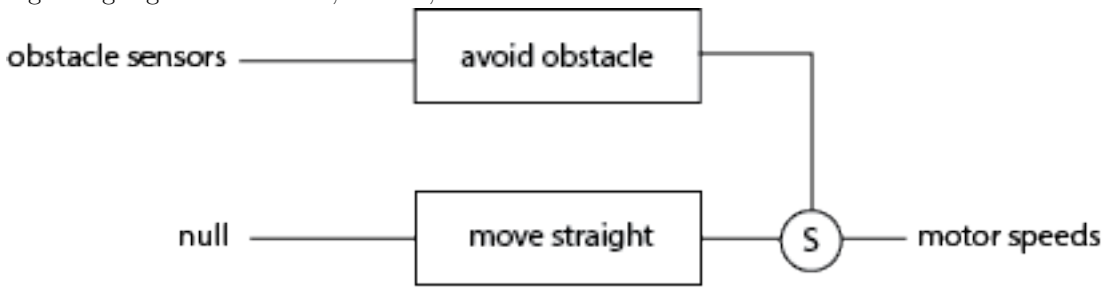
ENGINEERING MATHS EXAM SOLUTIONS 2015-2016

Q No.	PAPER NAME Bio-inspired Artificial Intelligence Q.SETTER INITIALS SH	Marks
1a	output1: 1, output2: -0.5717	2
1b	There are multiple correct answers: • 4 inputs (3 numbers and 1 bias), linear output function, one output. • 3 inputs (2 bits and 1 bias), two (or three if bias included) hidden neurons, step or sigmoid function, one output. • many possible architectures - most important is that the time sequence is either represented in the input (sliding window input), or that internal memory is enabled through recursion.	3
2a	[0 0 0 1 0 1 0 0 0], [0 0 1 0 1 0 1 0 0], [0 1 0 1 0 1 0 1 0], [1 0 1 0 1 0 1 0 1]	2
2b	Periodic final state.	1
2c	Anything a Turing machine can compute - universal machine.	1
3a	There are multiple correct answers: • genotype: $[w_1, w_2]$, where w_i is a float between 0 and 1. • phenotype: motorspeed1 = $default\_speed + w_1 * sensor\_1$, motorspeed1 = $default\_speed + w_2 * sensor\_2$ • fitness: Area covered by the robot. • initial population: 100 random genomes. • selection operator: tournament selection. • crossover and mutation probabilities: single point crossover, w_i mutation - probability = 0.1	5
3b	Improve the fitness function, increase the population size, increase diversity in the population, increase mutation and crossover probabilities.	2
4a	There are multiple correct answers: • Inspiration from eyes for optic flow sensing. • Inspiration from flapping wings for lift generation at small scales. • Inspiration from reactive behaviour and robustness/compliance to control flight using minimal processing. • Coordination in populations of insects using minimal local interactions.	4
4b	Reproducing certain aspects of fly behaviour or "hardware" could provide hypotheses to biologists regarding flight mechanisms, control, and coordination.	1
4c		2

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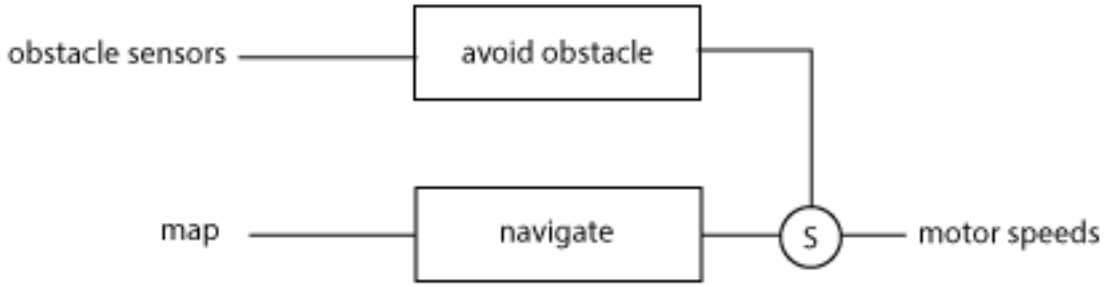
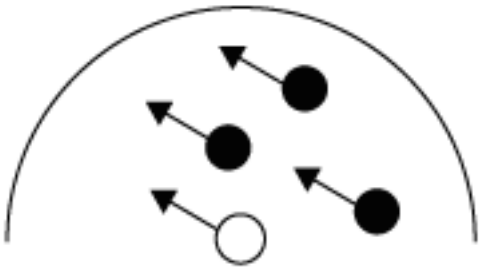
		
4d		1
5a	Robot Hand - pros: precise, controllability, similar to human hands; cons: many controllable degrees of freedom, requires planning and computation, expensive. Soft Robot - pros: cheap, conforms to shape of object, embodied control, robust; cons: limited precision and capabilities, difficult to model.	2
5b	Localisation (spiders can localise prey depending on where they land).	1
6a	• $N+X_1->Y$,$Y+X_1->N$ • $N+X_1->Y$,$Y+X_2->N$ • $X_1->2Y$ • $X_1+X_1->Y$ • $X_1->Y$,$X_2->Y$ • $X_1+X_2->Y$	6
		
7a		1
7b	For every agent: v1=compute attraction vector to neighboring agents; v2=compute repulsion vector from neighboring agents; v3=compute average velocity vector of neighboring agents; move in direction of the resulting vector combining v1, v2, and v3.	2
7c	Hand-coded (trial and error), bio-inspired, automatically designed (using artificial evolution for example).	2
7d	Group-level selection, homogeneous swarms.	2