

# Contents

<b>Certificate</b>	<b>i</b>
<b>Abstract</b>	<b>ii</b>
<b>Acknowledgements</b>	<b>v</b>
<b>Dedication</b>	<b>vi</b>
<b>Contents</b>	<b>vii</b>
<b>List of Figures</b>	<b>x</b>
<b>List of Tables</b>	<b>xii</b>
<b>Nomenclature</b>	<b>xv</b>
<b>1 Introduction</b>	<b>1</b>
1.1 Waste heat recovery . . . . .	3
1.2 Integrated energy systems . . . . .	3
1.2.1 Cogeneration systems . . . . .	4
1.2.2 Trigeneneration systems . . . . .	5
1.3 4E analyses . . . . .	8
1.4 Multi-objective Optimization . . . . .	11
1.5 Motivation and research objectives . . . . .	12
1.6 Outline of thesis chapter . . . . .	15
Bibliography . . . . .	17
<b>2 Literature review</b>	<b>22</b>
2.1 Energy and Exergy analyses . . . . .	22
2.2 Exergoeconomic analysis . . . . .	27
2.3 Environmental analysis . . . . .	32

2.4	Multi-objective optimization . . . . .	35
2.5	Scope of the present work . . . . .	38
	Bibliography . . . . .	40
<b>3</b>	<b>Energy and exergy analyses of four different combined power and cooling systems integrated with a topping gas turbine plant</b>	<b>51</b>
3.1	Description of CPC system configurations . . . . .	52
3.2	Modelling . . . . .	54
3.2.1	Assumptions . . . . .	54
3.2.2	Energy analysis . . . . .	56
3.2.3	Exergy analysis . . . . .	62
3.2.4	Overall performance criteria . . . . .	65
3.3	Results and discussion . . . . .	66
3.3.1	Model validation . . . . .	66
3.3.2	Energy-based results . . . . .	70
3.3.3	Exergy-based results . . . . .	76
3.4	Summary . . . . .	84
	Bibliography . . . . .	86
<b>4</b>	<b>Exergoeconomic investigation and multi-objective optimization of different ORC configurations for waste heat recovery</b>	<b>89</b>
4.1	Description of the ORC layouts . . . . .	90
4.2	Modelling . . . . .	90
4.2.1	Assumptions . . . . .	91
4.2.2	Energy analysis . . . . .	93
4.2.3	Exergy analysis . . . . .	93
4.2.4	Exergoeconomic analysis . . . . .	95
4.2.5	Multi-objective optimization . . . . .	98
4.3	Results and discussions . . . . .	102
4.3.1	Model validation . . . . .	102
4.3.2	Parametric results . . . . .	103
4.4	Multi-objective optimization-based results . . . . .	106
4.4.1	Energy results . . . . .	108
4.4.2	Exergy results . . . . .	108
4.4.3	Exergoeconomic results . . . . .	110
4.5	Summary . . . . .	113
	Bibliography . . . . .	115

<b>5</b>	<b>Multi-objective optimization of four recuperative gas turbine-based CCHP systems and 4E analyses at optimal conditions</b>	<b>118</b>
5.1	Description of CCHP system configurations . . . . .	118
5.2	Modelling . . . . .	121
5.2.1	Assumptions . . . . .	121
5.2.2	Energy analysis . . . . .	123
5.2.3	Exergy analysis . . . . .	125
5.2.4	Exergoeconomic analysis . . . . .	126
5.2.5	Environmental analysis . . . . .	133
5.2.6	Multi-objective optimization . . . . .	138
5.3	Results and discussion . . . . .	141
5.3.1	Model validation . . . . .	141
5.3.2	4E analysis at base case . . . . .	141
5.3.3	Comparative study . . . . .	155
5.3.4	Parametric results . . . . .	156
5.3.5	Multi-objective optimization-based results . . . . .	166
5.4	Summary . . . . .	174
	Bibliography . . . . .	177
<b>6</b>	<b>Conclusions and future scopes</b>	<b>181</b>
6.1	Conclusions . . . . .	181
6.1.1	Contributions of this research study . . . . .	187
6.2	Future research scope . . . . .	188
	<b>Appendix</b>	<b>189</b>
	<b>List of publications</b>	<b>191</b>