron Life Cycle 597	
	9.14	Reflectors 600	
	9.15	Heat Transfer and Fluid Flow in Nuclear Reactors 601	
	9.16	Types of Reactors 608	
	9.17	Pressurized Water Reactor (PWR) 610	
	9.18	Boiling Water Reactor (BWR) 612	
	9.19	Gas-cooled Reactors 615	
	9.20	Liquid Metal Fast Breeder Reactor 616	
	9.21	Heavy Water Reactors 619	
	9.22	India's Nuclear Power Programme 620	
	9.23	Fusion Power Reactors 621	

		Shired Examples 525	
		Short-answer Questions 627	
		Problems 629	
		Bibliography 629	
40	Hudrool	ectric Power Plant	630
10.	nyuruei	Introduction 630	
		Advantages and Disadvantages of Water Power 631	
		Optimization of Hydro-Thermal Mix 632	
	10.3		
		Hydrological Cycle 634	
		Hydrographs 635	
		2 2 1	
	10.7	Essential Elements of a Hydroelectric Power Plant 640	
		· · · · · · · · · · · · · · · · · · ·	
	10.9		
		Pelton Wheel 655	
		Degree of Reaction 660	
		Francis Turbines 661	
		Propeller and Kaplan Turbines 663	
		Deriaz Turbine 666	
		Bulb Turbine 667	
	10.18	Specific Speed 667	
	10.19	•	
	10.20	Cavitation 670	
	10.21	Governing of Hydraulic Turbines 670	
	10.22	E .	
	10.23	Surge Tanks 673	
		Performance of Turbines 675	
	10.25	Selection of Turbines 679	
		Solved Examples 680	
		Short-answer Questions 697	
		Problems 699	
		Bibliography 703	
11	Diasal F	ingine and Gas Turbine Power Plants	704
		Introduction 704	, 0
	11.2	Applications of Diesel Engines in Power Field 704	
	11.3	Advantages and Disadvantages of Diesel Engine Power Plant	705
	11.4	Types of Diesel Plants 705	,00
	11.5	General Layout 706	
	11.6	Combustion in a CI Engine 720	
	11.7	Performance Characteristics 723	
	11.7	Supercharging 730	
	11.8	Layout of a Diesel Engine Power Plant 734	
	11.10	Gas Turbine Power Plant 735	
	11.10	Oas Tulullic fower flailt /33	

Solved Examples 623

	11.11	Components of Gas Turbine Plant 748	
		Gas Turbine Fuels 755	
	11.13	Gas Turbine Materials 756	
	11.14	Free Piston Engine Plant 758	
		Solved Examples 759	
		Short-answer Questions 772	
		Problems 773	
		Bibliography 777	
12.	Energy S	Storage	778
	12.1	-	
	12.2	Pumped Hydro 780	
	12.3	Compressed Air Energy Storage (CAES) 783	
		Flywheel Energy Storage 786	
		Electrochemical Energy Storage 790	
		Magnetic Energy Storage 799	
		Thermal Energy Storage 801	
		Chemical Energy Storage 807	
	12.9	Hydrogen Energy 809	
		Solved Examples 813 Short-answer Questions 815	
		Short-answer Questions 815 Problems 817	
		Bibliography 818	
		Dibitography 010	
13.		nventional Power Generation: Direct Energy	
13.	Convers	sion	819
13.	Convers	sion Introduction 819	819
13.	13.1 13.2	ion Introduction 819 Magnetohydrodynamic (MHD) Power Generation 819	819
13.	13.1 13.2 13.3	Introduction 819 Magnetohydrodynamic (MHD) Power Generation 819 Thermionic Power Generation 826	819
13.	13.1 13.2 13.3 13.4	Introduction 819 Magnetohydrodynamic (MHD) Power Generation 819 Thermionic Power Generation 826 Thermoelectric Power Generation 832	819
13.	13.1 13.2 13.3 13.4 13.5	Introduction 819 Magnetohydrodynamic (MHD) Power Generation 819 Thermionic Power Generation 826 Thermoelectric Power Generation 832 Fuel Cells 841	819
13.	13.1 13.2 13.3 13.4 13.5 13.6	Introduction 819 Magnetohydrodynamic (MHD) Power Generation 819 Thermionic Power Generation 826 Thermoelectric Power Generation 832 Fuel Cells 841 Geothermal Energy 850	819
13.	13.1 13.2 13.3 13.4 13.5	Introduction 819 Magnetohydrodynamic (MHD) Power Generation 819 Thermionic Power Generation 826 Thermoelectric Power Generation 832 Fuel Cells 841 Geothermal Energy 850 Hydrogen Energy System 850	819
13.	13.1 13.2 13.3 13.4 13.5 13.6	Introduction 819 Magnetohydrodynamic (MHD) Power Generation 819 Thermionic Power Generation 826 Thermoelectric Power Generation 832 Fuel Cells 841 Geothermal Energy 850 Hydrogen Energy System 850 Solved Examples 852	819
13.	13.1 13.2 13.3 13.4 13.5 13.6	Introduction 819 Magnetohydrodynamic (MHD) Power Generation 819 Thermionic Power Generation 826 Thermoelectric Power Generation 832 Fuel Cells 841 Geothermal Energy 850 Hydrogen Energy System 850	819
13.	13.1 13.2 13.3 13.4 13.5 13.6	Introduction 819 Magnetohydrodynamic (MHD) Power Generation 819 Thermionic Power Generation 826 Thermoelectric Power Generation 832 Fuel Cells 841 Geothermal Energy 850 Hydrogen Energy System 850 Solved Examples 852 Short-answer Questions 855 Problems 856	819
	13.1 13.2 13.3 13.4 13.5 13.6 13.7	Introduction 819 Magnetohydrodynamic (MHD) Power Generation 819 Thermionic Power Generation 826 Thermoelectric Power Generation 832 Fuel Cells 841 Geothermal Energy 850 Hydrogen Energy System 850 Solved Examples 852 Short-answer Questions 855 Problems 856 Bibliography 857	
	13.1 13.2 13.3 13.4 13.5 13.6 13.7	Introduction 819 Magnetohydrodynamic (MHD) Power Generation 819 Thermionic Power Generation 826 Thermoelectric Power Generation 832 Fuel Cells 841 Geothermal Energy 850 Hydrogen Energy System 850 Solved Examples 852 Short-answer Questions 855 Problems 856 Bibliography 857 mental Degradation and Use of Renewable Energy	819
	13.1 13.2 13.3 13.4 13.5 13.6 13.7	Introduction 819 Magnetohydrodynamic (MHD) Power Generation 819 Thermionic Power Generation 826 Thermoelectric Power Generation 832 Fuel Cells 841 Geothermal Energy 850 Hydrogen Energy System 850 Solved Examples 852 Short-answer Questions 855 Problems 856 Bibliography 857 mental Degradation and Use of Renewable Energy Introduction 858	
	13.1 13.2 13.3 13.4 13.5 13.6 13.7	Introduction 819 Magnetohydrodynamic (MHD) Power Generation 819 Thermionic Power Generation 826 Thermoelectric Power Generation 832 Fuel Cells 841 Geothermal Energy 850 Hydrogen Energy System 850 Solved Examples 852 Short-answer Questions 855 Problems 856 Bibliography 857 mental Degradation and Use of Renewable Energy Introduction 858 Greenhouse Effect 859	
	13.1 13.2 13.3 13.4 13.5 13.6 13.7 Environ 14.1 14.2 14.3	Introduction 819 Magnetohydrodynamic (MHD) Power Generation 819 Thermionic Power Generation 826 Thermoelectric Power Generation 832 Fuel Cells 841 Geothermal Energy 850 Hydrogen Energy System 850 Solved Examples 852 Short-answer Questions 855 Problems 856 Bibliography 857 mental Degradation and Use of Renewable Energy Introduction 858 Greenhouse Effect 859 Acid Rain 860	
	13.1 13.2 13.3 13.4 13.5 13.6 13.7 Environ 14.1 14.2 14.3 14.4	Introduction 819 Magnetohydrodynamic (MHD) Power Generation 819 Thermionic Power Generation 826 Thermoelectric Power Generation 832 Fuel Cells 841 Geothermal Energy 850 Hydrogen Energy System 850 Solved Examples 852 Short-answer Questions 855 Problems 856 Bibliography 857 mental Degradation and Use of Renewable Energy Introduction 858 Greenhouse Effect 859 Acid Rain 860 Smog 860	
	13.1 13.2 13.3 13.4 13.5 13.6 13.7 Environ 14.1 14.2 14.3 14.4 14.5	Introduction 819 Magnetohydrodynamic (MHD) Power Generation 819 Thermionic Power Generation 826 Thermoelectric Power Generation 832 Fuel Cells 841 Geothermal Energy 850 Hydrogen Energy System 850 Solved Examples 852 Short-answer Questions 855 Problems 856 Bibliography 857 mental Degradation and Use of Renewable Energy Introduction 858 Greenhouse Effect 859 Acid Rain 860 Smog 860 Nuclear Radiation 861	
	13.1 13.2 13.3 13.4 13.5 13.6 13.7 Environ 14.1 14.2 14.3 14.4	Introduction 819 Magnetohydrodynamic (MHD) Power Generation 819 Thermionic Power Generation 826 Thermoelectric Power Generation 832 Fuel Cells 841 Geothermal Energy 850 Hydrogen Energy System 850 Solved Examples 852 Short-answer Questions 855 Problems 856 Bibliography 857 mental Degradation and Use of Renewable Energy Introduction 858 Greenhouse Effect 859 Acid Rain 860 Smog 860 Nuclear Radiation 861	
	13.1 13.2 13.3 13.4 13.5 13.6 13.7 Environ 14.1 14.2 14.3 14.4 14.5 14.6	Introduction 819 Magnetohydrodynamic (MHD) Power Generation 819 Thermionic Power Generation 826 Thermoelectric Power Generation 832 Fuel Cells 841 Geothermal Energy 850 Hydrogen Energy System 850 Solved Examples 852 Short-answer Questions 855 Problems 856 Bibliography 857 mental Degradation and Use of Renewable Energy Introduction 858 Greenhouse Effect 859 Acid Rain 860 Smog 860 Nuclear Radiation 861 Solar Energy 861	

Solved Examples 897 Short-answer Questions Bibliography 900	899
Objective Questions	902
Appendix A	918
Appendix B	943
Appendix C	945

948

14.9 Geothermal Energy 889 14.10 Small Hydro 894

14.11 Energy from Biomass 895

Index