S5 DAT Practice Paper 1 | Gear ratio, efficiency, moments, stress and circuits

Senior Secondary Design and Applied Technology

S5 DAT practice paper with worked answers: gear ratio and output speed, worm reduction, lever moments, material stress and safety factor, resistor networks and energy cost.

1. Gear ratio and output speed (16 marks)

Give speeds in rpm and velocity in m/s to 2 decimal places.

#	Question
1	(a) A 60-tooth driver gear at 900 rpm drives a 40-tooth driven gear. Find the gear ratio and the driven speed.
2	(b) A three-gear train has a 48-tooth driver, a 16-tooth idler and a 24-tooth driven gear at 900 rpm input. Find the output speed and state the function of the idler.
3	(c) A single-start worm drives a 40-tooth worm wheel from a 1440 rpm motor. Find the reduction ratio and the output speed.
4	(d) The 40-tooth driven gear has a module of 2 mm. Find its pitch circle diameter and, using the 600 rpm in (a), the pitch line velocity in m/s.

2. Mechanical advantage and efficiency (18 marks)

Show working; give efficiency to 1 decimal place.

#	Question
5	(a) A pulley system lifts a 1500 N load with an effort of 375 N. Find the mechanical advantage.
6	(b) While the effort moves 2.0 m the load rises only 0.4 m. Find the velocity ratio.
7	(c) Calculate the efficiency of the system and state where the remaining energy goes.
8	(d) The lift takes 5 s. Find the input work, output work, energy lost, and the input and output power.

3. Levers and moment balance (16 marks)

Give moments in N m and write the balance equation.

#	Question
9	(a) A 250 N downward force acts 0.8 m to the left of a fulcrum. What force is needed at 0.5 m to the right to balance it?
10	(b) A 120 N weight hangs 0.45 m to the left of the fulcrum. What weight is needed at 0.36 m to the right?
11	(c) A handle is 0.25 m long and an effort of 160 N is applied at right angles. Find the moment and explain why an inclined effort gives a smaller effective moment.
12	(d) A crowbar has a load arm of 0.25 m and an effort arm of 1.5 m for a 900 N load. Find the effort needed and the velocity ratio.

4. Material stress and safety factor (18 marks)

Give stress in MPa and use suitable units for strain and modulus.

#	Question
13	(a) A tie bar of cross-section 150 mm^2 carries a tensile force of 4500 N. Find the tensile stress.
14	(b) The 2.0 m gauge length extends by 1.2 mm under load. Find the strain and the Young modulus in GPa.
15	(c) The yield strength is 240 MPa. Find the safety factor at the working stress of 30.0 MPa and judge whether it meets the usual design requirement (at least 3).
16	(d) If the design code requires a safety factor of at least 3, find the allowable stress and the maximum permissible load on this bar.

5. Resistor networks and power (16 marks)

Current may be given in mA; give power to 3 decimal places.

#	Question
17	(a) A 180 ohm and a 270 ohm resistor are connected in series. Find the total resistance.
18	(b) The same pair is reconnected in parallel. Find the equivalent resistance.
19	(c) The series combination is connected to 12 V. Find the current in mA and the voltage drop across the 180 ohm resistor.
20	(d) Find the power dissipated in the 270 ohm resistor in W.

6. Energy, power and electricity cost (16 marks)

Take g = 9.81 m/s^2 and give energy to 2 decimal places.

#	Question
21	(a) A hoist raises a 25 kg load through 1.8 m in 4 s. Find the work done and the average power.
22	(b) If the motor input power is 160 W, find the system efficiency.
23	(c) Find the energy lost as heat and sound during these 4 s.
24	(d) If the system runs continuously for 2.5 hours at 160 W input, find the energy used in kWh and the cost at $1.20 per kWh.