

National Exams May 2011

04-For-B7, Transportation of Forest Products

3 Hours Duration

Notes:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.
2. The examination is closed book. As a consequence, candidates are not permitted to make use of any textbooks, references or notes.
3. The use of one of two calculators is permitted, the Casio or Sharp approved models.
4. The answers to five groups of questions, three of the four question groups from Part A (1, 2, 3, 4) and all questions of the two groups from Part B, comprise a complete examination.
5. Candidates must indicate the answers that they wish to have graded on the cover of the first examination book. Otherwise the answers will be graded in the order in which they appear in the examination book(s) up to a maximum of one group of questions in Part A and all questions in Part B.
6. The total value of six questions in three question groups in Part A is the same as for the six questions in two question groups in Part B.

Transportation of Forest Products

Part A

1. Stopping sight distance

One key element in horizontal and vertical road alignment is to allow for sufficient stopping sight distance according to the design speed of the road.

1.1 How is the stopping sight distance found for a certain design speed?

1.2 Name and explain factors influencing the stopping sight distance besides the design speed.

2. Vehicle characteristics

2.1 What is the function of the vehicle transmission?

2.2 Describe the torque and power requirements of an engine in a hauling truck on its way from landing to mill.

3. Vehicle stability during operation

3.1 List factors affecting vehicle stability when driving.

3.2 List and describe vehicle design features enhancing vehicle stability on the road, use A-, B- and C-trains as examples.

4. Variable tire inflation pressure systems (VTP)

4.1 Explain the concept of VTP and technical necessities.

4.2 Describe advantages and disadvantages of using VTP for log hauling.

Transportation of Forest Products

Part B

5. Gradeability

Gradeability is understood as the maximum gradient a particular vehicle can climb before wheels start to spin. In a simple model gradeability is explained by $\tan \theta \leq f$

- 5.1 Draw a free body diagram of a wheel on a gradient and indicate the acting forces when the wheel is just about to spin. Give the sum of forces in x and y direction.
- 5.2 Explain how $\tan \theta \leq f$ is derived from the forces in x and y direction.
- 5.3 Explain f and give a reasonable number for f of a forest road.
- 5.4 Apply your assumed f within $\tan \theta \leq f$. What would be the maximum allowable road gradient (in %)

6. Rail transportation (please see the formulas on the next page)

A train consists of 4500 hp locomotives with 4-axles weighing 165 tons and has a cross-sectional area of 135 ft². The train must haul 20 four-axle freight cars which each weigh 70 tons on average. The train must be able to ascend a 2.25% grade with a 2° curve at 60 mph.

- 6.1 How many locomotives are required for the train to maintain this speed up the hill and around the curve?
- 6.2 What is the maximum speed of this train on a level and straight section of track?

04-For-B7/ May 2011

Transportation of Forest Products

Propulsion

$$M = 375P \eta / V$$

[...where M = propulsive force (lbs), η = transmission efficiency (83%), P=power (hp), V=speed (mph)]

Inherent Resistance (locomotives)

$$R = 1.3T + 29N + 0.03TV + CAV^2$$

[...where, R= resistance (lbs), T is weight in tons, N is number of axles, V=speed m.p.h., and C= air resistance parameter= 0.0024 for locomotive]

Inherent Resistance (standard freight cars)

$$R = 1.5 T + 72.5N + 0.015 TV + 0.055 V^2$$

Grade Resistance

$$R_g = (T p)/100$$

[...where R_g = resistance (lbs), T= gross weight of vehicle(lb), p = percent grade]

Curvature Resistance

$$R_c = \epsilon DT$$

[...where R_c = resistance (lbs), ϵ = curvature resistance coeff. (0.81 lb per ton per degree), T=weight (tons)]