Kaushik Chakram
Professor Julia Kamenetzky
phys 425 &01
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```
$Assumptions = {x, t, m, ω, ℏ, p, a, n, c0} ∈ Reals
```

$(x \mid t \mid m \mid \omega \mid \hbar \mid p \mid a \mid n \mid c_0) \in \text{Reals}$

Problem 1) 4.3)

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(* Just checking some of the derivatives/Integrals that we needed in this problem.*)
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```
D[(x^2 - 1)^2, {x, 2}] (*Matches*)
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$8x^2 + 4(-1 + x^2)$

```
Simplify[(8 x^2 + 4 (-1 + x^2)) * (1/2^3)]
```

$\frac{1}{2}(-1 + 3x^2)$

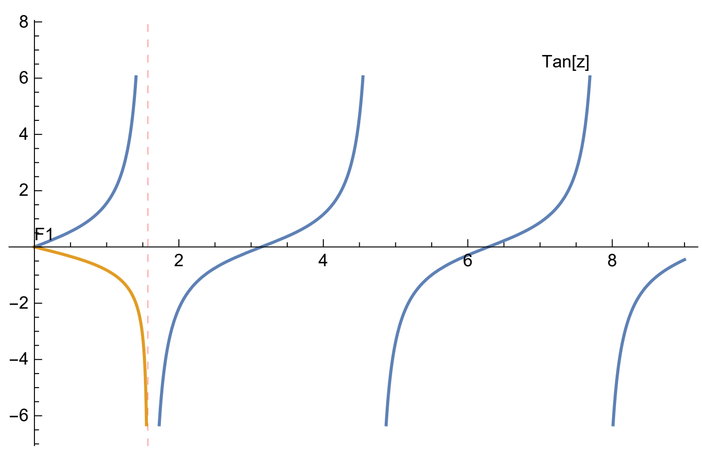
```
Integrate[Sin[ϕ]^3 * Cos[ϕ]^2, {ϕ, 0, π}] (*matches*)
```

$\frac{4}{15}$

Problem 3) 4.9)

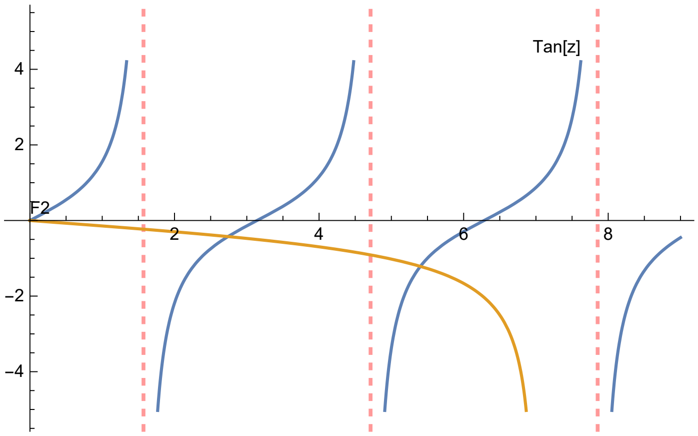
```
F1 := -1 / Sqrt[(((π/2)/z)^2 - 1)]
```

```
Plot[{Tan[z], F1}, {z, 0, 9}, PlotLabels → Placed[{"Tan[z]", "F1"}, Above],
 GridLines → {{{π/2, {Red, Dashed}}}, None}]
```



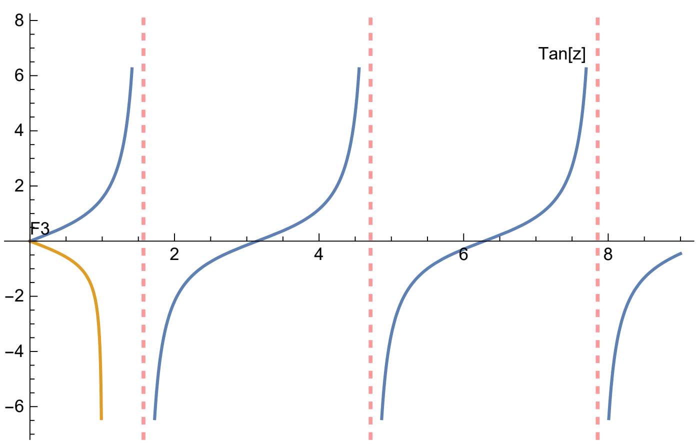
$$\text{F2} := \frac{-1}{\sqrt{\left(\left(\frac{Z}{z}\right)^{2} - 1\right)}}$$

```
Plot[{Tan[z], F2}, {z, 0, 9}, PlotLabels → Placed[{"Tan[z]", "F2"}, Above],
 GridLines → {{{π/2, {Thick, Red, Dashed}},
    {3*π/2, {Thick, Red, Dashed}}, {5*π/2, {Thick, Red, Dashed}}}, None}]
```



$$\text{F3} := \frac{-1}{\sqrt{\left(\left(\frac{1}{z}\right)^{2} - 1\right)}}$$

```
(* π/2 is aprrox 1.57 when z₀ <
  π/2 say 1. Then we will have no intersections. Because when z =
 π/2 we have an asymptote for Tan[z] and so does F3[z].*)
Plot[{Tan[z], F3}, {z, 0, 9}, PlotLabels → Placed[{"Tan[z]", "F3"}, Above],
 GridLines → {{{π/2, {Thick, Red, Dashed}}, {3*π/2, {Thick, Red, Dashed}},
    {5*π/2, {Thick, Red, Dashed}}}, None}] (* Clearly there are no intersections.*)
```



5)Problem 4.11)part a) We can the check the normalization constant value c_0 that we got for this problem based on the value for n and l.

```
R20[r_] := (c0/(2*a)) * (1 - (r/(2*a))) e^(-r/(2*a))
Assuming[a > 0, Solve[Integrate[r^2 * Abs[R20[r]]^2, {r, 0, ∞}] == 1, c0]] (*We have to
 take the positive root and the answer matches with the one computed manually.*)
```

$$\left\{\left\{c_0 \to -\frac{\sqrt{2}}{\sqrt{a}}\right\}, \left\{c_0 \to \frac{\sqrt{2}}{\sqrt{a}}\right\}\right\}$$

```
R21[r_] := (c0/(4*a^2)) * (r) * (e^(-r/(2*a)))
Assuming[a > 0, Solve[Integrate[r^2 * Abs[R21[r]]^2, {r, 0, ∞}] == 1, c0]]
(* Again we have to take the positive root
 and the answer matches with the one computed manually.*)
```

$$\left\{\left\{c_0 \to -\frac{\sqrt{\frac{2}{3}}}{\sqrt{a}}\right\}, \left\{c_0 \to \frac{\sqrt{\frac{2}{3}}}{\sqrt{a}}\right\}\right\}$$