INDUCTION MOTOR-I (ASYNCHRONOUS MOTOR)

UNIT-III

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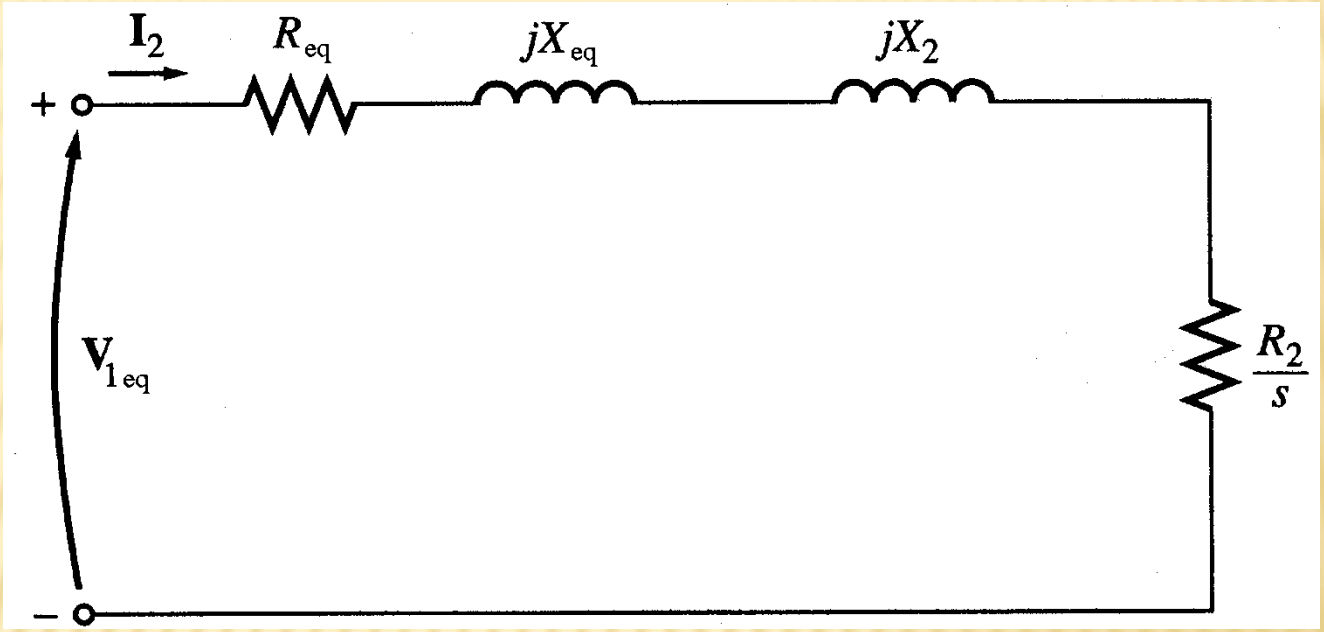
CONTENTS

Torque- slip characteristics

Lecture No. 6

TORQUE, POWER AND THEVENIN'S THEOREM



$$V_{1eq} = V_1 \frac{jX_M}{R_1 + j(X_1 + X_M)}$$

$$R_{eq} + jX_{eq} = (R_1 + jX_1) // jX_M$$

TORQUE, POWER AND THEVENIN'S THEOREM

$$I_2 = \frac{V_{1eq}}{Z_T} = \frac{V_{1eq}}{\sqrt{\left(R_{eq} + \frac{R_2}{s}\right)^2 + (X_{eq} + X_2)^2}}$$

Then the power converted to mechanical (P_{conv})

$$P_{conv} = I_2^2 \frac{R_2(1-s)}{s}$$

And the internal mechanical torque (T_{conv})

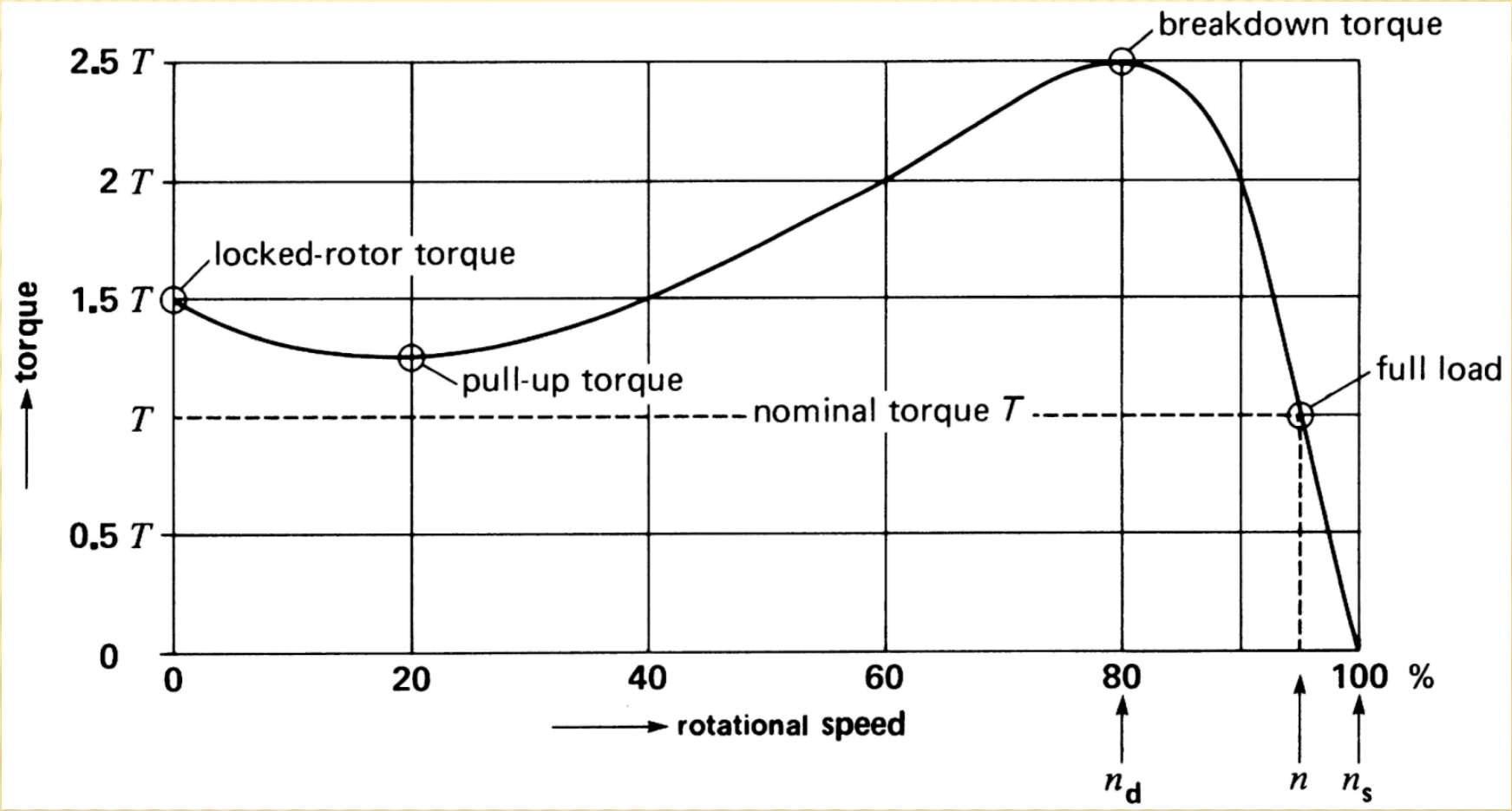
$$T_{conv} = \frac{P_{conv}}{\omega_m} = \frac{P_{conv}}{(1-s)\omega_s} = \frac{I_2^2 \frac{R_2}{s}}{\omega_s}$$

TORQUE, POWER AND THEVENIN'S THEOREM

$$T_{conv} = \frac{1}{\omega_s}\left(\frac{V_{1eq}}{\sqrt{\left(R_{eq}+\frac{R_2}{s}\right)^2+(X_{eq}+X_2)^2}}\right)^2\left(\frac{R_2}{s}\right)$$

$$T_{conv} \equiv \frac{1}{\omega_s}\frac{V_{1eq}^2\left(\frac{R_2}{s}\right)}{\left(R_{eq}+\frac{R_2}{s}\right)^2+(X_{eq}+X_2)^2}$$

TORQUE-SPEED CHARACTERISTICS



Typical torque-speed characteristics of induction motor

MAXIMUM TORQUE

- Maximum torque occurs when the power transferred to R_2/s is maximum.
- This condition occurs when R_2/s equals the magnitude of the impedance $R_{eq} + j\,(X_{eq} + X_2)$

$$\frac{R_2}{s_{T_{\max}}} = \sqrt{R_{eq}^2 + (X_{eq} + X_2)^2}$$

$$s_{T_{\max}} = \frac{R_2}{\sqrt{R_{eq}^2 + (X_{eq} + X_2)^2}}$$

MAXIMUM TORQUE

The corresponding maximum torque of an induction motor equals

$$T_{max} = \frac{1}{2\omega_s}\left(\frac{V_{eq}^2}{R_{eq} + \sqrt{R_{eq}^2 + (X_{eq} + X_2)^2}}\right)$$

The slip at maximum torque is directly proportional to the rotor resistance R_2

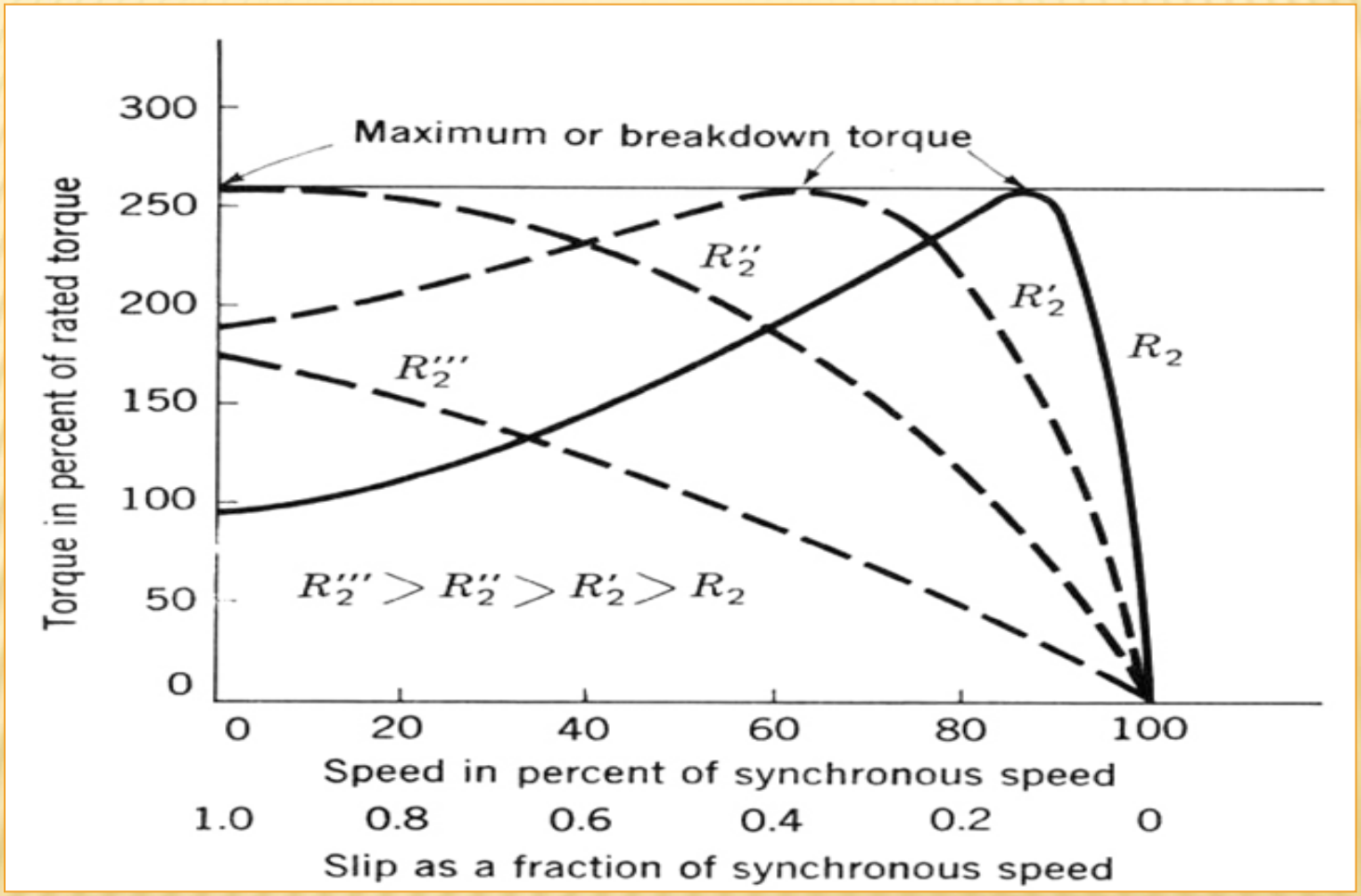
The maximum torque is independent of R_2

MAXIMUM TORQUE

- Rotor resistance can be increased by inserting external resistance in the rotor of a wound-rotor induction motor.

- The value of the maximum torque remains unaffected but the speed at which it occurs can be controlled.

MAXIMUM TORQUE



Effect of rotor resistance on torque-speed characteristic