## LIST OF FIGURES

FIGURE	DESCRIPTION	PAGE
	CHAPTER I	
1.1	Scope of work conducted during this project	9
1.2	Objectives and activities for developing the <i>Pleurotus ostreatus</i> spent mushroom substrate compost as biosorbent for heavy metal treatment in aqueous solutions	10
	CHAPTER II	
2.1	The biological neuron network is transformed and extracted to artificial neuron network system	47
	CHAPTER III	
3.1	(a) General sampling locations (b) Specific wastewater sampling location at phosphating tank, Perodua Manufacturing Sdn. Bhd.	64
3.2	Schematic diagram of heavy metal biosorption procedure	81
	CHAPTER IV	
4.1	Light metal concentration per gram of biosorbent for different biosorbent concentration in 200 mL UPW	92
4.2	Heavy metal concentration per gram of biosorbent for different biosorbent concentration in 200 mL UPW	93
4.3	Light metal concentration per gram of biosorbent for different immersion time	95
4.4	Heavy metal concentration per gram of biosorbent for different immersion time	95
4.5	Percentage of light metal removal for different number of washing cycle	96
4.6	Percentage of heavy metal removal for different number of washing cycle	97

4.7	The effect of NW-PSMC and PSMC on Ni(II) biosorption efficiency	98
4.8	SEM micrograph of PSMC (a) before biosorption (b) after Pb(II) biosorption (c) after Cu(II) biosorption and (d) after Ni(II) biosorption	103
4.9	EDX spectrum of PSMC (a) before biosorption (b) after Pb(II) biosorption (c) after Cu(II) biosorption and (d) after Ni(II) biosorption	104
4.10	Zeta potential of PSMC biosorbent as a function of initial pH of the liquid medium	108
4.11	FTIR spectrum of PSMC biosorbent (a) before biosorption (b) after Pb(II) biosorption (c) after Cu(II) biosorption and (d) after Ni(II) biosorption	108
4.12	Comparisan of CPMAS spectra for PSMC biosorbent before and after heavy metal biosorption	111
4.13	$^{13}C$ ssNMR spectra of DP SatRec before and after heavy metal biosorption	113
4.14	DP Invrec experiment for heavy metal ions paramagnetic effect evaluation (a) Pb(II) (b) Cu(II) and (c) Ni(II)	114
4.15	The $T_1$ time in TORCHIA experiments for (a) lignin carboxyl and (b) lignin C-1/C-4 of aromatic of syringyl and guaiacyl	115
4.16	ICP-OES analysis of Pb(II) and light metal behaviour	117
4.17	Effect of contact time on pH	119
4.18	Proposed derivation of complexation structures of syringyl and guaiacyl lignin components with Pb(II) based on results of this study	121
4.19	Hypothesed structure for lignin carboxyl-Pb(II) complex	122
4.20	Hypothesed structure for chitin-Pb(II) complex	123
4.21	The effect of biosorbent concentration on heavy metal biosorption	125
4.22	The effect of initial pH on heavy metal biosorption	126
4.23	The effect of contact time on heavy metal biosorption	129
4.24	The effect of initial heavy metal concentration on heavy metal biosorption	132

4.25	The effect of temperature on heavy metal biosorption	133
4.26	Schematic diagram of biosorption-desorption process for mass balance and recovery	151
4.27	MATLAB script – loading and scaling input data	156
4.28	MATLAB script – setting training parameters	157
4.29	Predictions of ANN with developed ANN model compared to trained data	157
4.30	Results obtained from ANN training showing the errors with varying hidden layer size	158
4.31	Results obtained from ANN training showing the errors for hidden layer 8 to 25	159
4.32	Results obtained from ANN training showing the errors with varying learning rate size	159
4.33	Results obtained from ANN training showing the errors with varying momentum rate	160
4.34	Comparison between the experimental values and the predicted values using developed ANN model	161