Question 1:
A 110kW 4WD tractor operates at a speed of 8.9 km/hr while pulling a field cultivator under firm soil. The draft of the field cultivator is 4.96 kN per meter of width when used in a given field. (3 points)

a) What maximum width of cultivator could be pulled?

Refer to this table:

<table>
<thead>
<tr>
<th>Tractor Type</th>
<th>Concrete</th>
<th>Firm Soil</th>
<th>Tilled Soil</th>
<th>Soft Soil</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-wheel drive</td>
<td>0.87</td>
<td>0.72</td>
<td>0.67</td>
<td>0.55</td>
</tr>
<tr>
<td>(1.15)</td>
<td>(1.39)</td>
<td>(1.49)</td>
<td>(1.82)</td>
<td></td>
</tr>
<tr>
<td>Front wheel assist</td>
<td>0.87</td>
<td>0.77</td>
<td>0.73</td>
<td>0.85</td>
</tr>
<tr>
<td>(1.15)</td>
<td>(1.30)</td>
<td>(1.37)</td>
<td>(1.54)</td>
<td></td>
</tr>
<tr>
<td>4-wheel drive</td>
<td>0.88</td>
<td>0.78</td>
<td>0.75</td>
<td>0.70</td>
</tr>
<tr>
<td>(1.14)</td>
<td>(1.28)</td>
<td>(1.33)</td>
<td>(1.43)</td>
<td></td>
</tr>
<tr>
<td>Track</td>
<td>0.88</td>
<td>0.79</td>
<td>0.80</td>
<td>0.78</td>
</tr>
<tr>
<td>(1.14)</td>
<td>(1.27)</td>
<td>(1.25)</td>
<td>(1.28)</td>
<td></td>
</tr>
</tbody>
</table>

\[ \text{Width} = \frac{\text{draft (kN) per meter}}{0.78 \times \text{110 kW} \times \frac{3.6 \text{ (kn)}}{8.9 \text{ (km/hr)}}} = \frac{4.96 \text{ (kN/m)}}{4.96 \text{ (kN/m)}} = 5.45 \text{ ~ 5.5 m} \]

b) If the tractor operates under same soil condition, and the draft was increase by 20 %, what is the new optimum tractor speed? State you assumptions, if necessary.

\[ 100 \% + 20\% = 1.2 \times \text{Dhp} \times \frac{3.6}{8.9} = 1.2 \times 0.67 \times 110 \times \frac{3.6}{8.9} = 23.97 \text{kN} \]
\[ \text{Speed} = 0.67 \times 0.67 \times 110 \times \frac{3.6}{23.96} = 7.42 \text{ km/hr} \]
Question 2:

A disk plow with three tandem disks on the 150 cm wide frame was used to plow the soil as a part of crop land preparation. The recorded ambient temperature at the beginning of the operation was at 27°C then raised to 35°C, with fan and radiator is on the service to operate the intermittent loads. If each disk contributed about 20 Hp during full load of the acting force from the soil;

a) If PTO power is 14% less than Indicated power, and Drawbar power is 86 % of the PTO power, calculate the tractor size requirement to be able to perform such tillage operation by using a safety factor of 10% of the calculated engine power?. (3 marks)

State the formula: \( D_{hp} = 0.86 \times PTO; \) \( PTO = 0.86 \times E_{hp} \)

Total \( D_{hp} = 20 \text{ Hp} \times 3 \text{ disk} = 60 \text{ Hp or 45 kW} \) (1 mark)

Thus, \( E_{hp} = 20 \text{ Hp} \times 3 \text{ disk} / (0.86 \times 0.86) = 81.12 \text{ Hp or 60.84 kW} \)

Use 10% safety factor, \( 1.10 \times 81.12 \text{ Hp} = 89.23 \text{ Hp or 66.92 kW} \)

Thus the most suitable tractor size to operate the disk plow with 3 disks is 90Hp tractor. (bonus = 0.5 mark)

b) If the draft force created from the implement was at 28.8 kN/m, calculate the optimum tractors speed.

\[
150 \text{ cm} = 1.5 \text{ m wide} \\
F = 28.8 \text{ kN/m} \times 1.50 \text{ m} = 43.2 \text{ kN or 43200 N} \text{ (1 mark)}
\]

Convert 60 Hp = 45 kW, 1 Hp = 0.75 kW

Draft (kN) = \( (D_{hp} \text{ (kW)} \times 3.6) / (V \text{ (km/hr)}) \)

\[
V \text{ (km/hr)} = (D_{hp} \text{ (kW)} \times 3.6) / (\text{Draft (kN)}) = 45kW \times 3.6 / 43.2kN = 3.75 \text{km/hr}
\]

C) Using calculated value of the tractor engine power in question 2(a), calculate the most current usable engine power by taking into consideration of the power loses. (2 marks)

Loss due to Temp at 35°C = 0.01 x (35-29/2.7) = 0.0222

Loss due to fan and radiator = 0.05 (5%)

Loss due to intermittent load = 0.1 (10%)

TOTAL losses = 0.1722 (17.22%) (2 marks)

Actual usable engine power = 89.23 Hp * (1-0.1722) = 73.86 Hp or 55.40 kW. Reduction power of 17%, OR

Actual usable engine power = 90 Hp * (1-0.1722) = 74.502 Hp or 55.88 kW. Reduction power of 17%,