Solution to Homework Set #3
CE 327 - Spring 2009
Assigned Sa, 4/11 Due Sa, 4/18

Problem 1

Textbook: 5.1
Weight of tractor, 48,000 lb $\Rightarrow$ 24 tons
Tension in the cable, 4,680 lb
Grade factor, 0.04

Tension in cable	=	4,680 lb
Deduct grade resistance, $0.04 \times 48{,}000$	=	-1,920 lb
Tension required to overcome rolling resistance	=	2,760 lb

Rolling resistance: $\dfrac{2{,}760 \text{ lb}}{24 \text{ tons}} =$ **115 lb/tn**

Problem 2

Textbook: 5.3
Gross weight, 94,000 lb

Speed, 12 mph: $\dfrac{12 \text{ miles}}{\text{hr}} \times \dfrac{5{,}280 \text{ ft}}{\text{mile}} \times \dfrac{\text{hr}}{60 \text{ min}} = 1{,}056$ ft per min

Effect of grade,	$0.04 \times 94{,}000$ lb	= 3,760 lb
Decreased force required to move the load down grade, $0.04 \times 94{,}170$ lb		= 3,760 lb
Difference in force resulting from grade		= 7,520 lb

Energy resulting from gain in force, 7,520 lb × 1,056 = 7,941,120 ft lb per min.

Equivalent gain in power: $\dfrac{7{,}941{,}120 \text{ ft} - \text{lb/min}}{33{,}000} =$ **241 hp**

Problem 3

A tractor has a 360-hp engine under standard conditions. What is the power of the engine when it is operating at an altitude 6500 ft above sea level and at a temperature of 90^0 F?

***** SOLUTION *****

$$HPavailable = RatedHP\left(\frac{P_{act}}{P_{std}}\right)\sqrt{\frac{T_{std}}{T_{act}}} = 360hp\left(\frac{23.45}{29.92}\right)\sqrt{\frac{520°R}{550°R}} = 274.35hp$$

Problem 4

Textbook: 6.1

DOZER PRODUCTION

Step 1. Idea maximum production.

D6H with a 6S blade; 200 ft push distance.

From Fig. 6-12 ideal production is 210 lcy per hour

Step 2. *Material-weight* correction factor.

Bank weight for this project is given as 110 pcf; therefore

$$110 \text{ lb/cu ft} \times 27 \text{ cu ft/cu yd} = 2{,}970 \text{ lb/bcy}$$

Soil Density correction: Table 4-1, 15%

$$\frac{2{,}970}{1.15} = 2{,}583 \text{ lb / lcy}$$

Standard condition is 2,300 lb/lcy

$$\text{Material weight correction} = \frac{2{,}300 \text{ lb / lcy}}{2{,}583 \text{ lb / lcy}} = 0.89$$

Step 3. Determine the operator correction factor (see Table 6-2).

Operator	0.75

Step 4. *Material-type* correction factor. dry noncohesive silty sand (see Table 6-2).

Material (type)	0.80

Step 5. Operating-technique correction factor. No special technique the factor is 1.

Normal Dozing	1.00

Step 6. Visibility correction factor. In the case of good visibility use 1.

Visibility	1.00

Step 7. Efficiency factor. See Table 6-2 or use the assumed number of operating minutes per hour divided by 60 minutes.

Job Efficiency	0.83

Step 8. Machine transmission factor. See Table 6-2.

Transmission	1.00

Step 9. Blade adjustment factor. See note bottom Table 6-2.

Blade	1.00

Step 10. Grade correction factor. Uphill on a 2% grade (Table 6-2 continued).

Grade	0.98

Step 11. Determine the product of the correction factors.

Product, correction factors =

$$0.89 \times 0.75 \times 0.80 \times 1.00 \times 1.00 \times 0.83 \times 1.00 \times 1.00 \times 0.98 = 0.43$$

Step 12. Determine the dozer production.

Production = 210 lcy/hr × 0.43 = 90 lcy/hr

Step 13. Conversion to bcy.

$$\frac{90 \text{ lcy / hr}}{1.15} = 78 \text{ bcy / hr}$$

Step 14. Determine the total cost to operate the dozer.

Cost:

O&O	\$54.00 per hour
Operator (\$12.00 × 1.35)	\$16.20
Total	\$70.20 per hour

Step 15. Determine the direct unit production cost.

$$\text{Direct production cost} = \frac{\$70.20 \text{ per hour}}{78 \text{ bcy / hr}} = \$0.900 \text{ per bcy}$$

Problem 5

A 300-hp crawler tractor will be used to clear small trees and brush from a 15-acre site. By operating in the first gear, the tractor should be able to maintain a continuous forward speed of 1.2 mph. An angle-clearing blade will be used, and from past experience the average resulting clear width will be 10 ft. Assuming an efficiency of 50-min-hr, how long will take to knock down the vegetation?

***** SOLUTION *****

Using Eq. 6.8 of Textbook, we have

$$\text{Pr}\textit{oduction} = \frac{\text{width of cut (ft)} \times \text{speed (mph)}}{10} = \frac{10(1.2)}{10} = 1.2 \text{ acre / hr}$$

$$\text{Time to knock down the vegetation} = \frac{\text{Number of Acres}}{\text{Production}} = \frac{15}{1.2} = 12.5 \textit{hours}$$

Problem 6

Textbook: 7.2

Using equation 7-2:

$$\text{Travel time per segment, min} = \frac{1{,}300 \text{ ft}}{88 \times 23 \text{ mph}} \Rightarrow 0.64 \text{ min}$$

Problem 7

Textbook: 7.6

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Step 1:

Empty weight (EVW)	Table 7-1	96,880 lb
Load volume:	0.90 × 31 cu yd = 27.9 lcy	
	swell factor cohesive = 0.76	
Load volume bank measure:	27.9 lcy × 0.76 × 1.1 = 23.3 bcy	
Weight of load:	23.3 bcy × 2,900 lb per bcy =	67,570 lb
	Gross weight (GVW)	164,450 lb

		Step 2	**Step 3**	**Step 4**	**Step 5**	**Step 6**
	Distance	RR	GR	TR	Speed	time
	ft	%	%	%	mph	min
Haul (164,450 lb	200 (acc.)	3	5	8	5	0.45
or 83.16 tons)	400	3	5	8	11	0.41
	1,800	3	-2	1	34	0.60
	200 (dec.)	3	-4	-1	5	0.45
Return (96,880 lb	200 (acc.)	3	4	7	5	0.45
or 48.44 tons)	1,800	3	2	5	26	0.79
	400	3	-5	-2	33	0.14
	200 (dec.)	3	-5	-2	5	0.45

Step 6: Travel time	3.74 min
Step 7: Load time	0.80 min
Step 8: Dump time	0.37 min
Step 9: Turn time fill	0.21 min
Turn time cut	0.30 min
Step 10: Total cycle time scraper	5.42 min

Step 11: $T_p = 1.4\ (0.80) + 0.25 \Rightarrow 1.37$ min

Step 12: $N = \dfrac{5.42 \text{ min}}{1.37 \text{ min}} \Rightarrow 3.96$ **Use 4 scrapers**

Step 13: 50 min per hr.

Step 14: Production

If 4 scrapers were used on the job production would be:

$$\text{Production pusher (controlling)} = \frac{50 \text{ min/hr}}{1.37 \text{ min}} \times 23.3 \text{ bcy} \Rightarrow \textbf{850 bcy/hr}$$