1. Integration Review

$\int f(x)dx$, the indefinite integral of f(x) is a function F(x) such that F'(x)=f(x).
F(x) is called an anti-derivative of f(x)
Some basic integrals:
$\int x^n dx =$
$\int \frac{1}{x} dx =$
$\int e^x dx =$
$\int cos(x)dx =$
$\int sec^2(x)dx =$
$\int \frac{1}{1+x^2} dx =$
You can verify your answers by differentiating your answer to see if you get back to the original question. $\frac{d}{dx}(sin(x) + C) = (sin(x) + C)' = cos(x)$

The Fundamental Theorem of Calculus asserts $\int f(x)dx = F(x)|_a^b = F(b) - F(a)$ where F(x) is an antiderivative of f(x).
Example. $\int_0^1 x^2 - xdx = \frac{x^3}{3} - \frac{x^2}{2}|_0^1 = (\frac{1}{3} - \frac{1}{2}) - (0 - 0) = \frac{-1}{6}$

2. Techniques of integration

Substitution:
$I = \int x^2 sin(x^3)dx$
Let $u = x^3$ then $du = 3x^2 dx$
I=$\int \frac{1}{3} sin(u)du = \frac{-1}{3} cos(u) + C = \frac{-1}{3} cos(x^3) + C$

Integration by Parts:
$\int udv = uv - \int vdu$
I=$\int xe^x dx$
Let $u = x$ and $dv = e^x dx$ then
$du = dx$ and $v = e^x$ then
$I = xe^x - \int e^x dx = xe^x - e^x + C$

Trig Identities:
$\int cos^2(x)dx = \int \frac{1}{2}(1 + cos(2x))dx = \frac{x}{2} + \frac{sin(2x)}{4} + C$

Partial Fractions:
I=$\int \frac{1}{x(x-1)}dx$
$\frac{1}{x(x-1)} = \frac{A}{x} + \frac{B}{x-1}$
1=A(x-1)+Bx=(A+B)x-A
(A+B)=0, A=-1, therefore B=1.
or
let x=0 then A=-1, let x=1 then B=1.
I=$\int \frac{-1}{x} + \frac{1}{x-1}dx = -ln|x| + ln|x-1| + C$

Trig Substitution:
$I = \int \frac{1}{\sqrt{1-x^2}}dx$
let x=sin(u) then dx=cos(u)du
I=$\int \frac{cos(u)}{\sqrt{1-sin^2(u)}}du = \int \frac{cos(u)}{cos(u)}du = u + C = sin^{-1}x + C$ or $arcsin(x) + C$