9.6 Constrained design project

Name: _____ Class: _____ Date: _____ **Total: 14 marks**

KEY WORDS weighted decision matrix • design spiral

Objective

Choose a concept with a weighted decision matrix, test how robust the choice is to the weights, and collect the checks of a design into one file that names the governing limit.

1 Key knowledge and worked examples

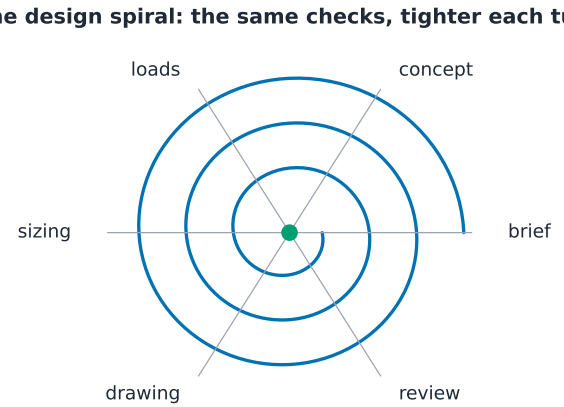
Decide, then check, then turn again

- **Weighted decision matrix** : score each concept 1 to 5 on each criterion, multiply by the weights (summing to 1) and add.
- A choice is robust only if it survives reasonable changes to the weights.
- **Design spiral** : each turn repeats the same checks (shaft, bearings, bolts, gears) with better numbers, and records what is still assumed.

Worked example. Choosing the drive concept

Weights: cost 0.35, size 0.25, efficiency 0.25, maintenance 0.15.

- A spur gears (4, 3, 4, 3): $0.35 \times 4 + 0.25 \times 3 + 0.25 \times 4 + 0.15 \times 3 = \mathbf{3.60}$.
- B belt drive (5, 2, 3, 3): **3.45**; C gearmotor (3, 4, 4, 5): **3.80**.
- C wins on this brief; the design file must say why the course still details A.



2 Practice

A conveyor drive brief weights cost 0.30, size 0.30, efficiency 0.25 and maintenance 0.15. Scores (cost, size, efficiency, maintenance): A spur gears (4, 3, 4, 3); B chain drive (5, 4, 3, 2); C gearmotor (3, 4, 5, 4).

2.1 Find each concept's weighted score (two decimals) and the winner. [4]

2.2 The client now weights cost 0.45, size 0.20, efficiency 0.20 and maintenance 0.15. Recompute and say whether the choice is robust. [4]

3 Exam-style questions

3.1 A design file lists: shaft Goodman $n = 2.13$, shaft yield $n = 3.95$, bearing $L_{10} = 49\,100$ h against 30 000 h required, bolt load factor 4.21, gear bending $n = 1.66$. Turn the bearing life into a factor on load (life $\propto 1/P^3$), name the governing check, and list two assumptions the next turn of the spiral must test. [6]