Facoltà di Ingegneria Civile e Industriale
Ambiente e Territorio, Sicurezza

Scienza delle Costruzioni

Paolo Casini

Dipartimento di Ingegneria Strutturale e Geotecnica
Università di Roma *La Sapienza*

E-mail: p.casini@uniroma1.it
pagina web: www.pcasini.it/disg/sdc

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SAPIENZA
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Lezione

Parte IV - Il Problema di Saint Venant

- Obiettivi, Generalità
- 1. Forza normale centrata
- 2. Flessione retta (flessione uniforme retta)
- **3a. Flessione deviata (flessione uniforme deviata)**
- 3b. Tensoflessione
- 3c. Forza normale eccentrica
- 4. Flessione e taglio (flessione non uniforme)
- 5. Torsione uniforme

Lezione

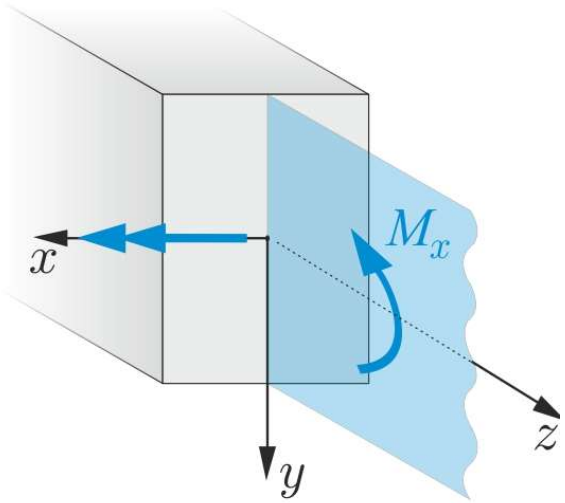
3. Sollecitazioni composte

- **Flessione deviata**
- Tensoflessione (pressoflessione) deviata
- Forza normale eccentrica
- Esercizi (sito: E16, testo: §19.5-19.7)

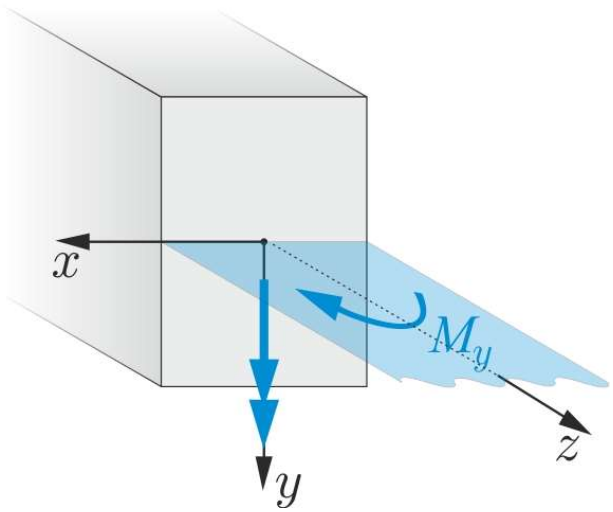
3a. Flessione deviata M

Richiami: flessione retta

Flessione retta M_x



Flessione retta M_y



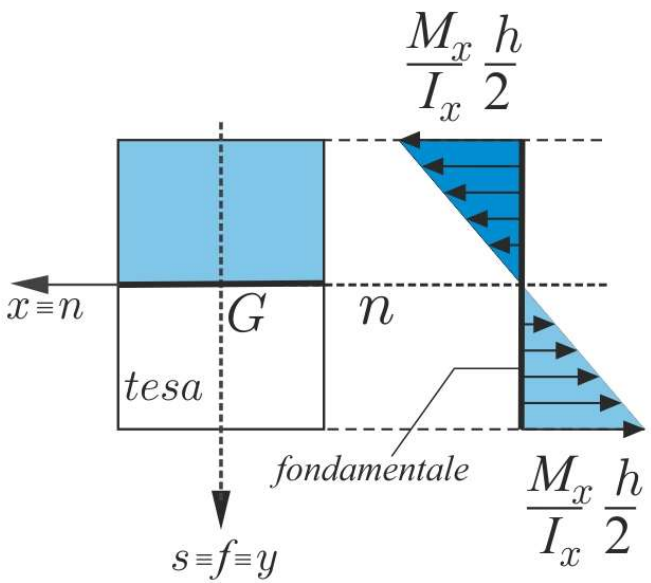
3a. Flessione deviata M

Richiami: stato tensionale flessione retta

Flessione retta M_x

$$\sigma_z = \frac{M_x}{I_x} y$$

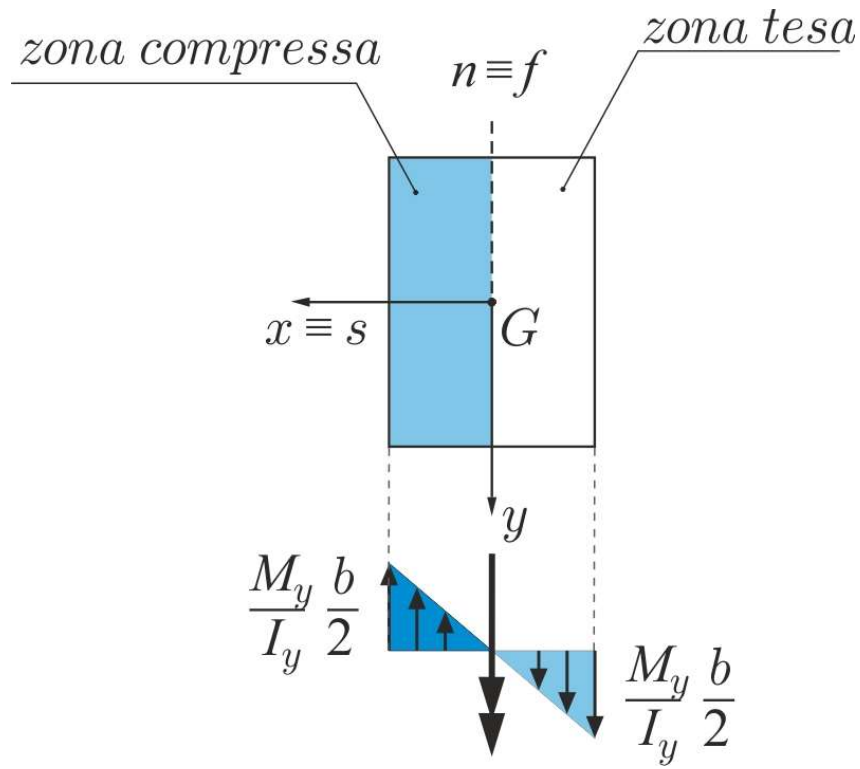
Asse neutro: $y = 0$



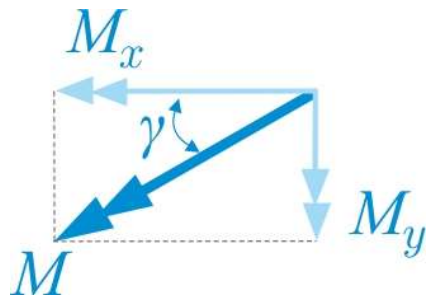
Flessione retta M_y

$$\sigma_z = -\frac{M_y}{I_y} x$$

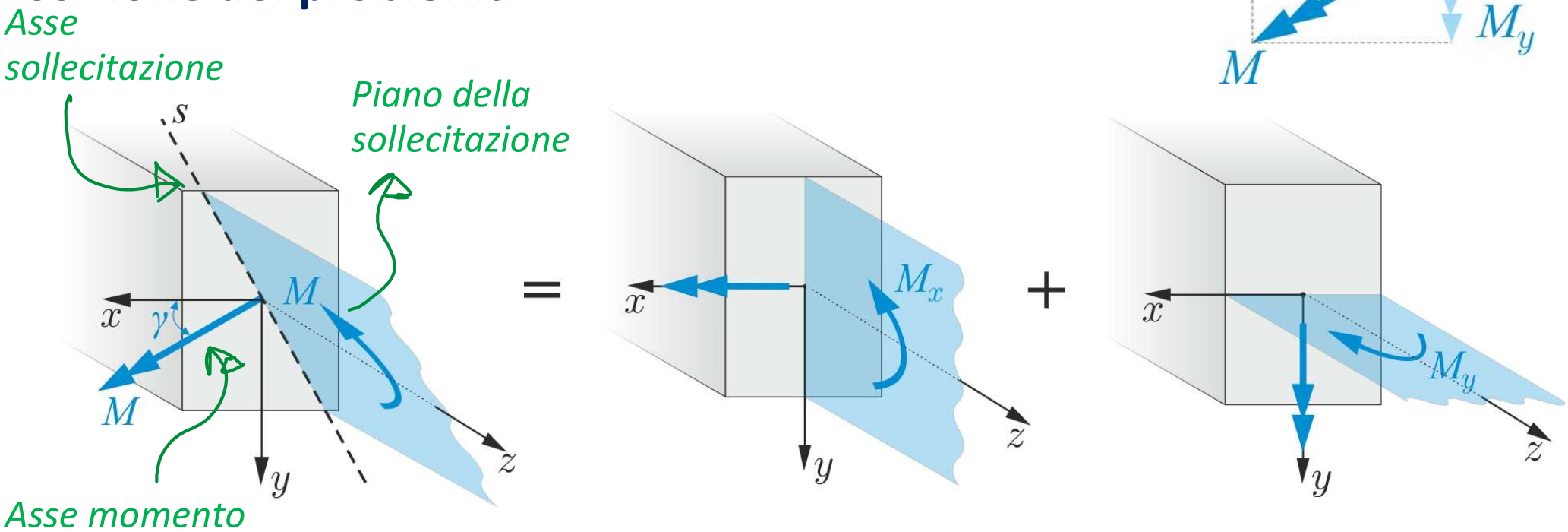
Asse neutro: $x = 0$



3a. Flessione deviata



Posizione del problema



$$M \qquad M_x = M\cos\gamma \qquad M_y = M\sin\gamma$$

Sovrapposizione degli effetti

$$\sigma_z = \sigma_z^{(M_x)} + \sigma_z^{(M_y)}$$

3a. Flessione deviata

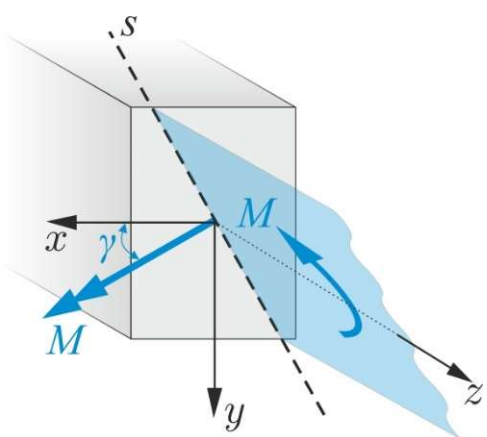
Soluzione in forma chiusa (tensioni)

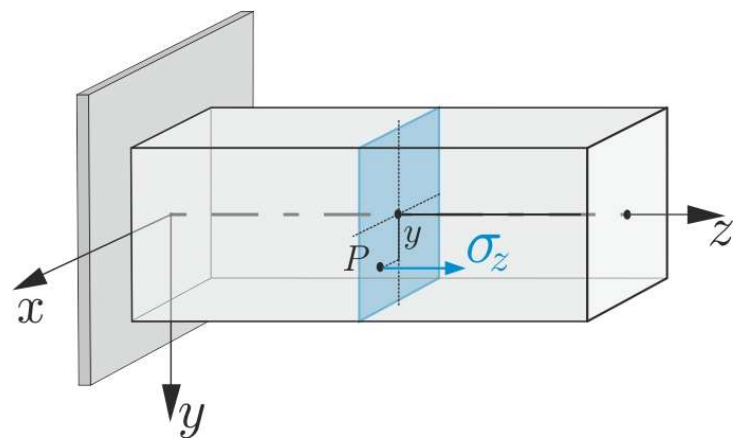
$$\sigma_z = \sigma_z^{(M_x)} + \sigma_z^{(M_y)}$$

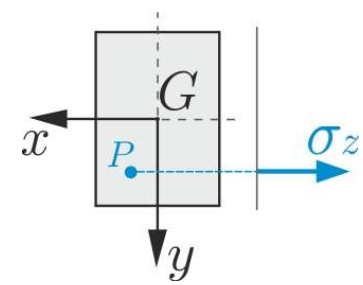
Formula di Navier

$$\boxed{\sigma_z = \frac{M_x}{I_x} y - \frac{M_y}{I_y} x}$$

$$\sigma_z = \frac{M \cos\gamma}{I_x} y - \frac{M \sin\gamma}{I_y} x$$







3a. Flessione deviata

Stato tensionale

Formula di Navier

$$\sigma_z = \frac{M_x}{I_x} y - \frac{M_y}{I_y} x$$

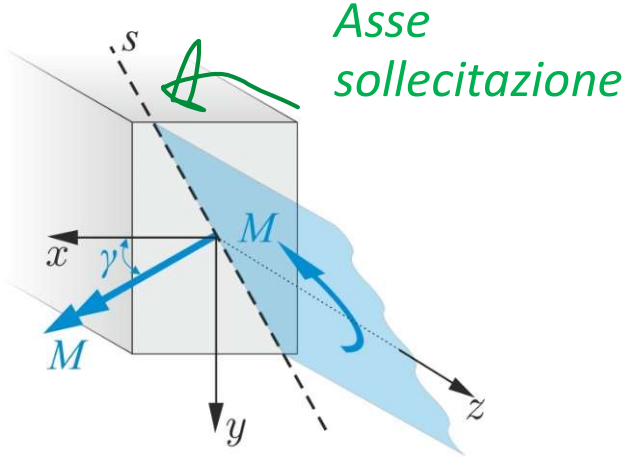
Asse neutro

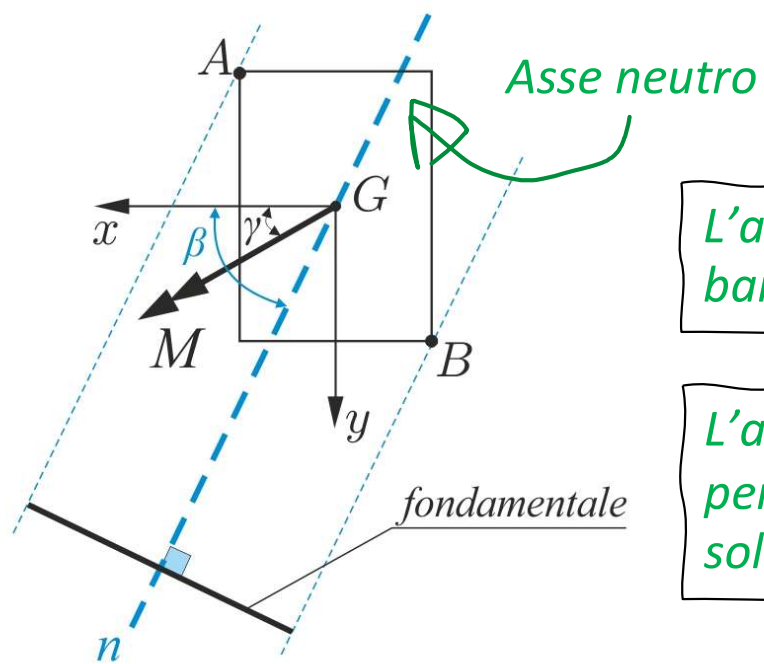
$$\sigma_z = 0 \quad \Rightarrow \quad y = \frac{M_y}{M_x}\frac{I_x}{I_y} x = \tan\gamma \frac{I_x}{I_y} x$$

tan β

$$\boxed{y = \tan\beta\, x}$$

$$\tan\beta = \frac{M_y}{M_x}\frac{I_x}{I_y} = \tan\gamma \frac{I_x}{I_y} \qquad \beta \neq \gamma$$





L'asse neutro passa per il baricentro

L'asse neutro NON è perpendicolare all'asse di sollecitazione ($\beta \neq \gamma$)

3a. Flessione deviata

Stato tensionale: rappresentazione grafica

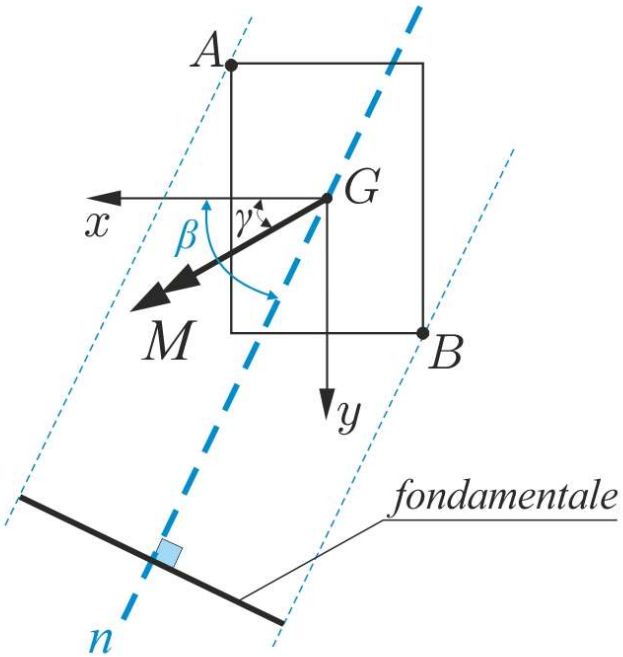
$$\tan\beta = \tan\gamma\,\frac{I_x}{I_y}$$

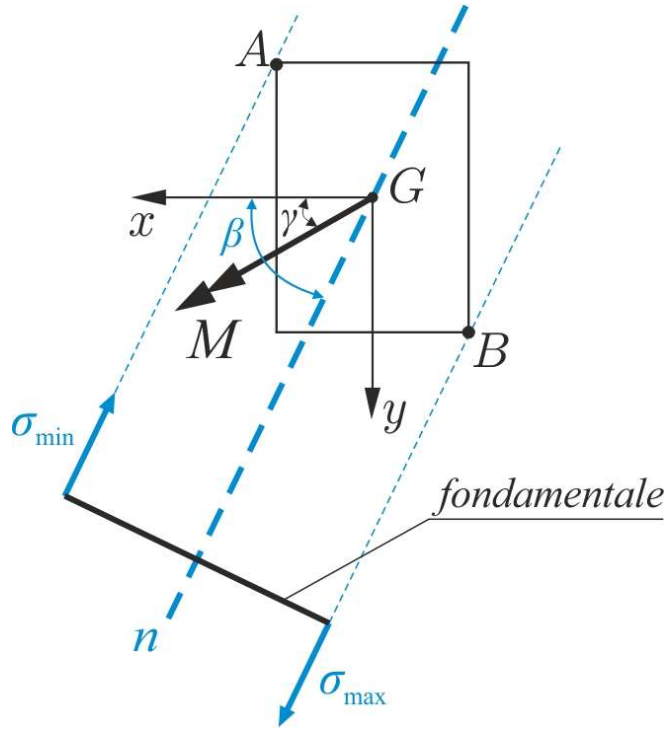
Formula di Navier

$$\boxed{\sigma_z = \frac{M\cos\gamma}{I_x}y - \frac{M\sin\gamma}{I_y}x}$$

Asse neutro

$$\sigma_z = 0 \quad \Rightarrow \quad \boxed{y = \tan\beta\, x}$$





$$A \equiv \left(\frac{b}{2}, -\frac{h}{2}\right) \quad B \equiv \left(-\frac{b}{2}, \frac{h}{2}\right)$$

$$\sigma_A = \sigma_{min} < 0$$
$$\sigma_B = \sigma_{max} > 0$$

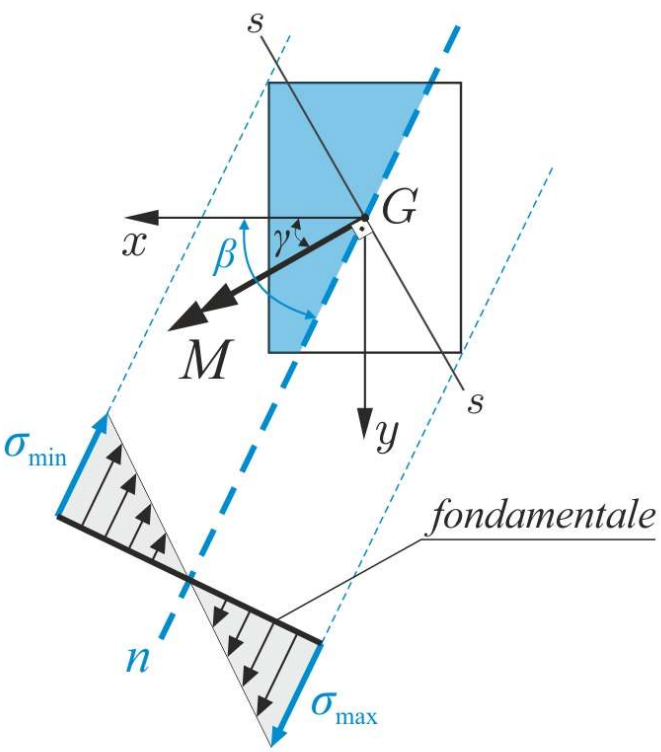
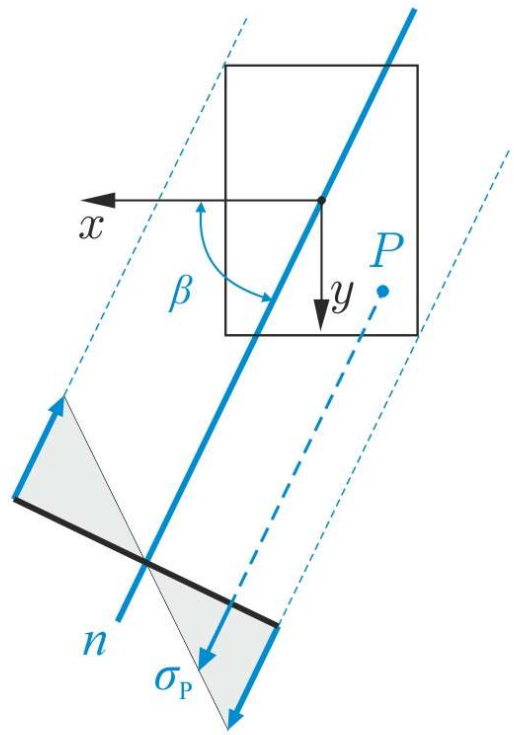
3a. Flessione deviata

Stato tensionale

Formula di Navier

$$\boxed{\sigma_z = \frac{M\cos\gamma}{I_x}y - \frac{M\sin\gamma}{I_y}x}$$

Asse neutro

$$\tan\beta = \tan\gamma\,\frac{I_x}{I_y}$$

$$\sigma_z = 0 \quad \Rightarrow \quad \boxed{y = \tan\beta\, x}$$