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# Problem5:

The **Riemann zeta function** or **Euler-Riemann zeta function**, denoted by the Greek letter $\zeta $ (zeta), is a mathematical function of a complex variable$s=\sigma +it$ defined as
$$
\zeta(s)=\sum_{n=1}^{\infty } \frac{1}{n^s}=\frac{1}{1^s}+\frac{1}{2^s}+\frac{1}{3^s}+\cdots
$$
for $Re(s) > 1$ and its analytic continuation elsewhere. When $Re(s)=\sigma > 1$, the function can bewritten as a converging summation or integral:
$$
\zeta(s)=\sum_{n=1}^{\infty } \frac{1}{n^s}=\frac{1}{\Gamma (s)}\int_{0}^{\infty }  \frac{x^{s-1}}{e^x-1}dx
$$
where
$$
{\Gamma (s)}=\int_{0}^{\infty }x^{s-1}e^{-x}dx
$$
is the gamma function.
In 1737, the connection between the zeta function and prime numbers was discovered by Euler, who proved the identity
$$
\sum_{n=1}^{\infty}\frac{1}{n^s}=\prod_{p \text { prime }} \frac{1}{1-p^{-s}}
$$
where, by definition, the left hand side is $\zeta(s)$ and the infinite product on the right hand side extends over all prime numbers $p$ (such expressions are called Euler products):
$$
\prod_{p \text { prime }} \frac{1}{1-p^{-s}}=\frac{1}{1-2^{-s}} \cdot \frac{1}{1-3^{-s}} \cdot \frac{1}{1-5^{-s}} \cdot \frac{1}{1-7^{-s}} \cdot \frac{1}{1-11^{-s}} \cdots \frac{1}{1-p^{-s}} \cdots
$$
Both sides of the Euler product formula converge for $Re(s) > 1$.
```

# Problem5:

The **Riemann zeta function** or **Euler-Riemann zeta function**, denoted by the Greek letter $\zeta $ (zeta), is a mathematical function of a complex variable$s=\sigma +it$ defined as

$$\zeta(s) = \sum n = 1^\infty \frac{1}{n^s} = \frac{1}{1^s} + \frac{1}{2^s} + \frac{1}{3^s} + \cdots$$

*for $Re(s) > 1$ and its analytic continuation elsewhere. When $Re(s)=\sigma > 1$, the function can bewritten as a converging summation or integral:*

$\zeta(s) = \sum$ {n=1}^{\infty } \frac{1}{n^s}=\frac{1}{\Gamma (s)}\int*{0}^{\infty } \frac{x^{s-1}}{e^x-1}dx*

*where*

$\Gamma(s) = \int$ {0}^{\infty }x^{s-1}e^{-x}dx

is the gamma function.
In 1737, the connection between the zeta function and prime numbers was discovered by Euler, who proved the identity

$$\sum n = 1^\infty \frac{1}{n^s} = \prod p \text{ prime } \frac{1}{1-p^{-s}}$$

where, by definition, the left hand side is $\zeta(s)$ and the infinite product on the right hand side extends over all prime numbers $p$ (such expressions are called Euler products):

$$\prod_p \text{prime } \frac{1}{1-p^{-s}} = \frac{1}{1-2^{-s}} \cdot \frac{1}{1-3^{-s}} \cdot \frac{1}{1-5^{-s}} \cdot \frac{1}{1-7^{-s}} \cdot \frac{1}{1-11^{-s}} \cdots \frac{1}{1-p^{-s}} \cdots$$

Both sides of the Euler product formula converge for $Re(s) > 1$.